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Memory performance following bilingual translation: lexical and conceptual determinants of cross-language transfer.

Alexandra Sholl
University of Massachusetts Amherst

MEMORY PERFORMANCE FOLLOWING BILINGUAL TRANSLATION: LEXICAL AND CONCEPTUAL DETERMINANTS OF CROSS-LANGUAGE TRANSFER

A Thesis Presented

by

ALEXANDRA SHOLL

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Approved as to style and content by:

Keith Rayner, Chair

Judith F. Kroll, Member

Nancy A. Myers, Member

Charles E. Clifton, Jr., Department Chair
Department of Psychology

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ABSTRACT

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ALEXANDRA SHOLL, B.A., POMONA COLLEGE

M.S., UNIVERSITY OF MASSACHUSETTS

Directed by: Professor Keith Rayner

Cross-language repetition priming tasks have been used to evaluate models of bilingual memory representation. The locus of the repetition priming effect, however, has not been firmly established in the literature. Previous studies tested for cross-language priming under conditions that restricted access to both lexical and conceptual information. The current experiment compared facilitation in naming and lexical decision latencies following bilingual translation. If repetition priming requires a match in the level of processing for both the prime and the target, and if cross-language repetition priming is a reflection of a shared level of conceptual representation, then cross-language repetition priming will be observed only when both the prime and the target are processed at the conceptual level. If, however, cross-language repetition priming is a lexical-level effect, then processing of a given target will only be facilitated when its lexical representation has been activated during the study task. The results of this experiment indicate that, while cross-language repetition priming can take place when both lexical representations have been activated, conceptual-level processing significantly increases the magnitude of priming for translation equivalents. A model of cross-language repetition priming is proposed to account for this observation.

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CHAPTER I

INTRODUCTION

A. Early Models of Bilingual Memory Representation

1. Dual-code versus common-code models

Like the picture representation literature, research concerning bilingual memory representation systems has long been focused on the "dual code vs. common code" debate. Depictions of these two types of models are presented in Figure 1.1 and Figure 1.2 on pages 2-3. Proponents of the dual code theory of memory representation (e.g., Paivio, 1986) propose that a separate representational system exists in memory for each language that an individual knows, and that these representational systems are interconnected through access to images that are shared across languages for the objects corresponding to concrete words. Supporters of the common code theory (e.g., Potter, So, von Eckardt, & Feldman, 1984) suggest that, while lexical level representations of a bilingual's two languages are independent, both languages share a common conceptual level of representation. This shared conceptual store is amodal, in contrast to the imaginal system depicted in the dual code model.

2. Evidence for Dual-Code and Common-Code Models

Repetition priming tasks, in which processing of a given word facilitates later processing of the identical word or its translation, rarely produce priming across languages (Kirsner, Brown, Abrol, Chadha, & Sharma, 1980; Kirsner, Smith, Lockhart, King, & Jain, 1984; Scarborough, Gerard, & Cortese, 1984). These findings have been taken as evidence for separate lexical representations for the bilingual's two languages because

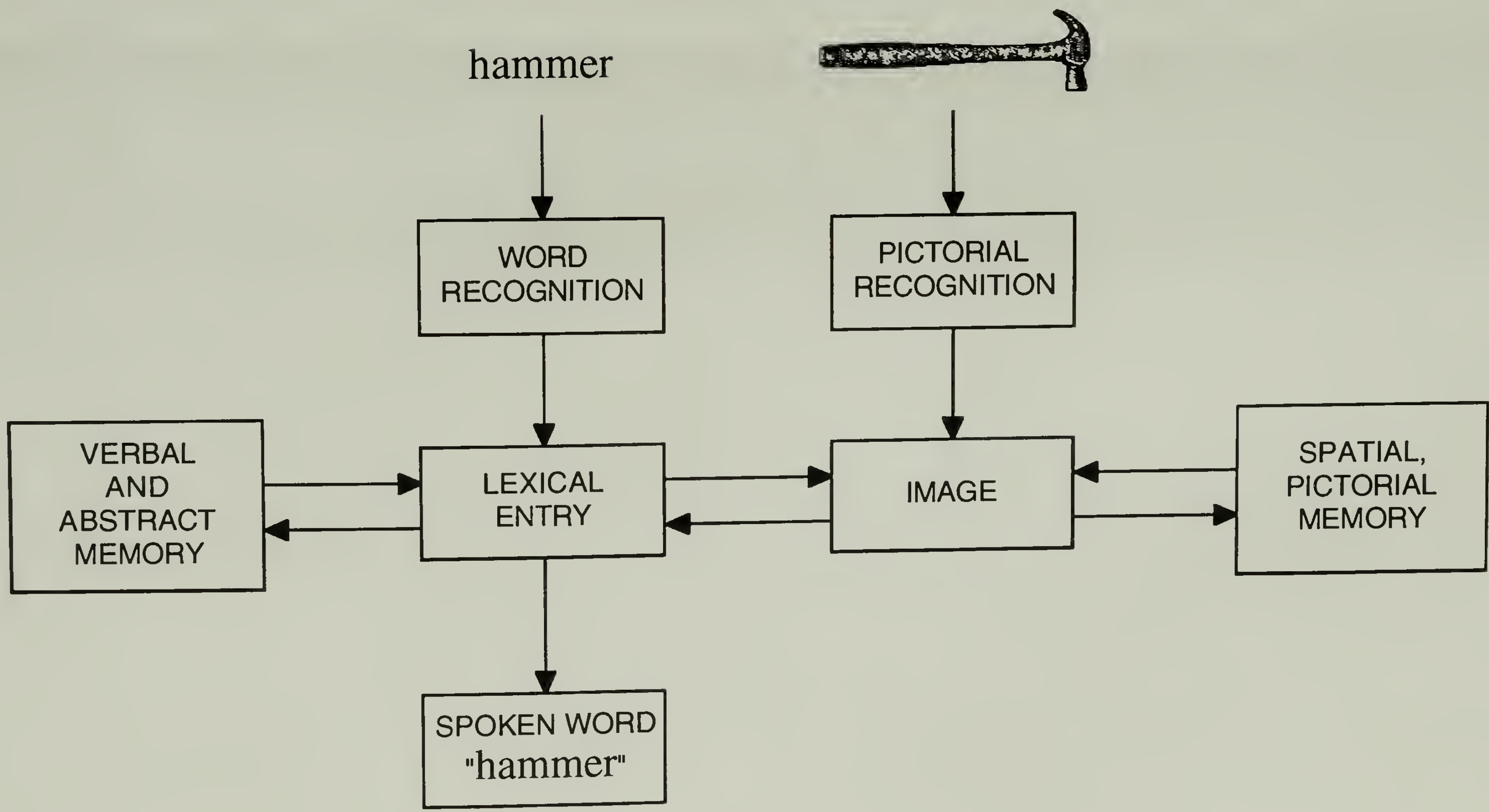

Figure 1.1: Dual-code model of picture and word representation (adapted from Potter, 1979)

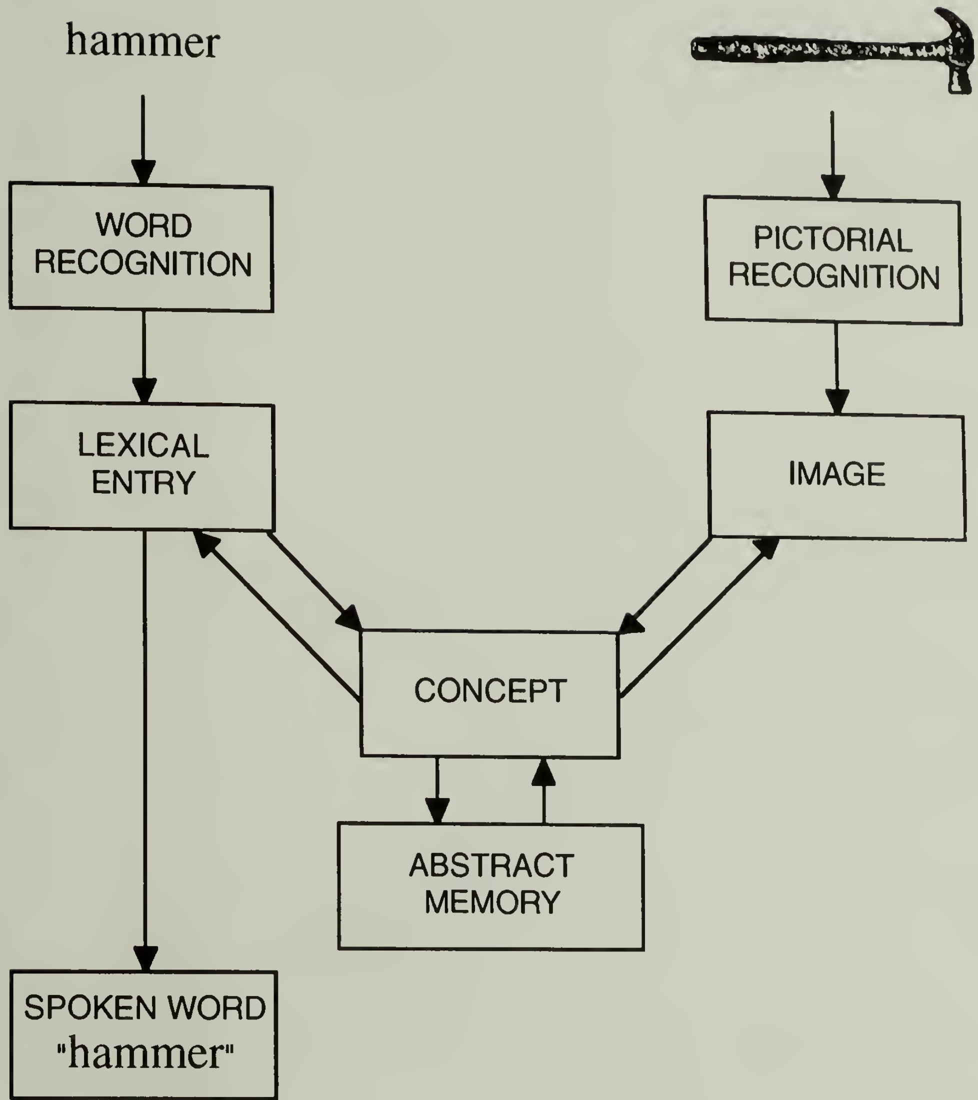

Figure 1.2: Common-code model of picture and word representation (adapted from Potter, 1979).

activation of a lexical entry in one language does not necessarily produce activation of its translation equivalent in the other language.

Other lexical-level effects provide converging evidence for separate lexicons in the bilingual's memory. Scarborough et al. (1984) had Spanish/English bilinguals perform a lexical decision task in which they were instructed to respond positively to words from one language, and to treat words from another language as nonwords. Actual nonwords were presented along with words from the non-target language. Rejection latencies for words from the non-target language did not differ significantly from rejection latencies for nonwords. This result indicates that bilinguals can selectively access the lexicon for the first language without accessing lexical representations in the second language. In another study, Gerard and Scarborough (1989) presented bilingual subjects with homographic noncognates, or words that are spelled identically across languages but do not share the same meaning, in a lexical decision task. The homographic noncognates were English and Spanish words that varied in frequency of usage across languages. For example, the word "fin" in English refers to a part of a fish and is not encountered frequently in the language, whereas "fin" in Spanish means "end"and is a frequently-used word. An analysis of subjects' decision latencies indicated an interaction of word frequency and language for homographic noncognates; that is, when the target language was English, subjects were slow in responding to homographic noncognates like "fin" (a low-frequency English word). When the target language was Spanish, however, decision latencies for "fin" (a high-frequency Spanish word) were significantly faster. Frequency effects have been hypothesized to occur at the lexical level; therefore, Gerard et al.'s (1989) results support the independent-lexicons hypothesis.

When tested with tasks that require access at the conceptual level of representation, however, bilinguals appear to have a single, language-independent memory system. For example, semantic priming, in which the processing of a prime word facilitates the later processing of a semantically-related target word, requires access at the conceptual level of representation. Experiments in which a prime word is presented in one language and is followed by a semantically-related target word in another language have produced cross-language priming; these results suggest a shared conceptual representation across languages (Meyer & Ruddy, 1974; Schwanenflugel & Rey, 1986; Frenck & Pynte, 1987; Chen & Ng, 1989; Altarriba, 1990; Keatley, Spinks, & de Gelder, 1990). Other semantic-level tasks, such as semantic verification (Caramazza & Brones, 1980), Stroop interference (Magiste, 1984; La Heij, de Bruyn, Elens, Hartsuiker, Helaha, & van Schelven, 1990; Mazibuko, 1990), and cross-language sentence processing (Altarriba, Kroll, Sholl, & Rayner, 1993) have also provided support for a common code theory of bilingual memory representation.

3. Criticisms of Previous Priming Research

Most experiments that used repetition priming as a means of mapping out bilingual memory representation reached the conclusion that languages are represented in independent memory systems. Cross-language semantic priming experiments provide data that support the proposal of a common representational system for a bilingual's two languages. These findings seem to contradict each other; how can this conflict be resolved? The results from both the repetition priming and the semantic priming literature can be reconciled if the levels of processing engaged by these two priming tasks are taken into account. Previous cross-language repetition priming experiments

used tasks that did not encourage conceptual-level processing. The failure to obtain cross-language repetition priming in experiments that do not require subjects to access conceptual representations of lexical items only allows researchers to reject the hypothesis that both languages share a common lexical representation. When the experimental task is conceptually-driven, as in the case of bilingual semantic priming, the results tend to support the common-code theory. Thus, semantic priming and repetition priming explore representational architecture at two distinct levels. Since support for the dual-code and common-code models has been gathered using experimental paradigms that require either lexical-level processing or conceptual-level processing, but do not necessarily engage both levels of processing, the dualistic approach previously taken to the question of bilingual memory representation might not be appropriate.

B. Cross-language repetition priming

The use of the cross-language repetition priming task as an investigative tool to map out bilingual representation systems has drawbacks because the locus of the repetition priming effect has not been firmly established. Cross-language repetition priming could result from the activation of a single conceptual representation that is shared by a given word and its translation. This phenomenon could also occur when the lexical representations of a given word and its translation are activated.

Most previous attempts to find cross-language repetition priming have been unsuccessful; the results from these experiments provided support for the hypothesis that bilinguals have separate lexicons for their respective languages. Scarborough et al. (1984) had Spanish/English bilinguals perform a lexical decision task in either English or Spanish during the first part of the

experiment. Subjects did not know that in the second part of the experiment they would be asked to make lexical decisions for another set of words, some of which were translations of words presented in the first half of the experiment. No cross-language repetition priming was observed.

Kirsner, Brown, Abrol, Chadha, and Sharma (1980), using a between-subjects design with regard to language, had Hindi/English bilinguals perform a lexical decision task divided into two blocks. In the second block of lexical decision trials, half of the subjects saw the words presented in the first block, and half of the subjects saw the translations of the words presented in the first block. Subjects also saw new words and nonwords in the second half of the experiment. The experiment was designed so as to prevent subjects from translating during the training segment. Kirsner et al. (1980) did not observe any cross-language repetition priming effects.

Kirsner, Smith, Lockhart, King, and Jain (1984) performed a series of experiments that used cross-language repetition priming to investigate bilingual memory representation. In Experiment 1, highly-fluent French/English bilinguals made lexical decisions for two blocks of French and English words. The second block of letter strings contained repetitions and translations of words encountered in the first block of trials. No cross-language repetition priming occurred.

These experiments, however, all employed designs that did not encourage subjects to either access the conceptual level of representation or activate lexical representations for both languages. The experimental tasks were designed specifically to discourage subjects from translating the prime words. For example, Scarborough et al. (1984) had subjects perform a lexical decision task during the study phase of the experiment. In order to successfully perform this task, subjects did not necessarily have to translate

the words; thus, it is unlikely that both lexical representations of a given word were accessed during the first part of the experiment. Kirsner et al. (1980) actively discouraged their subjects from translating the primes, therefore it is unlikely that both lexical representations were activated. Consequently, if cross-language repetition priming is merely a reflection of orthographic facilitation, then such an experimental design would not produce cross-language repetition priming (unless the translation equivalents were orthographically similar, as in the case of cognates).

Experimental designs that have produced cross-language repetition priming effects have allowed subjects to process at the conceptual level and/or access both lexicons during the study phase of the experiment. Kirsner et al. (1984, Experiment 2) had English/French bilinguals perform a training session prior to completing a lexical decision task. During this training session, subjects saw English and French words, and were asked to report the first letter of each word's translation and the number of letters in that translation. Following the training session, subjects made lexical decisions for letter strings, some of which were translations of words presented during the training session. Under these conditions, decision latencies for translations presented in the lexical decision task were significantly faster than decision latencies for newly-presented words. Cross-language repetition priming was observed in both the English/French and the French/English conditions.

The source of this cross-language effect is not clear, however, because the training task involved both lexical and conceptual processing. It is difficult to determine whether the cross-language repetition priming resulted from activation of the two lexical representations during the training task, or whether activation of a shared conceptual representation during the

translation task facilitated later processing of the translation. In an attempt to discriminate between these two possible sources of cross-language facilitation, Smith (1991) had English/French bilinguals generate specific one-word inferences from short sentences. For example, a subject was supposed to infer the word "SHARK" when presented with the phrase,"FISH ATTACKED SWIMMER." Subjects always generated inferences in the language of the presented sentence. After completing the inference-generation task, subjects completed a word-fragment completion task. Subjects completed word fragments either in the same language as the inference-generation task, or in the opposite language. Half of the word fragments corresponded to words in the actual sentences presented during the first part of the experiment, and the other half of the word fragments corresponded to words that the subjects had generated as inferences. Smith (1991) found cross-language repetition priming, and explained her results in terms of how initial processing influences later test performance. Subjects were required to process at the conceptual level during the inference-generation task, and this initial conceptual-level processing might have allowed subjects to use semantic information in completing the word fragments. Thus, Smith (1991) claimed that the only criterion for cross-language repetition priming is activation at the conceptual level.

1. Evidence for separate lexical and conceptual levels of representation

Past comparisons between dual code models and common code models have not always clearly defined the level of representation being investigated; therefore, experimental tests between such models are often poorly specified. For example, Meyer and Ruddy (1974) depict the language representation system as a single level containing both semantic and lexical information.

Researchers who propose such models interpret the absence of cross-language facilitation effects as evidence for entirely separate representational systems; yet, the lack of cross-language transfer occurs only for tasks that do not require conceptual-level processing. The proposal that bilinguals have completely separate memory systems for their two languages, based on evidence from lexical-level tasks, is therefore an incorrect conclusion, because semantic processing is not adequately differentiated in these models.

Specification of the levels of bilingual memory representation is imperative to answering questions regarding the composition of those systems. Evidence from a variety of tasks in a single language support the assumption that lexical and conceptual representations are located in two distinct levels, or systems, in memory. For example, Besner, Smith, and MacLeod (1990) had subjects perform either a paired lexical decision task, which required subjects to process at the semantic level, or a letter-search task, which required subjects to process at the lexical level. Some of the stimulus pairs were categorically related (e.g., lion/tiger). Lexical decision latencies were faster for categorically related word pairs than for unrelated word pairs, but letter-search latencies were significantly longer for categorically related word pairs than for unrelated word pairs. The interaction between semantic relatedness and task showed that the two tasks involved two different levels of processing, suggesting that those levels were represented in distinct loci within the memory system.

Examining the time course of lexical and conceptual processing provides another source of evidence for the existence of two distinct levels of representation. Vitkovitch and Humphreys (1991) had subjects perform a picture naming task under deadline conditions. Pictures were presented one at a time in categorized blocks. Half of the pictures in a given category

corresponded to low-frequency words, and the remaining pictures corresponded to high-frequency words. Subjects had 600 ms to name each picture. Under these speeded conditions, subjects made significantly more semantic errors (e.g., naming another member of the category). Also, subjects made significantly more errors for pictures with low-frequency names than for pictures with high-frequency names. The deadline condition prevented the entire time course of picture naming from taking place, and the pattern of errors indicated that the process of picture naming is composed of distinct steps. Semantic activation occurs first, and then the phonological representation of the selected semantic representation is activated. Low-frequency words take longer to activate than high-frequency words, so the deadline condition prevented subjects from selecting the correct low-frequency names in time. Thus, these results, like the recent results of language production studies (e.g., Levelt, Schreifers, Vorberg, Meyer, Pechman, & Havinga, 1991) indicate that lexical and semantic representations are stored in separate locations in memory.

C. Models of Bilingual Memory Representation that Assume Distinct Lexical and Conceptual Levels of Representation

1. Hierarchical models of bilingual memory representation

Potter et al.'s (1984) hierarchical model of representation, proposed initially to account for differences between word and picture naming latencies, provides a more parsimonious explanation for the repetition priming and semantic priming results than does either the dual code model or the common code model. Many common-code models of bilingual memory representation did not distinguish between lexical and conceptual levels of representation; such models described bilingual memory systems as being completely integrated across languages (e.g., Meyer & Ruddy, 1974). This lack of distinction between levels made it difficult to account for the absence of cross-language facilitation at the lexical level. Therefore, the observation of language independence at the lexical level was misinterpreted as evidence for complete representational independence at all levels of representation. Potter et al.'s (1984) hierarchical model depicts two distinct levels of representation (i.e., a lexical level and a conceptual level) that are linked such that the lexical representations for a bilingual's two languages are independent, whereas the conceptual representations for the two languages are shared. This hierarchical model of memory representation has been used to describe how different surface modalities (e.g., words, pictures, second-language words, etc.) are processed and stored in memory.

In order to fully map out a model of bilingual memory representation, the routes that connect the lexical and conceptual levels also need to be determined. If lexical representations for each language are stored separately, while conceptual information is stored in a language-independent system,

then there are several alternative routes by which a bilingual can get from L1 to L2. These routes are determined by the processing requirements of the task at hand. Following the logic of transfer-appropriate processing, Durgunoglu and Roediger (1987) provided a description of bilingual memory representation in terms of the processing requirements posed by various experimental tasks. To test the effect of processing level at encoding on processing during retrieval, Durgunoglu and Roediger had subjects complete one of five different encoding tasks. Some encoding tasks required only lexical-level processing (e. g., see words twice in English, see words twice in Spanish, see words once in each language), while other encoding tasks required conceptual-level processing (e. g., see the word in Spanish and generate its English translation, and see words twice in Spanish and generate an image of the word). Following the study task, subjects completed either a free-recall task, a yes/no recognition task, or a word-fragment completion task. These tasks were chosen because completion of each task entails different processing requirements. Free-recall requires conceptual-level processing, word-fragment completion is a lexical-level task, and yes/no recognition involves both lexical- and conceptual-level processing. When subjects performed retrieval tasks that involved the same level of processing incurred during an initial encoding task, performance on the retrieval task was enhanced, (Durgunoglu & Roediger, 1987). Thus, the transfer-appropriate processing model can be used to describe not only how bilinguals represent their languages in memory, but also the extent to which words in those languages are processed during second language acquisition and translation.

Assumptions regarding the form of interlanguage connection in bilingual memory are also thought to reflect the process by which the

bilingual incorporates a new second language into this system, and how the system changes as the bilingual becomes more proficient in that second language. Two possible means of incorporation have been proposed: word association, in which the beginning bilingual acquires representations for new second-language words by associating their lexical representations with the previously-established lexical representations of first-language words; and concept mediation, in which the beginning bilingual acquires new second-language lexical representations by linking them to the amodal conceptual representations that are already present in the system. These two models are presented in Figure 1.3 on page 16.

Potter et al. (1984) compared fluent and novice bilinguals' latencies for L1-L2 translation and L2 picture naming. The word association model predicts that naming a picture in L2, which requires both conceptual and lexical access, should take longer than L1-L2 translation, which only requires lexical access. The concept mediation model, on the other hand, predicts no difference in latencies for L2 picture naming and L1-L2 translation, since both tasks would involve the same processing requirements. Potter et al. (1984) found that both beginning and more fluent bilinguals showed no difference between L2 picture naming latencies and L1-L2 translation latencies, and concluded that both groups of bilinguals were concept mediators. The beginning bilingual subjects in that experiment, however, had taken French in high school for three years, and were preparing to spend a semester abroad in France. Thus, this subject group might have passed a critical period in their second-language acquisition, and therefore might not have been representative of typical beginning bilinguals (Chen & Leung, 1989; Kroll & Curley, 1988).

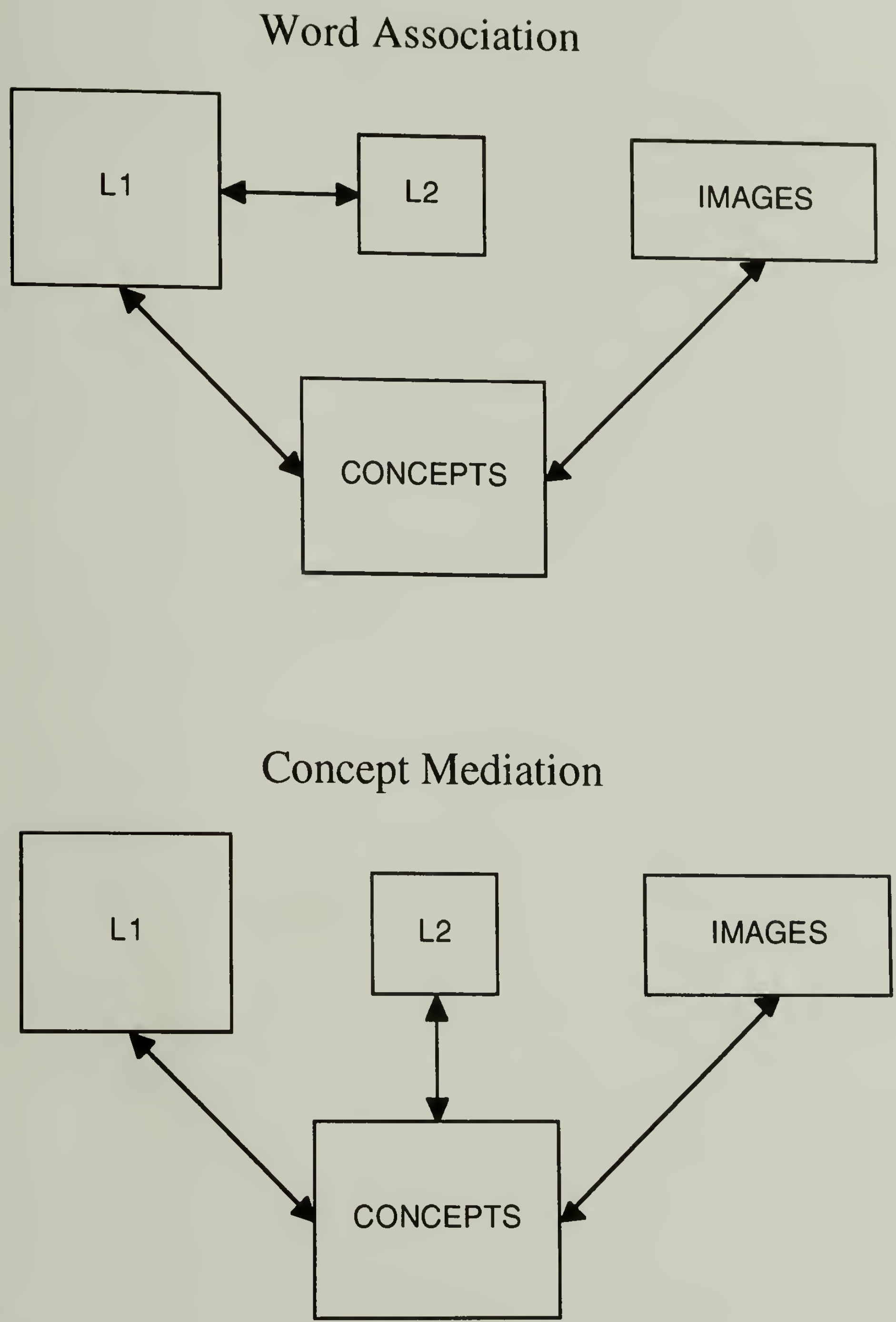

Figure 1.3: Word association and concept mediation models of bilingual memory representation (adapted from Potter et al., 1984).

Kroll and Curley (1988) and Chen and Leung (1989) found that, as bilinguals became more proficient in their second language, they depended less on associations between L1 and L2 words and began to conceptually mediate their second language. Both experiments compared L1 to L2 translation latencies with picture naming latencies in L2. Because picture naming requires conceptual access, this condition was used to evaluate the extent to which bilinguals activated conceptual representations while translating into their second language. The results of both experiments indicated an interaction between subject fluency and route of translation. More fluent subjects' L1 to L2 translation latencies were not significantly different from their L2 picture naming latencies, which indicated that subjects translated via the conceptual level. Less-fluent subjects, however, were significantly faster in translating from L1 to L2 than in naming pictures in their second language. This latter finding indicated that subjects translated from their first language to their second language via connections between the two lexicons.

2. Revised Hierarchical Model of Bilingual Memory Representation

If second-language acquisition involves this observed shift from word association to concept mediation as the bilingual becomes more fluent, then how do the links between the first and second language lexicons and the conceptual level of representation change over the course of second-language acquisition? When the bilingual begins to acquire her/his second language, s/he associates new second-language lexical representations with firmly-established first-language lexical representations, and relies on this link to translate from L2 to L1. The reason associations develop in this direction is that the first language can be used to access meaning. As the bilingual

becomes more proficient in her/his second language, s/he relies less on the lexical link between L2 and L1, and begins to translate via the link between the conceptual level and the L2 lexicon. According to this model, L1 to L2 translation is mediated via the conceptual level shared by the two languages. Translating via this conceptual route involves twice as many steps as translating via lexical associations (similar to word naming vs. picture naming latencies); therefore, L1 to L2 translation should be slower than L2 to L1 translation. Potter et al. (1984) assumed that all bilinguals conceptually mediate their second language, and the hierarchical model did not make any predictions regarding differential translation latencies. The transfer-appropriate processing theory, which does not directly address the issue of translation routes, also does not make predictions concerning asymmetries in translation latencies as a function of direction of translation.

Kroll and Curley (1988) and Kroll and Stewart (1989; 1990) found, however, that L2 to L1 translation was significantly faster than L1 to L2 translation. This asymmetry in translation latencies suggests an underlying asymmetry in the bilingual's lexical and conceptual representations of her/his two languages. Because lexical representations in the bilingual's first language are already strongly associated to concepts, whereas newly-acquired second-language lexical representations are not, translation from L1 into L2 is accomplished via concept mediation. Additionally, since a coordinate bilingual's second language is typically learned by associating new L2 words with previously-established first-language words (and not vice versa), translation from L2 into L1 is accomplished via word association. Although the difference in translation latencies is greater in magnitude for less-fluent bilinguals (Kroll & Curley, 1988; Kroll & Stewart, 1989; 1990), the link between the two lexicons does not disappear as fluency increases, as shown by the

significant difference in translation latencies for fluent bilinguals (i.e., L2 to L1 translation is always faster than L1 to L2 translation).

The revised hierarchical model of bilingual memory representation was proposed to account for the observed asymmetries in translation performance (Kroll & Stewart, 1990; 1992). The model is presented in Figure 1.4 on page 20, and makes several predictions regarding the effect of direction of translation and fluency of the bilingual on translation latencies. First, because L1 to L2 translation is accomplished via the conceptual route, L1 to L2 translation should be affected by semantic variables. L2 to L1 translation, however, which occurs at the lexical level, should not be affected by conceptual level variables. Second, if the link from L2 to L1 is established as the bilingual begins to acquire her/his second language, and the link from the conceptual level to L2 develops as the bilingual becomes more fluent, then the speed of L1 to L2 translation should increase with greater magnitude than the speed of L2 to L1 translation. The results of a series of studies supported each of these predictions. Kroll and Stewart (1990; 1992) found that the semantic context of the list in which bilinguals translated affected performance only for L1 to L2 translation. Moreover, L1 to L2 translation latencies were significantly longer than L2 to L1 latencies. Roufca (1992) had novice and fluent bilinguals translate in both directions and found that both groups were slower for L1 to L2 translation than for L2 to L1 translation. However, the magnitude of the difference between the two directions of translation was greater for the novice subjects than for the fluent subjects and it was the L1 to L2 condition that most differentiated the two groups. This result suggests that over the course of second language learning lexical associations between the two languages are acquired before conceptual mediation is possible.

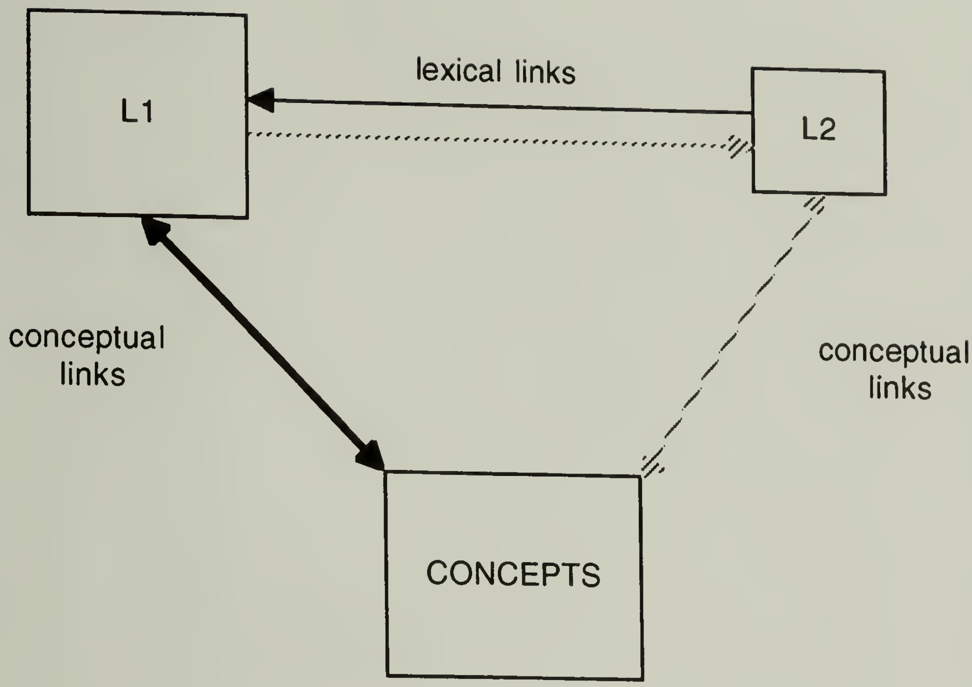

Figure 1.4: A revised hierarchical model of bilingual memory representation (from Kroll & Stewart, 1990; 1992).

Finally, the model should be able to account for asymmetries in other cross-language tasks. For example, cross-language semantic priming should be asymmetric because of the differences in strength between the two conceptual links. Many experiments that have examined cross-language semantic priming (e.g., Meyer & Ruddy, 1974; Schwanenflugel & Rey, 1986; Frenck & Pynte, 1987; Chen & Ng, 1989) did not explore the differences in these two links; a review of the results from these experiments, however, showed that semantic priming was greater for prime-target pairs in which the prime was an L2 word and the target was a semantically-related L1 word. Additionally, experiments that did take this representational asymmetry into account also reported larger cross-language semantic priming effects for L1 prime-L2 target pairs (Altarriba, 1990; Keatley, Spinks, & de Gelder, 1990). A comparison of asymmetries in the magnitude of semantic priming for a set of bilingual priming studies that examined cross-language conditions is presented in Table 1.1 (Kroll & Sholl, 1992) on page 23.

Table 1.1: A comparison of asymmetries in the magnitude of semantic priming for a set of bilingual priming studies that examined cross-language conditions (adapted from Kroll & Sholl, 1992)

Study	Language	SOA/ISI	Magnitude of Priming (ms)	
			L1-L2	L2-L1
Meyer & Ruddy (1974)	English/German[a]	Simultaneous	+ 143	+ 116
Kirsner, Smith, Lockhart, King, & Jain (1984)	French/English	2 s ISI	+ 44	+ 48
Schwanenflugel & Rey (1986)	English/Spanish	300 ms	+ 135	+ 47
		100 ms	+ 63	+ 12
Frenck & Pynte (1987)	English/French	500 ms	+ 63	+ 51
Chen & Ng (1989)	Chinese/English	300 ms	+ 120[b]	+ 55
Keatley, Spinks, & de Gelder (1990)	Chinese/English	250 ms	+ 38	- 6
		2000 ms	+ 13	- 8
	Dutch/French	200 ms	+ 20	- 1
Altarriba (1991)	English/Spanish	200 ms	+ 59	+ 35
		1000 ms	+ 74	+ 40

[a] The first language listed is either the native or the dominant language.
[b] These values were estimated from published figures.

D. Current Experiment

The purpose of the present experiment was twofold: first, this experiment was designed to test the predictions of the revised hierarchical model (Kroll & Stewart, 1990; 1992) using cross-language repetition priming as a tool. Second, results of this experiment can be used to investigate previous claims in the literature regarding cross-language repetition priming. In the present experiment, German/English and English/German bilinguals

translated categorized and randomized blocks of words. Subjects did not perform the translation task in both directions; instead, subjects either translated from their first language to their second, or vice versa. Varying the semantic context in which the words were presented provided an opportunity to test the revised hierarchical model of bilingual memory representation (Kroll & Stewart, 1990; 1992) by comparing differential effects of categorization on translation latencies for the two directions of translation. The second part of the experiment was designed to test both the revised hierarchical model and the transfer-appropriate processing hypothesis. In the second part of the experiment, subjects were presented with half of the words seen in the first part of the experiment, plus new words from categories used in both the categorized and randomized lists and filler items. Half of the subjects performed the second part of the experiment in German, and the remaining subjects performed the second part of the experiment in English. Half of the subjects performed a naming task, which appears to require lexical-level processing, and half of the subjects performed a lexical decision task, which is hypothesized to require both lexical- and conceptual-level processing. If cross-language repetition priming is the result of a match between processing at study and test, and if the two directions of translation differ in terms of level-of-processing requirements, then cross-language repetition priming should only be observed when the level of processing required for the Part 2 task matches the processing required for the initial translation task. Moreover, if cross-language priming occurs whenever both lexical representations are activated, then both directions of translation in Part 1 would be expected to produce priming in Part 2. If, however, cross-language priming occurs only when the shared conceptual store is activated, then repetition priming across languages should be observed only following translation from L1 to L2.

CHAPTER II

PART 1: TRANSLATION STUDY TASKS

A. Method

1. Subjects

Thirty-four German/English bilinguals and 30 English/German bilinguals participated as subjects in this experiment. Subjects were recruited via newspaper advertisements and posters and received $3.00 for their participation in the experiment.

2. Materials

One hundred and ninety six English words and their German translations were used as stimuli in this experiment. Two lists of 64 words were constructed using exemplars from eight semantic categories. Each list consisted of four categories, and contained 16 exemplars per category. List A contained animals, kitchen utensils, vehicles and musical instruments. List B contained fruits/vegetables, clothes, furniture, and tools. Please refer to Appendix A for lists of experimental materials.

Each category was further divided into four subgroups that were matched for frequency. Categorized lists were created by combining three subgroups from a list. Randomized lists were created by combining two subgroups from a list with 16 filler items (matched for frequency). One subgroup per category was reserved for use in the second half of the experiment. In addition, 16 English filler items and their German translations were used as new items in the second half of the experiment.

For practice trials prior to the translation task, 24 English words and their German translations were used. An additional 12 English words and

their German translations were presented along with 12 English-based nonwords or 12 German-based nonwords, respectively, as practice for the lexical decision task in Part 2.

A Language History Questionnaire was also administered to assess subjects' fluency in their first and second languages (see Appendix B).

3. Procedure

Subjects read and signed a consent form prior to participating in the experiment (see Appendix C). The subject was seated in front of the computer screen, so that his/her visual field was centered with the computer screen. Instructions for Part 1 were then presented to the subject on the screen, and the experimenter also read the instructions out loud (see Appendix D for a copy of the instructions given to subjects). The subject then translated 12 (English/German) words into (German/English) as practice in order to familiarize him/herself with the experimental task. The experimenter then gave the subject feedback on her/his performance, and repeated the practice session if necessary.

Part 1 contained a categorized block and a randomized block of words. The order of presentation was counterbalanced across subjects. The subject translated a total of 48 categorized (or 48 randomized) words as quickly and as accurately as possible. Each word to be translated appeared one at a time in the center of the computer screen. A fixation point appeared on the screen for 600 ms. The word to be translated appeared immediately following the fixation point, and remained on the screen for 500 ms. Subjects' translation latencies were recorded by a timer attached to a voice key. Subjects' vocal responses in both parts of the experiment were also recorded by a tape recorder, so that accuracy of subjects' translation and naming responses could

be determined. When the subject had completed the first block of Part 1, the subject completed another 12-word practice exercise. The subject then translated a total of 48 randomized (or 48 categorized) words as quickly and as accurately as possible in the second block.

B. Results and Discussion

Data considered for analysis in Part 1 consisted of both translation latencies and error rates. Translation latencies examined below are for correct responses only. A subject's response was not included in the analyses if it fell more than 3 standard deviations beyond that subject's overall mean response latency. Analyses of translation latencies will be reported first, and analyses of error rates will be discussed in the second half of this section.

1. Subject Characteristics

Table 2.1 on page 28 presents language background data for the English and German subject groups, obtained from their responses on the Language History Questionnaire administered during the course of the experiment.

Table 2.1: Language background data for the English and German subject groups

Variable	English	German	
Age (in years)	25.6	25.7	n.s.
Years in the U.S.	20.8	2.4	$p < .05$
Years in U.S. Schools	14.1	1.6	$p < .05$
Years of L2 experience	15.4	15.1	n.s.
Years of German Reading Experience	12.8	19.8	$p < .05$
Mean Self-Rated L2 Reading & Writing Ability (1 = not fluent, 10 = fluent)	7.5	8.3	$p < .05$
Mean Self-Rated L2 Conversational Fluency (1 = not fluent, 10 = fluent)	8.6	8.5	n.s.

These data indicate that the two groups of subjects are well matched on the basis of age, and that each group of subjects has equivalent L1 and L2 experience (measured in terms of years). English subjects, however, showed greater variability than German subjects on all measures reported, and did rate their L2 reading and writing proficiency significantly lower than did their German counterparts. In sum, these data seem to indicate that the two groups of subjects examined in this experiment are representative of two distinct populations of bilinguals.

2. Translation Latencies

The translation latencies were initially analyzed in a 2 (direction of translation) x 2 (list type -- categorized or randomized) ANOVA. Analyses were performed using both subjects and items as a random factor. Mean translation latencies (in milliseconds) as a function of direction of translation and list type are presented in Table 2.2.

Table 2.2: Mean translation latencies (in milliseconds) as a function of direction of translation and list type

Direction of Translation	Categorized List	Randomized List
L1-L2	1442	1630
L2-L1	1222	1351

Direction of translation had a significant effect on subjects' translation latencies, $F_1(1, 62) = 12.01$, $MSe = 166091.88$, $p = .001$, $F_2(1, 63) = 39.65$, $MSe = 44085.42$, $p < .001$. Subjects were significantly slower in performing L1-L2 translation relative to L2-L1 translation latencies. List type also significantly affected subjects' reaction times in Part 1, $F_1(1, 62) = 18.72$, $MSe = 42932.64$, $p < .001$, but was not significant for items, $F_2(1, 63) = 2.27$, $MSe = 65467.59$, $p > .10$. Subjects' translation latencies for words presented in a categorized format were faster than their translation latencies for words presented in a randomized format. The interaction between direction of translation and list type was not significant, $F_1(1, 62) < 1$, $F_2(1, 63) = 1.22$, $MSe = 39272.48$, $p > .10$, indicating that subjects' showed facilitated translation latencies for categorized words in both directions of translation. To explore whether this pattern of categorical facilitation applied to both groups of bilingual subjects,

translation latencies were then analyzed using a 2 (native language) x 2 (direction of translation) x 2 (list type) ANOVA. Table 2.3 shows the mean latencies for L1-L2 and L2-L1 translation of categorized and randomized lists for both English and German subjects.

Table 2.3: Mean translation latencies (in milliseconds) for English and German subjects

	Native Language			
	English		German	
Direction of Translation	CAT List	RAN List	CAT List	RAN List
L1-L2	1560	1780	1330	1490
L2-L1	1261	1473	1190	1250

Native language had a significant effect on subjects' translation performance, $F_1(1, 60) = 8.92$, $MSe = 147534.43$, $p < .01$, $F_2(1, 63) = 31.13$, $MSe = 82974.36$, $p < .001$. German subjects' translation latencies were faster than English subjects' translation latencies. The main effect of direction of translation was also highly significant, reflecting that subjects were significantly faster translating from L2-L1 (1293 ms) than from L1-L2 (1540 ms), $F_1(1, 60) = 13.11$, $MSe = 147534.43$, $p < .001$, $F_2(1, 63) = 40.61$, $MSe = 75003.99$, $p < .001$. List type had a significant effect on subjects' translation latencies, $F_1(1, 60) = 19.74$, $MSe = 42640.09$, $p < .01$, $F_2(1, 63) = 5.27$, $MSe = 98155.87$, $p < .05$. Subjects were significantly faster in translating words presented in a categorized list (1335 ms) than translating words presented in a randomized list (1498 ms). No significant interaction was observed between direction of translation and list type, $F_1(1, 60) < 1$, $F_2(1, 63) = 1.42$, $MSe =$

54992.79, $p > .10$; subjects showed facilitation for translating categorized lists in both directions of translation.

This observation of categorical facilitation in both directions of translation runs counter to the results reported by Kroll and Stewart (1990; 1992), who observed categorical interference in L1-L2 translation and no effect of list type in L2-L1 translation. This difference could be due to differences between the subject populations tested in the two experiments. Kroll and Stewart tested Dutch-English bilinguals who were highly fluent in both their first and second languages. These subjects also had a great deal of reading experience in both their L1 and their L2. Evidence supporting the proposal that the German subjects and English subjects tested in the current experiment are representative of two distinct populations includes the observation of a significant effect of native language, such that German subjects translated more rapidly than English subjects (1315 ms and 1518 ms, respectively). Also, while the native language x direction of translation interaction failed to reach significance, the difference between L1-L2 translation and L2-L1 translation is approximately 100 msec smaller for the German-English bilinguals, indicating a smaller difference in fluency for their two languages relative to the English-German bilinguals. To further explore these results, and since the German-English bilinguals tested in the current experiment were similar in language background and proficiency to the Dutch-English bilinguals who participated in Kroll and Stewart's study, separate analyses of the two groups of bilinguals in this experiment were performed to determine whether fluency in the second language was the source of this category facilitation effect.

The same pattern obtained for the overall group was found for each group of subjects independently. For both the English-dominant and the

German-dominant groups, subjects were faster translating from L2-L1 than from L1-L2. Note, however, that the difference between L1-L2 translation and L2-L1 translation is approximately 100 msec smaller for the German-English bilinguals, indicating a smaller difference in fluency for their two languages relative to the English-German bilinguals. Both English and German subjects showed facilitation for translating items presented in categorized lists as compared to items presented in randomized lists. Finally, both English and German subjects showed categorical facilitation in both directions of translation. For the English subjects, the magnitude of category facilitation observed for L1-L2 translation was equivalent to the magnitude of category facilitation in L2-L1 translation; for the German subjects, however, the magnitude of this facilitation, however, was smaller for L2-L1 translation (60 ms) than for L1-L2 translation (160 ms).

Thus, for both groups of subjects, the translation asymmetry reported by Kroll and Stewart (1990; 1992) was observed, such that L1-L2 translation latencies were significantly longer than L2-L1 translation latencies. This type of result was the basis for the proposal of the revised hierarchical model. However, further results reported for the current experiment indicated significant facilitation of translation latencies for items presented in a categorized format, and this facilitation was observed for both directions of translation. As mentioned above, in a similar experiment, Kroll and Stewart (1990; 1992) observed interference rather than facilitation for subjects' translation latencies for words presented in a categorized format. More importantly, Kroll and Stewart observed this effect of list type only for L1 to L2 translation; in the current experiment, categorical facilitation was observed in both directions of translation. This result poses a challenge to Kroll and Stewart's revised hierarchical model, which bases its characterization of L2-L1

translation as a lexically-mediated process on the absence of any conceptual-level effects in this direction of translation. Thus, the question remains as to whether the results of the present study can be accounted for by Kroll and Stewart's model. One difference between Kroll and Stewart's experiment and the current study concerns the methodologies used to test subjects. Kroll and Stewart had subjects name and translate blocks of L1 and L2 words. Perhaps subjects' naming performance in the context of performing translation encouraged the use of primarily lexical routes of translation. Further consideration of the implications of these methodological differences will be addressed in the general discussion section.

3. Error Rates

Error rates for all 64 subjects were analyzed in a 2 (native language) x 2 (direction of translation) x 2 (list type) ANOVA. Mean percent errors for English and German subjects are shown in Table 2.4.

Table 2.4: Mean percent errors for English and German subjects

	Native Language			
	English		German	
Direction of Translation	CAT List	RAN List	CAT List	RAN List
L1-L2	44.8%	46.1%	25.8%	25.4%
L2-L1	25.4%	32.4%	20.2%	26.1%

The effect of native language was highly significant, $F_1(1, 60) = 14.37$, $MSe = .03$, $p < .001$, $F_2(1, 63) = 55.66$, $MSe = 0.02$, $p < .001$. German subjects made significantly fewer errors than did English subjects (24.4% versus 37.2%,

respectively), consistent with the claim that they were more fluent in their second language than the English subjects. Direction of translation also had a significant effect on subjects' error rates, $F_1(1, 60) = 7.85$, $MSe = .03$, $p < .01$, $F_2(1, 63) = 51.07$, $MSe = 0.03$, $p < .001$. Subjects made a greater percentage of erroneous responses when translating from L1-L2 (35.2%) than when translating from L2-L1 (25.8%). A significant effect of list type was observed for subjects, $F_1(1, 60) = 5.92$, $MSe = .006$, $p = .01$, whereas the effect of list type was marginal for items, $F_2(1, 63) = 3.03$, $MSe = 0.02$, $p < .10$, reflecting a smaller percentage of errors for items presented in categorized lists. Unlike the results for the translation latencies, the interaction between direction of translation and list type was significant for error rates, $F_1(1, 60) = 4.48$, $MSe = .006$, $p < .05$, $F_2(1, 63) = 4.99$, $MSe = 0.02$, $p < .05$. Subjects showed no difference in error rates for the two list types when translating from L1 to L2 (35% for both list types), but showed significantly fewer errors for items presented in categorized lists than for items presented in randomized lists when translating from L2 to L1 (22.5% and 29%, respectively).

The error data show that subjects were more accurate in translating from L2 to L1 than in translating from L1 to L2. This finding is not surprising, since neither the German nor the English subjects were highly balanced bilinguals. If the second language is initially acquired via lexical associations to the first language, then subjects should always have an L1 representation that corresponds to every L2 word they know. Subjects should not, however, have an L2 representation that corresponds to every L1 word they know; thus, L1 to L2 translation should be more error-prone. The revised hierarchical model would make similar predictions regarding differences in error rates between the two directions of translation, but for different reasons.

Both English and German subjects also showed greater accuracy for translating words in a categorized context when performing L2-L1 translation; list type had no effect in L1-L2 translation. Initially, this finding might be interpreted as evidence against the proposal that L2-L1 translation is accomplished via a predominantly lexical route. This result could be explained in terms of ease of accessing a representation in L1 as compared to L2. As explained previously, if L2 is initially lexically-mediated through L1, then for every L2 word a subject knows, there will be a corresponding L1 representation; the converse, however, will not necessarily hold true, especially for bilinguals who are not balanced. Thus, the absence of a category effect on subjects' error rates in L1-L2 translation might simply reflect poorer performance in this direction of translation overall. That is, knowing the category of the L1 word cannot facilitate the retrieval of its L2 counterpart if that L2 representation has not been acquired. Greater accuracy for L2-L1 translation in a categorized context might also reflect the means by which subjects acquired their L2 in the classroom. A typical method of teaching foreign languages in academic settings involves the presentation of new L2 words in categorized sets. The L2-L1 categorized translation condition in the current experiment may have corresponded most closely to the manner in which these subjects acquired their L2, thereby creating a match between processing engaged during encoding and processing required for retrieval; thus, performance in this condition may have reflected some sort of transfer appropriate processing, and this subset of responses may have been enhanced above and beyond any of the other three conditions in Part 1.

Due to high variability observed for English subjects' error rates, which can be interpreted as a reflection of differences in fluency among subjects in this sample, these subjects were classified into two groups according to their

mean percent error in Part 1. English-dominant subjects were placed in the high error rate group if they made 45% or greater errors in the translation task, and were placed in the low error rate group if they made less than 45% errors.

Separate 2 (direction of translation) x 2 (list type) ANOVAS were performed on the two groups of English subjects considering subjects as a random factor only For English subjects in the high error rate group, the effect of direction of translation was not significant, $F_1(1, 10) = .91$, $MSe = .012$, $p > .10$. The effect of list type was highly significant, $F_1(1, 10) = 16.37$, $MSe = .004$, $p < .01$, as was the interaction between direction of translation and list type, $F_1(1, 10) = 13.70$, $MSe = .004$, $p < .01$. English subjects who produced a high proportion of errors in Part 1 performed more accurately when translating categorized lists of words (48.9% errors) than when translating words presented in a randomized format (63% errors). This significantly better performance for translating categorized lists was only observed for subjects who translated from L2 to L1. For English subjects in the low error rate group, the effect of direction of translation was not significant, $F_1(1, 16) < 1$. The effect of list type also failed to reach significance, $F_1(1, 16) = 1.82$, $MSe = .003$, $p > .10$, as did the interaction between direction of translation and list type, $F_1(1, 16) < 1$.

Thus, only the subjects who made a significantly larger proportion of erroneous responses in Part 1 showed greater accuracy when translating categorized lists of words from L2 to L1. Subjects whose overall error rates were low did not show any effect of list type on their error rates in either direction of translation. If error rates are interpreted as reflecting subjects' fluency in L2, then the direction of translation x list type interaction observed for subjects who make many errors can be explained in terms of the number

of representations per lexicon available to less-fluent bilingual subjects. As proposed above, the categorized context might help to increase non-fluent subjects' accuracy in L2-L1 translation because the context might serve to activate a large set of potential candidates in L1. List type should show no effect in L1-L2 translation for less-fluent bilinguals, however, because these subjects know fewer L2 words; that is, context cannot affect retrieval of non-existent representations.

The translation results in Part 1 raise questions about whether the two directions of translation engage different levels of processing, since categorical facilitation was observed for both L1-L2 and L2-L1 translation. Thus, predictions initially made on the basis of the revised hierarchical model, which challenged Smith's (1991) claim that conceptual access alone was responsible for cross-language repetition priming, are now more difficult to interpret. Initially, L2-L1 translation was proposed to take place at an entirely lexical level of processing; if cross-language repetition priming were observed following this direction of translation, Smith's strong claim would indeed be weakened. This logic is now questionable, since conceptual-level effects were observed in a supposedly lexical-level translation task. However, the asymmetry between the two directions of translation still holds for translation latencies observed in Part 1 of the current experiment; L1-L2 translation latencies were significantly longer than L2-L1 translation latencies, and L1-L2 translation was significantly more error-prone than L2-L1 translation for both English and German subjects. On the basis of this asymmetry, the two directions of translation remain as important factors in determining the basis of cross-language repetition priming. The additional time required for L1-L2 translation, coupled with the increased difficulty of translating in this direction, indicates that additional retrieval processes are

necessary relative to L2-L1 translation. The issue of conceptual-level processing as reflected by effects of list type in the two translation routes, and whether conceptual-level processing directly affects the magnitude of cross-language repetition priming, will be discussed in the final portion of the Part 2 results section.

CHAPTER III

PART 2: REPETITION TRANSFER TASKS

The lexical decision and naming tasks used in Part 2 were intended to measure transfer effects induced by the two different directions of translation. The initial predictions proposed that translation as a study task should produce cross-language priming; that is, subjects should show facilitated lexical decision and naming latencies for words that had been presented in the previous translation task, regardless of the language in which those words had appeared in Part 1. This prediction was indeed supported by the results of Part 2. Cross-language repetition priming was observed under some conditions. The effect of direction of translation performed in the study task is an important variable to consider in terms of whether conceptual processing is necessary for the observation of repetition priming across a bilingual's two languages. As proposed earlier, cross-language repetition priming should be observed as long as each language's lexical representation is activated; conceptual activation may not be the sole requirement for cross-language repetition priming, as claimed by Smith (1991). A specific test of this prediction involves the comparison of priming magnitudes following L1-L2 translation, which is hypothesized to be a conceptually-mediated process, to priming magnitudes following L2-L1 translation, which hypothetically does not involve conceptual access.

A. Method

1. Materials

Following the translation task, subjects participated in one of four possible tasks: L1 lexical decision, L2 lexical decision, L1 naming, or L2

naming. In all four tasks, half of the words that subjects had translated in Part 1 were repeated. These repetitions occurred either within- or across-languages, depending on both the direction of translation in which subjects had previously translated and the assignment of Part 2 task. In addition to the 48 repeated words presented in the Part 2 tasks, subjects also saw 48 new words. Of these 48 new words, 16 were new exemplars from categories represented in the categorized list that had previously been translated, and 16 were new exemplars from categories used to construct the randomized list that had previously been translated. The remaining 16 words were entirely new filler words, and were not drawn from any of the categories used to create the Part 1 lists. However, in a monolingual control study performed to test these materials, 8 items were found to produce unreasonably long latencies due to their length. These items were therefore not included in the Part 2 analyses. Please refer to Appendix E for a description of the control study.

For the English and the German lexical decision tasks, 192 nonwords were created (96 per language). Nonword materials are listed in Appendix A. German-based nonwords were used for the German lexical decision task, and English-based nonwords were used for the English lexical decision task. The nonwords were created to look as wordlike as possible without actually resembling any of the real words used in the study. German nonwords were verified by a member of the Mount Holyoke College German department, and by two fluent German speakers, to ensure that the nonwords were indeed nonwords.

2. Procedure

Subjects participating in the lexical decision condition performed a practice lexical decision task (composed of 12 words and 12 nonwords) in either German or English. If the subject participated in the naming condition, s/he received instructions for the task on the computer screen, and the experimenter read the instructions out loud. The subject did not perform a practice naming task, however, since the requirements for the task did not merit further explanation and all subjects had performed one of the translation tasks in Part 1 and thus were aware of the sensitivity requirements of the voice key.

After receiving instructions and/or practice for Part 2, the subject began Part 2 of the experiment (see Appendix D for a copy of the instructions given to subjects). In the lexical decision condition, the subject made lexical decisions for 192 letter strings (96 words and 96 nonwords) as quickly and as accurately as possible. In the naming condition, the subject named 96 words out loud as quickly and as accurately as possible.

When the subject had completed the experiment, s/he was lead outside of the experimental room and into a larger room for completion of a Language History Questionnaire. Subjects were then debriefed and dismissed.

B. Results and Discussion

1. Old Words versus New Words

a. Lexical Decision and Naming Latencies

In order to evaluate these proposals, several comparisons among the items presented in Part 2 were examined. Latencies for words that were presented in both Part 1 and Part 2 were initially compared to latencies for

new exemplars of categories presented in Part 1 (please refer to the Appendix for a list of Part 2 stimuli). Correct lexical decision responses in Part 2 were analyzed in separate 2 (direction of translation) x 2 (presentation language) x 2 (repetition) ANOVA's. Subjects' mean decision latencies for the lexical decision task are presented in Table 3.1.

Table 3.1: Mean lexical decision latencies (in milliseconds) for old and new words

	Presentation Language					
	L1			L2		
Direction of Translation	Old	New	New-Old	Old	New	New-Old
L1-L2	700	742	42	787	848	61
L2-L1	667	688	21	702	748	46

For the lexical decision task, a highly significant effect of repetition was observed, $F_1(1, 27) = 22.26$, $MSe = 1252.68$, $p < .001$, $F_2(1, 65) = 4.85$, $MSe = 25465.59$, $p < .05$. Subjects' decision latencies were significantly faster for words that had been presented in the translation task, regardless of the language in which they had initially appeared. Direction of translation performed in Part 1 did not have any overall effect on subjects' decision latencies, $F_1(1, 27) = 1.30$, $MSe = 54372.64$, $p > .10$, but was significant for items, $F_2(1, 65) = 24.89$, $MSe = 7302.64$, $p < .001$; additionally, direction of translation did not interact significantly with repetition, $F_1(1, 27) = 1.05$, $MSe = 1252.68$, $p > .10$, $F_2(1, 65) < 1$, indicating that significant repetition effects were observed following both directions of translation.

Finally, although the direction of translation x presentation language x repetition interaction failed to reach significance, $F_1(1, 27) < 1$, $F_2(1, 65) = < 1$, a comparison of priming magnitudes for the four experimental conditions reveals an interesting pattern. First, the magnitudes of priming for the two within-language conditions (L1-L2 translation in Part 1/L1 words in Part 2, and L2-L1 translation in Part 1/L2 words in Part 2) are virtually identical (42 msec and 46 msec, respectively). Secondly, direction of translation appears to have a differential effect on the magnitude of the between-language priming. For L2 words following L1-L2 translation, a large priming effect is observed (61 msec), whereas L1 words following L2-L1 translation show a much smaller priming effect (21 msec). This difference between the two between-language conditions could reflect the role of conceptual access in cross-language repetition priming. Larger cross-language priming effects are observed following L1-L2 translation; according to the revised hierarchical model (Kroll & Stewart, 1990; 1992), this direction of translation is conceptually-mediated. Smaller cross-language priming effects are observed following L2-L1 translation. Hypothetically, L2-L1 translation can be accomplished without conceptual-level access; although the magnitude of cross-language priming observed following L2-L1 translation is small, it is still significant. Thus, cross-language repetition priming can take place in the absence of conceptual access, but conceptual-level processing does appear to increase the magnitude of the priming effect.

Naming latencies for correctly-pronounced items were also analyzed in a 2 (direction of translation) x 2 (presentation language) x 2 (repetition) ANOVA. Mean naming latencies (in milliseconds) for old and new words are presented in Table 3.2 on page 44.

Table 3.2: Mean naming latencies (in milliseconds) for old and new words

	Presentation Language					
	L1			L2		
Direction of Translation	Old	New	New-Old	Old	New	New-Old
L1-L2	685	721	36	696	708	12
L2-L1	618	627	9	728	748	20

As in the lexical decision task, a significant repetition effect was observed for naming latencies, $F_1(1, 29) = 24.24$, $MSe = 250.58$, $p < .001$, $F_2(1, 65) = 3.79$, $MSe = 8644.58$, $p = .05$. Words that had been translated in Part 1 were named faster than words presented for the first time in Part 2. The language in which Part 2 stimuli were presented did not significantly affect subjects' naming latencies, $F_1(1, 29) = 2.06$, $MSe = 26402.51$, $p > .10$, but presentation language was significant for items, $F_2(1, 65) = 112.61$, $MSe = 1673.58$, $p < .001$. This result indicates that subjects' named L1 words faster than L2 words. The between-subjects design of Part 2 is a potential source of the lack of a language effect for subjects.

While the direction of translation x repetition interaction failed to reach significance for the naming task, $F_1(1, 29) = 1.49$, $MSe = 250.58$, $p > .10$, $F_2(1, 65) < 1$, the three-way interaction of direction of translation x presentation language x repetition was significant, $F_1(1, 29) = 5.12$, $MSe = 250.58$, $p < .05$, $F_2(1, 65) = 6.03$, $MSe = 1628.80$, $p = .01$. Like lexical decision latencies, naming latencies were not differentially affected overall by the direction of translation performed in Part 1; facilitation for repeated items was observed following both directions of translation. The pattern of priming magnitudes for within- and between-language conditions, however, reveals

differential effects of direction of translation on cross-language repetition priming. The magnitudes of within-language repetition priming for L1 and L2 are comparable (36 msec and 20 msec, respectively). The between-language repetition priming effects, however, are extremely small. For L2 naming latencies following L1-L2 translation, a 12 msec priming effect is observed, and L1 words named following L2-L1 translation show only a 9 msec facilitation effect. A Newman-Keuls test revealed that both between-language priming effects were significant, $q(2, 29) = 3.27$, $p < .05$, and $q(2, 29) = 4.35$, $p < .01$, although the magnitude of priming was quite small. However, the small priming effects observed for the between-language conditions are particularly interesting because they show that repeating the production itself does not produce much priming if the same encoding processes are not activated. While the condition in which subjects named L2 words following L1-L2 translation is not a particularly good reflection of production repetition because subjects were much less likely to produce the correct L2 word during L1-L2 translation in Part 1, this argument does not hold for the condition in which subjects named L1 words following L2-L1 translation. In this condition, subjects were much more likely to produce the correct L1 word in translation; the small repetition priming effect observed in this condition demonstrates that the production process itself does not seem to be the source of the repetition priming effect.

b. Error Rates in Lexical Decision and Naming Tasks

Subjects' error rates for the words presented in the lexical decision task and the naming task were analyzed in separate 2 (direction of translation) x 2 (presentation language) x 2 (repetition) ANOVA's. For the lexical decision task, errors were defined as trials in which subjects either responded "no" to a

real word or "yes" to a nonword. The overall error rates for the nonwords in lexical decision were relatively low and will not be discussed further.. For the naming task, errors were defined as trials in which subjects either mispronounced the target word, failed to make a response to the target word, or took an unreasonably long time in producing a correct response. Trials for which the voice key failed to record the first utterance of a correct response were also considered as errors in the naming task. Because errors were defined with respect to the task, they must be interpreted as reflecting different aspects of processing in naming and lexical decision. Percent errors for old and new words in the lexical decision task and naming task are presented in Tables 3.3 and 3.4, respectively.

Table 3.3: Percent errors for old and new words in the lexical decision task

	Presentation Language			
	L1		L2	
Direction of Translation	Old	New	Old	New
L1-L2	3.6%	8.8%	15.4%	11.6%
L2-L1	4.8%	5.0%	11.1%	12.3%

Table 3.4: Percent errors for old and new words in the naming task

	Presentation Language			
	L1		L2	
Direction of Translation	Old	New	Old	New
L1-L2	4.2%	7.0%	11.8%	12.3%
L2-L1	6.0%	7.5%	9.3%	13.5%

In the lexical decision task, the language in which words were presented had a highly significant effect on subjects' error rates, $F_1(1, 27) = 8.69$, $MSe = .009$, $p < .01$, $F_2(1, 65) = 17.07$, $MSe = .02$, $p < .001$. Subjects made more incorrect lexical decisions for words in their second language than for words in their first language. Presentation language also interacted significantly with repetition for subjects, $F_1(1, 27) = 4.14$, $MSe = .002$, $p = .05$, but not for items, $F_2(1, 65) = 1.70$, $MSe = .02$, $p > .10$. For L1 words, subjects showed greater accuracy for repeated words as compared to new words (4.15% and 6.89%, respectively), whereas repetition did not increase subjects' accuracy for L2 words (13.29% errors for old L2 words versus 11.93% errors for new L2 words). The direction of translation x presentation language x repetition interaction was also highly significant, $F_1(1, 27) = 6.14$, $MSe = .002$, $p = .01$, $F_2(1, 65) = 4.14$, $MSe = .01$, $p < .05$. Subjects showed an advantage for repeated words in both L1 and L2 following L1-L2 translation, but showed no difference in error rates for old and new words following L2-L1 translation. This interaction may reflect the differential error rates observed for the two directions of translation in Part 1. Subjects made many more errors in L1-L2 translation, whereas L2-L1 translation performance tended to be more accurate. This performance difference was interpreted as a reflection of L2 fluency; subjects were more likely to know the correct L1 counterpart of an L2 word than vice versa. This logic can be applied to the current pattern of error rates. Repetition should produce a greater benefit in terms of accuracy following L1-L2 translation because subjects were more likely to have experienced difficulty with the repeated item in Part 1. Because L2-L1 translation is less error-prone, repetition shouldn't have a large effect on accuracy in Part 2 (i.e., it's more likely that subjects produced the correct

translation for these items in Part 1, so repeating the items doesn't provide any advantage).

In the naming task, language also had a significant effect on error rates, $\underline{F}_1(1, 29) = 5.94$, $\underline{MSe} = .008$, $\underline{p} < .05$, $\underline{F}_2(1, 65) = 18.79$, $\underline{MSe} = .01$, $\underline{p} < .001$. Subjects made more errors in naming L2 words than in naming L1 words. Repetition also significantly affected subjects' accuracy, $\underline{F}_1(1, 29) = 5.58$, $\underline{MSe} = .002$, $\underline{p} < .05$, but was not significant for items, $\underline{F}_2(1, 65) = 1.64$, $\underline{MSe} = .03$, $\underline{p} > .10$. Subjects' error rates were lower for repeated items than for new items. The presentation language x repetition interaction was not significant, $\underline{F}_1(1, 29) < 1$, $\underline{F}_2(1,65) < 1$; the direction of translation x presentation language x repetition interaction also failed to reach significance, $\underline{F}_1(1, 29) = 1.73$, $\underline{MSe} = .002$, $\underline{p} > .10$, $\underline{F}_2(1,65) < 1$. Unlike the pattern of error rates observed in the lexical decision task, repeated words were named more accurately than new words, and this pattern of errors was observed for both L1 and L2 naming latencies. This trend was also observed following both directions of translation, whereas in the lexical decision task, repeated words showed lower error rates only following L1-L2 translation.

2. Old Words versus Filler Words

While the analyses reported above show significant facilitation in both naming and lexical decision latencies for repeated items, the comparison of repeated words to the set of new words is potentially complicated because of the method by which the set of new words was constructed. Recall that the new words in Part 2 were members of categories encountered in the translation task. While the new items were indeed novel (i.e., they had not been presented previously), they were semantically related to previously-processed items. Thus, the potential for interference in processing these new

exemplars of previously-encountered categories is not negligible, and any observation of a repetition effect based on this comparison might be artificially inflated by interference for the new items. Therefore, a second set of analyses was performed using the small set of filler items presented in Part 2 as a comparison against repeated items. These filler items were not semantically related to the repeated words, and were also slightly more frequent than the repeated words. Thus, the filler words constitute an alternative comparison group for the assessment of repetition priming. Rather than including old words, new words, and filler words in a single analysis, the comparison between old words and filler words was performed separately. The set of filler items was not initially intended to be a comparison group; rather, the filler words were included in order to dilute the context repeated from the Part 1 translation task. In addition, the set of filler words was small (13 words total). Thus, the old versus filler comparison was considered to be a post-hoc analysis, and was performed as a control analysis.

a. Lexical Decision and Naming Latencies

Correct naming and lexical decision responses in Part 2 were analyzed in separate 2 (direction of translation) x 2 (presentation language) x 2 (repetition) ANOVA's. Mean lexical decision and naming latencies (in milliseconds) for old words and filler words are presented in Table 3.5 and Table 3.6, on page 50.

Table 3.5: Mean lexical decision latencies (in milliseconds) for old words and filler words

	Presentation Language					
	L1			L2		
Direction of Translation	Old	Filler	Filler-Old	Old	Filler	Filler-Old
L1-L2	700	779	79	787	909	122
L2-L1	667	707	40	702	774	72

Table 3.6: Mean naming latencies (in milliseconds) for old words and filler words

	Presentation Language					
	L1			L2		
Direction of Translation	Old	Filler	Filler-Old	Old	Filler	Filler-Old
L1-L2	685	723	38	696	688	-8
L2-L1	618	650	32	728	749	21

For the lexical decision data, the pattern of results was similar to that observed in the old versus new comparison described above. The main effect of repetition was highly significant, $F_1(1, 27) = 38.49$, $MSe = 2441.09$, $p < .001$, $F_2(1, 51) = 11.18$, $MSe = 22837.35$, $p = .001$. Subjects' decision latencies were faster for repeated items than for filler items. The direction of translation x repetition interaction was marginally significant for subjects, $F_1(1, 27) = 3.20$, $MSe = 2441.09$, $p < .10$, and significant for items, $F_2(1, 51) = 5.74$, $MSe = 5884.90$, $p < .05$. The magnitude of repetition priming was approximately two times greater for words following L1-L2 translation than for words following L2-L1 translation, regardless of the language in which words were presented in the lexical decision task (101 msec and 56 msec, respectively). If L1-L2 translation

is conceptually-mediated, and L2-L1 translation does not involve conceptual access, then this trend suggests that, while cross-language repetition priming can take place in the absence of conceptual access, conceptual-level processing produces a much larger cross-language repetition priming effect.

For the naming data, the effect of repetition was highly significant for subjects, $F_1(1, 29) = 8.71$, $MSe = 813.00$, $p < .01$, but not for items, $F_2(1, 51) = 2.07$, $MSe = 9044.31$, $p > .10$. Words that subjects had translated in Part 1 were named faster than words presented for the first time in Part 2. A significant language x repetition interaction was also observed, $F_1(1, 29) = 4.40$, $MSe = 813.00$, $p < .05$, $F_2(1, 51) = 7.54$, $MSe = 1668.70$, $p < .01$, reflecting a significantly smaller priming effect for words in the subject's second language. A Newman-Keuls analysis performed on the mean naming latencies for old and filler words in L1 and L2 revealed that the priming effect for L2 words was not significant, $q(2, 29) = 1.71$. Finally, whereas the direction of translation x presentation language x repetition interaction was significant for naming latencies when the new items were used as a comparison group, this three-way interaction failed to reach significance for subjects when the filler words were used as control items, $F_1(1, 29) = 1.54$, $MSe = 813.00$, $p > .10$, but was significant for items, $F_2(1, 51) = 4.20$, $MSe = 1656.96$, $p < .05$. Both within-language conditions showed significant priming effects (38 msec and 21 msec), but between-language repetition priming was only observed for L1 words.

b. Error Rates in Lexical Decision and Naming Tasks

Error rates for old items and filler items in the lexical decision and naming tasks were compared in separate 2 (direction of translation) x 2 (presentation language) x 2 (repetition) ANOVA's. Mean error rates for lexical decision and naming performance are presented in Tables 3.7 and 3.8.

Table 3.7: Percent errors for old words and filler words in the lexical decision task

	Presentation Language			
	L1		L2	
Direction of Translation	Old	Filler	Old	Filler
L1-L2	3.6%	8.8%	15.4%	12.1%
L2-L1	4.8%	9.6%	11.1%	12.1%

Table 3.8: Percent errors for old words and filler words in the naming task

	Presentation Language			
	L1		L2	
Direction of Translation	Old	Filler	Old	Filler
L1-L2	4.2%	7.9%	11.8%	15.4%
L2-L1	6.0%	9.8%	9.3%	11.5%

For lexical decision, the language in which words appeared had a significant effect on subjects' accuracy, $F_1(1, 27) = 8.00$, $MSe = .007$, $p < .01$, $F_2(1, 51) = 7.17$, $MSe = .02$, $p < .01$. Subjects made more accurate lexical decisions for words in their first language than for words in their second language. Presentation language also interacted significantly with repetition for subjects,

$F_1(1, 27) = 4.29$, MSe = .003, $p < .05$, but not for items, $F_2(1, 51) = 2.00$, MSe = .02, $p > .10$. For L1 words, subjects made fewer errors for repeated items than for filler items (4.15% and 9.15%, respectively), whereas repetition did not differentially affect accuracy for L2 words (13.29% errors for old L2 words and 12.14% errors for filler L2 words). Unlike the analysis of lexical decision error rates for the old versus Filler comparison, the direction of translation x presentation language x repetition interaction was not significant, $F_1(1, 27) = 0.58$, MSe = .003, $p > .10$, $F_2(1, 51) = .67$, MSe = .009, $p > .10$. Lower error rates were observed generally for old items, regardless of the language in which those items appeared or the direction of translation performed in Part 1. The only condition for which this pattern did not hold was the between-language condition following L1-L2 translation; as proposed previously, the higher error rate for repeated items could be a result of subjects' poorer performance in the L1-L2 translation task (i.e., subjects were much less likely to have produced the correct translation in Part 1 for this condition).

For naming, the main effect of presentation language was significant, $F_1(1, 29) = 3.86$, MSe = .01, $p = .05$, $F_2(1, 51) = 10.17$, MSe = .008, $p < .01$. Subjects made fewer naming errors for words presented in their first language than for words presented in their second language. Repetition also affected error rates significantly for subjects, $F_1(1, 29) = 8.79$, MSe = .002, $p < .01$, but not for items, $F_2(1, 51) = 1.81$, MSe = .02, $p > .10$. Subjects made more errors when naming filler items than when naming repeated items. The direction of translation x presentation language x repetition interaction was not significant, $F_1(1, 29) = < 1$, $F_2(1, 51) < 1$, reflecting that higher accuracy rates for repeated words were observed for both L1 and L2 words, and were observed following both directions of translation.

While some small differences were observed in priming effects when filler items were used as a comparison group, the overall pattern of results remained unchanged. Cross-language repetition priming was observed even when the filler words were used as a more neutral comparison group. In fact, comparing the old words to the filler words revealed larger repetition priming effects than those observed in the previous comparison between the old and new words, which were semantically related. It is interesting to note that latencies for the new words were actually faster than latencies for the filler words; this difference suggests that conceptual information is relevant in determining the magnitude of transfer observed in Part 2, because the only way in which the new words and the filler words differ is in terms of their semantic relatedness to the old items.

3. Effects of Part 1 List Type on Cross-Language Repetition Priming

As mentioned previously, one of the main objectives of the current study is to assess the role of conceptual access in cross-language repetition priming. Comparing the differences in priming following the two directions of translation provides one method of evaluating whether conceptual access is a necessary component of repetition priming. The results reported for the lexical decision task and the naming task showed cross-language repetition priming following both directions of translation. Initially, this result might indicate that conceptual access is not necessary for repetition priming to occur. However, this conclusion cannot be drawn without some hesitation, because L2-L1 translation in Part 1 was shown to be affected by the context in which words were presented (i.e., whether words appeared in a categorized or a randomized list); thus, the lexically-mediated route of translation (L2-L1) seems to be affected by conceptual-level factors, and conceptual-level

processing might also be responsible for the cross-language repetition priming effect observed following L2-L1 translation.

One method by which this issue can potentially be resolved involves the comparison of repetition priming effects for words repeated from the categorized lists in Part 1 and words repeated from the randomized lists in Part 1. If L2-L1 translation involves conceptual processing, then list type should affect the magnitude of repetition priming observed in Part 2 following L2-L1 translation. Separate 2 (direction of translation) x 2 (presentation language) x 2 (repetition) x 2 (list type) ANOVA's were performed for the lexical decision data and the naming data, respectively. Magnitude of repetition priming (in milliseconds) for categorized and randomized items in the lexical decision task and the naming task are presented in Table 3.9 and 3.10, respectively.

Table 3.9: Magnitude of repetition priming (in milliseconds) for categorized and randomized items in the lexical decision task

	Presentation Language			
	L1		L2	
Direction of Translation	CAT List	RAN List	CAT List	RAN List
L1-L2	47	42	83	41
L2-L1	18	25	41	39

Table 3.10: Magnitude of repetition priming (in milliseconds) for categorized and randomized items in the naming task

	Presentation Language			
	L1		L2	
Direction of Translation	CAT List	RAN List	CAT List	RAN List
L1-L2	39	34	14	13
L2-L1	19	0	24	11

The two within-language conditions in the lexical decision task showed no effect of list type, $\underline{F}(1, 27) = 1.45$, $\underline{MSe} = 108444.71$, $\underline{p} > .10$; this result demonstrates that when the actual form of the target word is repeated in Part 2, the conceptual context in which that word was presented did not affect processing. For the between-language conditions (L2 words following L1-L2 translation and L1 words following L2-L1 translation), the pattern of priming effects for items taken from categorized and randomized lists in Part 1 reveals differential list type effects following the two directions of translation. List type only affects the between-language condition in which L1-L2 translation is performed prior to lexical decision. No difference in repetition priming is observed between categorized and randomized words following L2-L1 translation. This result implies that L2-L1 translation does not provide conceptual-level information that could influence later processing of repeated words.

The results are not as clear for the naming data. For naming, the three-way interaction of direction of translation x presentation language x repetition was marginally significant, $\underline{F}_1(1, 29) = 3.43$, $\underline{MSe} = 564.11$, $\underline{p} < .10$. This interaction resulted from smaller priming effects in the between-language conditions, relative to the within-language conditions. Unlike the

lexical decision data, the naming data reveal an effect of list type only following L2-L1 translation. This finding, coupled with the observation of categorical facilitation in L2-L1 translation, might indicate a match between level of processing during study and level of processing during test when naming words following L2-L1 translation. That is, the magnitude of cross-language repetition priming observed for naming, a lexical-level task, is greater following the translation route proposed to require lexical-level processing. Indeed, no effect of list context was observed following L1-L2 translation; apparently, naming performance cannot be affected by prior conceptual-level processing.

CHAPTER IV
GENERAL DISCUSSION

The main prediction tested in the current experiment concerned the ability of a transfer-appropriate processing framework to account for repetition priming effects across a bilingual's two languages. According to such a framework, cross-language repetition priming should be observed in conditions where the level of processing required during the study task matched the processing requirements at the time of testing (Durgunoglu & Roediger, 1987). This logic was in turn used to test predictions regarding the level of processing engaged by the two directions of translation. Based on assumptions made by the revised hierarchical model of bilingual memory representation (Kroll & Stewart, 1990; 1992), L1-L2 translation served as the conceptual-level study task, while L2-L1 translation constituted a lexical-level study task. According to the revised hierarchical model, translation from L1 to L2 requires conceptual access in addition to activation of the lexical representations within each language. However, translation from L2 to L1 is hypothesized to require lexical but not conceptual access. If cross-language repetition priming is the result of a match between processing at study and test, and if the two directions of translation differ in terms of processing requirements, then repetition priming should be observed across languages only when the processing requirements for the task in which translation equivalents are repeated matches the processing engaged during the initial encounter with the translation equivalents. Lexical decision, which is sensitive to semantic or conceptual-level context effects, was expected to be sensitive to the conditions of conceptual encoding during Part 1. Naming,

which is hypothesized to be a purely lexical task, was not expected to vary as a function of the degree of conceptual processing during Part 1.

The overall results of Part 2 in this experiment support the predictions of transfer-appropriate processing theory. Although repetition priming was observed across languages in both the naming and the lexical decision tasks the magnitude and pattern of transfer differed for the two tasks. In lexical decision, the magnitude of the cross-language repetition priming effect following L1-L2 translation was much greater than that observed following L2-L1 translation. According to the revised hierarchical model, L1-L2 translation is accomplished via a conceptual route, whereas L2-L1 translation is a lexical-level task. Thus, making lexical decisions for repeated translation equivalents, which engage both lexical and conceptual level processes, is facilitated following both types of translation. Because lexical decision is sensitive to conceptual level factors, however, processing an L2 word following L1-L2 translation shows an additional benefit of this match between processing at study and processing at test.

In the naming task, a different pattern of priming effects emerges. While significant cross-language repetition priming was observed in the naming task, the magnitude of those priming effects was extremely small and was not a function of the direction in which subjects translated during Part 1. Because word naming is a task that is not sensitive to conceptual-level variables, engaging conceptual processes during the initial encounter of a translation equivalent provides no additional facilitation for naming that translation equivalent in a subsequent task. Rather, the small cross-language repetition priming effects observed in the naming task may be due to the access of both the L1 and the L2 lexical representations during the translation task. Regardless of the direction in which subjects translated during Part 1,

the use of translation as a study task provides the opportunity for both lexical representations to be activated prior to the presentation of a repeated target word. As discussed in the introduction, the failure to find cross-language repetition priming in previous research may be understood as a consequence of the choice of study tasks that did not encourage subjects to access both the L1 and the L2 lexical representations of translation equivalents.

Taken together, the results of both the lexical decision and naming tasks suggest that cross-language repetition priming occurs when the lexical representations associated with each of the languages are activated during study. However, the differential pattern of cross-language priming in lexical decision and its sensitivity to the semantic context in which the study task was performed, further suggests that conceptual factors contribute to the degree of priming if the task at test is sensitive to them. This finding lends additional support to arguments made in the current implicit memory literature, that propose that the implicit/explicit distinction is not as dichotomous as previously suggested. Past experimental manipulations of implicit memory tasks have assumed that implicit tasks are data-driven, whereas explicit memory tasks are conceptually-driven (e.g., Jacoby, 1983). This distinction seems to be too extreme, however, since a number of recent experiments have produced conceptual-level transfer using implicit memory tasks. The present experiment also constituted an implicit memory task; subjects were not instructed to consciously study the words presented during the initial translation task, and performance in the subsequent naming and lexical decision tasks did not require explicit knowledge gained during the preliminary translation task. Thus, any facilitation of repeated items in the naming and lexical decision tasks could only be attributed to the prior processing of those items in the translation task;these implicit tasks were not

simply data-driven. The conceptual-level effects observed in this study are similar to findings of explicit memory tasks; for example, Kroll and Stewart (1990; 1992) had subjects perform an explicit recall task following both directions of translation. Explicit recall performance was influenced by list context following L1-L2 translation. Following L2-L1 translation, however, explicit recall showed no effect of the context in which the words had been translated. Apparently, the distinction between implicit and explicit memory tasks is not as sharp as previous researchers have proposed, since both types of tasks can potentially be affected by semantic variables.

It is important to note that, in the naming task, the between-language conditions are also the conditions in which the repeated words have been produced twice. For example, if subjects performed L2-L1 translation in Part 1, then they would have potentially produced an L1 word in response to a displayed word in L2. For the subset of those subjects who subsequently participated in the L1 naming task in Part 2, the production of some of those L1 words would be repeated. Apparently, repetition of the production process itself does not produce priming. Nonetheless, the repetition priming effects observed for the two between-language conditions in the naming task were significant despite their small size, suggesting the presence of lexical-level transfer.

The results of the present study serve to highlight the contributions of different levels of processing to cross-language repetition priming, and to make predictions regarding the importance of different types of processing in the production of repetition priming across languages. The four representational components that can potentially determine the presence (or absence) of cross-language repetition priming are (1) form/orthographic representation, (2) phonological representation, (3) lexical representations in

both L1 and L2, and (4) conceptual representation. The strongest repetition priming effects observed in this experiment were for the within-language conditions, which indicates that the primary component of repetition appears to be orthographic overlap. The importance of form repetition has also been demonstrated in the cross-modal priming literature; most studies exploring picture-word priming have failed to find significant repetition priming effects across form (Scarborough, Gerard, & Cortese, 1979; Durso & Johnson, 1979; Kroll & Potter, 1984; Sholl, 1990). In the case of cross-language repetition, however, orthographic representation is usually not identical across translation equivalents, and thus does not tend to play a large role in the production of cross-language repetition priming. Note, however, that strong repetition priming effects are observed for cognates (Caramazza & Brones, 1980; Cristoffanini, Kirsner, & Milech, 1986; de Groot & Nas, 1991; Sanchez-Casas, Davis, & Garcia-Albea, in press). Cognates are defined as translation equivalents that share a high degree of orthographic overlap. The repetition of phonological representation, as demonstrated in the between-language conditions in the naming task, also do not seem to produce priming across languages. While activation of both L1 and L2 lexical representations does produce marginal priming across languages, the key component of cross-language repetition priming appears to be the activation of the language-independent conceptual representation.

As proposed in the introduction, the failure in previous experiments to obtain cross-language repetition priming can most likely be attributed to the failure to engage conceptual-level processing during both the encoding and retrieval tasks. The null results of the previous literature have been interpreted as support for a model of bilingual memory representation with language-dependent lexicons. The present results could, in turn, imply that

bilinguals have a single, language-independent lexicon. For example, Grainger and Dikjstra (1992) propose such a model, in which orthographic representations in both languages are activated simultaneously within a shared lexicon. This type of model is not supported by the current results, which show generally smaller repetition priming effects for between-language conditions (presumably due to a lack of orthographic overlap). More importantly, interpreting the present results as support for a single lexicon is not appropriate. The absence of repetition priming effects across languages in the previous literature does not provide any evidence concerning the conceptual level of representation. The main flaw with past experiments was the lack of attention paid to semantic processing. Instead of discarding the conclusions drawn from the past literature, those conclusions should be incorporated with the results of the current study to demonstrate that, while bilinguals do seem to have language-dependent lexicons, the language-independent conceptual store serves to connect them.

Two experiments from the cross-modal priming literature provide conflicting evidence for the role of conceptual-level access in the production of repetition priming across form types. Conceptual access did not appear to produce repetition priming across modalities in an experiment conducted by Scarborough et al. (1979). Scarborough et al. examined the effects of naming both words and pictures on subsequent lexical decisions involving repetitions of the words and picture names. Their results indicated that previously-named words facilitated the lexical decision latencies for the repeated words, whereas previously-named pictures did not improve subjects' lexical decision latencies for the repeated names. This result implies that conceptual activation does not produce repetition priming across different forms. In another experiment that demonstrated the facilitatory effect of conceptual

activation in cross-modal priming, Kroll and Potter (1984) had subjects perform a reality decision task; pictures of objects and non-objects, words, and nonwords were presented in a random, mixed format, and subjects had to decide whether or not items were real. Critical stimuli were repeated within and across modalities to determine the amount of facilitation provided via repetition. This type of task was chosen because conceptual access was required for processing in both modalities. Results did indicate a small but significant amount of facilitation for lexical decisions preceded by object decisions for the same stimulus concept, indicating that access of the conceptual representation shared across forms produced cross-modal repetition priming.

These current results pose a challenge to the hypothesis put forward by Smith (1991). In her recent work, she proposed that the locus of the cross-language repetition priming effect was at the conceptual level of representation that serves to connect the bilingual's two languages. This claim was based on cross-language repetition priming obtained in a word-fragment completion task following an inference generation task. According to Smith, subjects showed facilitated performance in completing word fragments based on translations of words generated during the inferencing task because of the conceptual processing required by the inference generation task. That is, activation of a conceptual representation via one of its lexical representations facilitated the later processing of the other lexical representation. None of the conditions in Smith's experiment provided a test of the priming capability of lexical-level processing. The results of the current experiment certainly lend some credence to Smith's proposal that activation of the language-independent conceptual store produces strong

repetition priming effects across a bilingual's two languages. Conceptual activation, however, does not seem to be the only source for such effects.

This argument must be made with some hesitation, due to some unexpected findings in the Part 1 translation task. Initial predictions, based on the revised hierarchical model, assumed that L2-L1 translation was not conceptually mediated. The results of the translation task revealed an effect of the semantic context of the list in which a to-be-translated word appeared (i.e., whether the list was categorized or randomized) in both directions of translation. This result is not immediately explained by the revised hierarchical model, which would have predicted an effect of list context for L1-L2 translation only, but could be accounted for by examining the fluency of the bilingual subjects tested in this study. A post-hoc analysis compared translation latencies for both directions of translation as a function of subjects' average error rates; the results are shown in Table 4.1.

Table 4.1: Mean translation latencies (in milliseconds) as a function of fluency, list context, and direction of translation

	Direction of Translation			
	L1-L2		L2-L1	
Subject Fluency	CAT List	RAN List	CAT List	RAN List
Fluent (< 25% errors)	1290	1469	1213	1274
Novice (> 25% errors)	1568	1765	1231	1432

For L2-L1 translation, only subjects whose average error rate was higher than 25% showed category facilitation in the translation task. Subjects with error rates lower than 25% showed no effect of list context when translating from L2 to L1. This result implies that, for subjects who are error prone (i.e., less

fluent), the context in which to-be-translated words appear can facilitate translation performance. Subjects who are more accurate (i.e., more fluent) do not gain any benefit from list context in their translation performance. Additionally, error rate did not interact with list context in L1-L2 translation performance; subjects with low error rates and subjects with high error rates both showed category facilitation when translating from L1 to L2. This dissociation in terms of fluency effects between L1-L2 translation and L2-L1 translation strengthens the proposal that the two directions of translation reflect different processing requirements.

The observation of a highly significant effect of direction of translation in Part 1 (L1-L2 translation takes longer than L2-L1 translation), coupled with a higher error rate for L1-L2 translation, provide further support for the asymmetry in translation performance on which the revised hierarchical model was initially based. This asymmetry may reflect the additional retrieval processes required for L1-L2 translation. For example, the access of L2 phonology in L1-L2 translation is presumably more difficult than the access of L1 phonology in L2-L1 translation. The asymmetry can also be characterized in terms of recognition and recall performance; L1-L2 translation is similar to recall, since a non-balanced bilingual is less likely to have an L2 lexical representation for every L1 lexical representation, whereas L2-L1 translation can be compared to recognition, since an L1 lexical representation should be present for every L2 lexical representation.

Another surprising result in the translation task was the observation of facilitated translation latencies for words presented in categorized lists. While this result was not predicted, it does not necessarily conflict with the revised hierarchical model. Kroll and Stewart (1990; 1992), in a similar translation task, had observed increased translation latencies for items presented in a

categorized format. They attributed this interference to the activation of candidates that were semantically related to the translation; these activated lexical representations would compete with the correct translation, thus making production of the single correct candidate more difficult. The observation of categorical facilitation in the current experiment could be due to the lower level of fluency exhibited by these subjects in their second language. Results showed that categorical facilitation was much greater for less-fluent bilinguals. Kroll and Curley (1988) reported a similar result for translation from L1 to L2; for fluent bilinguals there was interference in categorized lists, but for novice bilinguals there was facilitation under the same conditions. Perhaps this effect of list context reflects the method by which these bilinguals learned their second language. That is, the less-fluent subjects in this experiment were sampled from a population of U.S. college students attending a school with a foreign language requirement. Many of these subjects had begun to acquire their second language within the past four to six years (during high school and/or college). Many textbooks used in the United States to teach foreign languages introduce students to new L2 words in categorical groups (e.g., students learn vocabulary words based on themes such as "going to a restaurant," "going to class," "members of the family," "animals at the zoo," etc.). Students who acquire L2 vocabulary in this manner may use the context in which words appear to a greater extent in their translation performance; thus, these novice bilinguals may actually show facilitation effects for translating categorized lists of words. As these bilinguals become more proficient in their second language, however, the categorization that once served to aid their translation performance could begin to affect their translation latencies in a more adverse way. More fluent bilinguals should have stronger links between the L2 lexicon and the

conceptual level of representation, thus the potential for feedback from the conceptual level of representation to the lexical level increases as the bilingual becomes more fluent.

Another factor that may have contributed to the categorical facilitation effect observed in the present study is the experimental design. In the current experiment, the presentation of items was blocked by translation direction, and subjects only performed the translation task in one direction. In Kroll and Stewart's (1990) experiment, subjects named words in both languages and translated in both directions. The within-subject design employed by Kroll and Stewart (1990; 1992) could have contributed to an overall categorical interference effect. Additionally, the number of presented exemplars per category differed across the two studies, such that Kroll and Stewart's subjects saw 18 exemplars per category, while subjects in the present study saw only 12 exemplars per category. The presentation of a longer list of semantically-related items in a translation task could increase the likelihood of categorical interference, as suggested by Brown (1981).

In considering the varying fluency of the German and English bilinguals who participated as subjects in this experiment, yet another concern is raised. Because most of the variables in this experiment were tested using a between-subjects design, could the results obtained in this study reflect overall speed differences among groups of subjects, rather than theoretically-motivated differences? For example, could the different magnitudes of cross-language repetition priming observed in the lexical decision task be due to individual differences in baseline lexical decision latencies rather than differential processing requirements engaged by the two directions of translation during Part 1? This possibility is unlikely, because comparisons of latencies and error rates in the within-language conditions

reveal similar results across subject groups. However, a revised version of this study is being created using a completely within- subject design and only highly fluent bilinguals, so that the results of the current study can be replicated under less variable conditions.

In conclusion, the most striking result in the current experiment is the observation of repetition priming across the two languages of bilingual subjects. Cross-language repetition priming was observed following both directions of translation, indicating that activation of a shared conceptual representation is not the only means of obtaining the effect. Additionally, the results of the current experiment provide further support for the revised hierarchical model of bilingual memory representation (Kroll & Stewart, 1990; 1992), and demonstrate that fluency is an important factor in defining represenational models.

APPENDIX A

EXPERIMENTAL MATERIALS

Part 1 Practice Stimuli:

Categorized:

English:	**German:**
face	Gesicht
eye	Auge
ear	Ohr
elbow	Ellbogen
arm	Arm
mouth	Mund
leg	Bein
foot	Fuß
nose	Nase
hair	Haar
head	Kopf
neck	Hals

Randomized:

English:	**German:**
bee	Hummel
spider	Spinne
crayon	Zeichenstift
pen	Kugelschreiber
bracelet	Armband
earring	Ohrringe
square	Viereckig
circle	Kreis
church	Kirche
finger	Finger
gun	Pistole
telephone	Telefon

Part 2 Practice Stimuli:

English:	**German:**
bag	Sack
elm	Ulme
road	Straße
town	Stadt
nurse	Krankenschwester
juice	Saft
lawyer	Rechtsanwalt
winter	Winter
husband	Ehemann
volcano	Vulkan
audience	Publikum
calendar	Kalender
calt	Abschliß
kand	Dilch
bemmer	Ebend
terwin	Gehürn
mab	Jamner
hox	Grauel
ruver	Dische
shabe	Fessung
votanim	Wolber
sceance	Kepner
dastruct	Zautung
gorevron	Vorord

Categorized translation words:

Category 1 (Animals):

English:	German:
elephant	Elefant
cat	Katze
tiger	Tiger
pig	Schwein
camel	Kamel
cow	Kuh
squirrel	Eichhörnchen
monkey	Affe
giraffe	Giraffe
gorilla	Gorilla
dog	Hund
raccoon	Waschbär
zebra	Zebra
lion	Löwe
mouse	Maus
rabbit	Kaninchen

Category 2 (kitchen utensils):

English:	German:
oven	Ofen
cup	Tasse
spoon	Löffel
bowl	Schale
knife	Messer
corkscrew	Korkenzieher
rolling pin	Nudelholz
pan	Pfanne
toaster	Toaster
ladle	Schöpflöffel
saltshaker	Salzfaßchen
glass	Glas
pot	Topf
refrigerator	Kühlschrank
fork	Gabel
pitcher	Krug

Category 3 (vehicles):

English:	German:
wagon	Wagen
bus	Bus
helicopter	Hubschrauber
wheelbarrow	Schubkarre
bicycle	Fahrrad
train	Zug
airplane	Flugzeug
rollerskate	Rollschuh
motorcycle	Motorrad
sled	Schlitten
car	Auto
skateboard	Skateboard
rocket	Rakete
ambulance	Krankenwagen
truck	Lastkraftwagen
submarine	Unterseeboot

Category 4 (musical instruments):

English:	German:
bagpipes	Dudelsack
violin	Geige
tuba	Tuba
drum	Trommel
harp	Harfe
clarinet	Klarinette
trumpet	Trompete
bell	Glocke
accordion	Akkordeon
flute	Flöte
guitar	Gitarre
saxophone	Saxophon
piano	Klavier
harmonica	Harmonika
trombone	Posaune
cello	Cello

Randomized translation words:

Random group 1:

English:	German:
pineapple	Ananas
orange	Orange
belt	Gürtel
skirt	Rock
dresser	Kommode
television	Fernsehen
nut	Schraubenmutter
scissors	Schere
box	Büchse
ashtray	Aschenbecher
spool	Rolle
comb	Kamm
artichoke	Artischocke
shoe	Schuhe
vase	Vase
screw	Schraube

Random group 2:

English:	German:
banana	Banane
apple	Apfel
boot	Stiefel
glove	Handschuh
drapes	Vorhänge
chair	Stuhl
chisel	Meißel
saw	Säge
fence	Zaun
candle	Kerze
arrow	Pfeil
iron	Bügeleisen
potato	Kartoffel
tie	Schlips
sofa	Sofa
ruler	Lineal

Random group 3:

English:	German:
cherry	Kirsch
celery	Sellerie
vest	Unterhemd
pants	Hose
table	Tisch
stool	Hocker
hoe	Hacke
ladder	Leiter
watch	Armbanduhr
zipper	Reißverschluß
peanut	Erdnuß
thimble	Fingerhut
onion	Zwiebel
glove	Fausthandschuh
bed	Bett
nail	Nagel

Random group 4:

English:	German:
lemon	Zitrone
carrot	Karotte
dress	Kleid
hat	Hut
bookcase	Bücherregal
rug	Teppich
shovel	Schaufel
pliers	Zange
pencil	Bleistift
stamp	Briefmarke
suitcase	Handkoffer
bottle	Flasche
grapes	Weinbeeren
jacket	Jacke
rocking chair	Schaukelstuhl
hammer	Hammer

Filler words:

English:	German:	English:	German:
bread	Brot	book	Buch
snowman	Schneeman	barrel	Faß
hanger	Kleiderbügel	swing	Schwung
feather	Feder	cloud	Wolke
chain	Kette	pipe	Pfeife
lawnmower	Rasenmäher	whistle	Pfiff
igloo	Igloo	windmill	Windmühle
clothespin	Wäscheklammer	butterfly	Schmetterling

Nonwords:

English:

pirry
tragopan
brosna
pratons
nutch
schloss
quenda
fermalin
drom
tomp
pesfure
praiss
rov
galipot
steck
insepior
carobin
plime
endrumpf
ligure
konnel
diagoner
wellet
stalbard
topepo
plonk
hallock
stammel
sheder
himation
buddle
haratons
roolist
swoin
conscrit
winze
insret
arctoon
zow
speamer
eyra
daftar
japer

arbalest
bonang
juey
cruck
thapter
slockery
erbor
spanghew
shrenk
quocken
lig
chrotta
colugo
tartine
ettercap
acate
ruban
gelson
chirmist
dreve
abralian
aglet
nirles
fantor
halidom
exprack
jox
anly
puteli
voxcera
arnaper
tinal
slifter
irch
crumnal
egashire
betch
thribble
hawlined
gebang
tolin
strow
plong

German:

Abschliß
Anbliek
Biert
Baun
Begraff
Berflaug
Birge
Chronst
Dieten
Dilch
Dänkel
Dische
Dreidt
Einöße
Ebend
Faben
Fessung
Fötzen
Gefüß
Gehürn
Grauel
Hentel
Hender
Hüdel
Jamner
Jungter
Kampt
Kande
Kelb
Kepner
Klicks
Knüß
Krieze
Kurst
Laud
Landt
Leip
Laucht
Liepfe
Mardinnen
Miester
Minsch
Müßtel

Nurm
Nutsch
Obdecht
Ordgang
Öbe
Pecht
Peldt
Pekel
Pflick
Plinke
Pilder
Pürch
Pulster
Rahn
Raden
Reklade
Raß
Rundt
Rünsch
Satche
Saldt
Schößel
Schintel
Schlein
Stiepfe
Strank
Sturn
Tift
Truhne
Treube
Tüßch
Umpflatz
Unmansch
Urticht
Urkandt
Verpotz
Verschlapf
Versach
Vorord
Wechskurze
Wirze
Wöckel
Worbel

Nonwords, continued:

nazzle
valatory
dreckler
heng
dowter

digor
heg
fompuler
bight
codintale

Möwe
Nöhe
Nubel
Neipte
Nirz

Wolber
Wenzer
Zähler
Zautung
Zögel

APPENDIX B

BILINGUAL SUBJECT QUESTIONNAIRE

Subject number:________

Part I: Language Background

1. Age:_____ 2. Sex:_____ 3. Native Country:__________________

4. Years in U.S.:______________ 5. Years in U.S. schools:_______

6. What countries other than the USA and your native country have you visited for longer than a month? How long were you there?

7. How many languages do you know?___________

8. List, **from most fluent to least fluent**, all of the languages that you know. Specify the age at which you began to learn the language and where you learned it (i.e., home, school, religious institution, etc.). For example, if English was your first language you would indicate this by writing "English, Birth, Home" under the appropriate headings below. Include languages to which you have been exposed although you may not have received any formal training in them and may not be able to speak or read them.

Language:	Age:	Learning Situation:
______________________	______	________________
______________________	______	________________
______________________	______	________________
______________________	______	________________

9. What language do you speak at home with your family most frequently? (List languages spoken in your home in order of frequency.)

10. What languages were spoken in your home when you were a child?

11. If English is not your first language, how many years have you studied English? Where? (Please indicate if your experience has been other than that of classroom learning.)

Part II: Fluency

12. Please rate your second and third language literacy (reading and writing) on a ten-point scale (1=not literate, 10=very literate).

Language:____________________

1	2	3	4	5	6	7	8	9	10
not literate									very literate

Language:____________________

1	2	3	4	5	6	7	8	9	10
not literate									very literate

13. Please rate your second and third language conversational fluency on a ten-point scale (1=unable to form a complete sentence in conversation, 10=able to relay your thoughts in any situation).

Language:____________________

1	2	3	4	5	6	7	8	9	10
not fluent									very fluent

Language:____________________

1	2	3	4	5	6	7	8	9	10
not fluent									very fluent

Part III: German Background

14. At what age did you begin speaking German?

15. At what age did you begin reading German?

16. If German is not your native language, how many years have you studied German? Where? (Please indicate if your experience has been other than that of classroom learning.)

17. Does any member of your family speak German? Who?

18. List any additional comments on your language background on the back of this form. Thank you for your participation!!!

APPENDIX C

CONSENT FORM

Department of Psychology
University of Massachusetts

Consent Form

This is to request your participation in an experiment on first and second language processing.

1. In the first half of this experiment, you will see (English/German) words on the computer screen. You will then be asked to translate the words into (German/English) as rapidly as possible.
2a. In the second half of this experiment, you will see (English/German) words on the computer screen. You will be asked to name the words as quickly as possible.
2b. In the second part of the experiment, you will see letter strings on the screen, and you will be asked to decide whether or not these letter strings are real (English/German) words.
3. Your responses will be tape-recorded, because the voice-activated response key used in our lab does not record what you have said, but only that you've made noise. The tape recording will be used only to analyze your data, and your anonymity will be protected.
4. The entire session should last about 45 minutes.
5. There is no discomfort expected during the session; however, you have the right to terminate the session at any time without explanation.
6. Further instructions will be shown to you on the computer screen and explained verbally.
7. If you wish to learn about the results of this study, please check below and fill in your address.
8. You will receive one credit or $3.00 for your participation.

I have read the above statement and consent to participate in this experiment of my own free will. I understand that I am free to discontinue participation at any time without explanation. I understand that this form will not be used in conjunction with the results of the study, so that my identity will be protected. I understand that if I am dissatisfied with any aspect of this experiment, I may report grievances anonymously to the department of Psychology at the University of Massachusetts.

Signed:______________________________ Date:____________________

______Yes, I would like to learn about the results of this study. Please send a summary of the results to:

Name:______________________________________
(please print)

Address:______________________________

____

____

APPENDIX D

INSTRUCTIONS

Instructions for Part 1 Translation Task

This experiment has two parts. In the first part of the experiment, you will be presented with a series of (German/English) words. These words will appear one at a time, in the center of the computer screen. Your task is to translate each word into English as it is presented on the screen. When a (German/English) word appears, you will respond by translating it into (English/German) out loud, into the microphone, as quickly and as accurately as possible. The microphone is attached to a voice key that will pick up and record your response. Please speak loudly, and try not to cough, say "um", tap your fingers on the table, etc. because the voice key is extremely sensitive to any noise and will record such noises as responses. If you do make a mistake, however, do not worry and do not try to change your response.

You may start each trial by pressing the space bar with your left hand. Press the space bar after each response to bring the next word up onto the computer screen. Remember--translate each (German/English) word into (English/German) into the microphone as quickly and as accurately as possible. If you need to take a break, wait to press the space bar. Breaks will be offered by the program periodically--to resume, press the space bar.

You will now have the opportunity to perform some practice trials, so that you can become comfortable with the translation task.

Do you have any questions?

Instructions for Part 2 Naming

In the second part of the experiment, you will be presented with a series of (German/English) words. These words will appear one at a time, in the center of the computer screen. Your task is to name each word as it is presented on the screen. When a word appears, you will respond by naming it out loud, into the microphone, as quickly and as accurately as possible. The microphone is attached to a voice key that will pick up and record your response. Please speak loudly, and try not to cough, say "um", tap your fingers on the table, etc. because the voice key is extremely sensitive to any noise and will record such noises as responses. If you do make a mistake, however, do not worry and do not try to change your response.

You may start each trial by pressing the space bar with your left hand. Press the space bar after each response to bring the next word up onto the computer screen. Remember--pronounce each word out loud into the microphone as quickly and as accurately as possible. If you need to take a break, wait to press the space bar. Breaks will be offered by the program periodically--to resume, press the space bar.

Do you have any questions?

Instructions for Part 2 Lexical Decision

In the second part of this experiment, you will be presented with a series of letter strings. These letter strings will be presented one at a time, in the center of the computer screen. Your task is to decide whether each letter string is a real German/English word or not. You will respond by using the pushbutton response box. Orient the box so that the cord is facing away from you. Place a thumb on each button. Note that "YES" is on your LEFT, and "NO" is on your RIGHT. If the letter string presented on the computer screen is a real (German/English) word (e.g., "MUTTER"/"MOTHER"), then you will respond by pressing the "YES" button with your left thumb. If the letter string presented on the computer screen is not a real (German/English) word (e.g.,"MIESTER"/"MOSTER") then you will respond by pressing the "NO" button with your right thumb.

Please be as quick and as accurate as you possibly can. If you make a mistake, do not worry and do not try to change your response. You may start each trial by pressing the space bar with your pinkies, while keeping your thumbs on the pushbuttons.

We will give you practice to get used to the task. Remember--respond as quickly and as accurately as possible.

Do you have any questions?

APPENDIX E

MONOLINGUAL CONTROL STUDY

A control study was performed in order to check baseline lexical decision and naming latencies for the Part 2 materials. Thirty-two monolingual English speakers participated as subjects in this control study. Sixteen subjects completed an English version of the lexical decision task used in Part 2 of the current experiment, and 16 subjects completed an English version of the naming task. Mean latencies were calculated for both subjects and items. The following items produced significantly longer reaction times and/or significantly higher error rates in comparison to other items presented in the experiment: cello, clothespin, lawnmower, pitcher, refrigerator, snowman, trombone. These items were not included in the current analyses because they were members of the new and filler sets; had they been included in the analyses, repetition priming effects based on comparisons using new and filler words could be artificially inflated.

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