

UNIVERSITY OF CALIFORNIA

SANTA CRUZ

CONCRETENESS EFFECTS IN HIGH FREQUENCY WORDS: A TEST OF THE  
REVISED HIERARCHICAL AND THE MIXED MODELS OF BILINGUAL  
MEMORY REPRESENTATIONS

A dissertation submitted in partial satisfaction  
of the requirements for the degree of

DOCTOR OF PHILOSOPHY

in

PSYCHOLOGY

by

Roberto Ramírez Heredia

June, 1995

The dissertation of Roberto  
Ramírez Heredia is approved:

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Copyright © by  
Roberto Ramírez Heredia  
1995

## Table of Contents

Table of Contents	iii
List of Figures	v
List of Tables	vi
Abstract	vii
Acknowledgements	ix
<b>Introduction</b>	<b>1</b>
<b>Chapter 1: Theoretical Formulations and Empirical Support</b>	<b>3</b>
Early Theoretical Formulation	3
Kolers' Shared vs. Separate Systems	5
Present View of Bilingual Memory	7
Bilingual Memory Findings: An Illustration	9
<b>Chapter 2: Lexical-Conceptual Models of Bilingual Memory</b>	<b>12</b>
Evidence for Lexical and Conceptual Representations	12
Hierarchical Models : The Association and Concept Mediation Models	13
The Revised Hierarchical Model	17
Bilingual Memory Representations at the Word Type Level	21
<b>Chapter 3: Relevance of Word Type in Bilingual Memory Representations</b>	<b>27</b>
Relevance of Word type in Bilingual Memory Representations	26
The Revised Hierarchical Model	28
The Distributed Model	29
<b>Chapter 4: Effects of Concreteness on Lexical Processing</b>	<b>31</b>

<i>Experiment 1: Naming Task</i>	31
Methods	32
Results and Discussion	39
<i>Experiment 2: Normal Translation Task</i>	46
Methods	47
Results and Discussion	48
<i>Experiment 3 : Translation-Recognition Task</i>	57
Methods	58
Results and Discussion	61
<b>Chapter 5: General Discussion</b>	67
Evidence for the hierarchical model	67
Evidence for the distributed model	70
Implications for models of bilingual memory representations	71
Implications for future work	72
References	74
Appendix A	87
Appendix B	94



**List of Tables****Table 1** 33

Background Information for the Spanish-English Subjects

**Table 2** 40

Mean Naming Latencies (ms) and Mean Percentage Accuracy to Perform the Naming Task as a Function of Word Type and Language.

**Table 3** 50

Mean Translation Latencies (Ms) and Mean Percentage Accuracy to Perform Translations as a Function of Word Type and Language.

**Table 4** 53

Mean Percentage Accuracy to Perform Translations as a Function Word Type and Language.

**Table 5** 55

Mean Translation Latency (ms) differences between Experiment 1 and Experiment 2 as a Function of Word Type and Language.

**Table 6** 62

Mean Translation-Recognition Latencies (ms) and Mean Percentage Accuracy to  
Recognize Translations as a Function of Word Type and Language for Experiment 3.

**Concreteness Effects in High Frequency Words: A Test of The Revised  
Hierarchical and the Mixed Models of Bilingual Memory Representations**

**Roberto Ramírez Heredia**

Three experiments using high frequency abstract and concrete words tested two current models of bilingual memory representation (e.g., the *hierarchical* and the *mixed* models). Experiment 1 explored the differential effects of concreteness in a naming task. Contrary to the predictions of the hierarchical model, subjects named abstract and concrete L2 (second language) words faster than L1 (first language) words. More important, naming L1 concrete words did not differ from naming L1 abstract words. The subjects' L1 was more sensitive to lexical processing, whereas the subjects' L2 was more sensitive to semantic processing. Experiment 2 repeated Experiment 1 utilizing a translation task. The results showed that in the concrete condition, L1 to L2 translation latencies were not significantly different than L2 to L1 translations. Both language translations took advantage of the semantic processing requirements of the translation task and the semantic code of concrete words. However, subjects were faster translating L1 to L2 abstract words than L2 to L1 abstract words. Unlike Experiment 1 that showed that subjects were faster in naming L2 words, subjects experienced more difficulties translating L2 to L1 than L1 to L2 words. Experiment 3 replicated Experiment 2 using a translation-recognition task (De Groot, 1992a). Both language translations took advantage of the semantic code of concrete words. However, recognizing L1 to L2 concrete translations did not differ from recognizing abstract L1 to L2 translations. Like Experiment 1, subjects' L1 was more sensitive to the lexical processing demands of the

translation-recognition task. The subjects' L2 was more sensitive to the semantic processing of the task. This study clearly demonstrated the importance of controlling word type, word frequency and language effects in bilingual memory experiments.

Overall, the present findings support the hypothesis that concrete and abstract words are fundamentally different and represented differently in bilingual memory. Concrete words are processed similarly across-languages and abstract words are processed differently across-languages. The implications of these findings are discussed in terms of the hierarchical and the mixed (distributed) models of bilingual memory representation.

### **Acknowledgements**

I'd like to thank Barry McLaughlin for his help as dissertation advisor and for his guidance and support throughout my graduate career, Mary Susan Weldon for her guidance and willingness to sit on my committee and her excellent insights and recommendations, Dominic Massaro for his willingness to be my committee chair and for his support and advise and Kenji Hakuta for his willingness to sit on my committee. I am indebted to a large number of fellow graduate students and friends who have contributed to my understanding and appreciation of life and friendship (e.g., Margarita Azmitia, Dinara Beitel, Pablo Chavajay, Herb Colston, William Farrar, Antoinette Gesi, Sandra Pacheco, Luis Vega, Tony Villar and John Zemblidge). Of course, my parents (Esperanza and Eliseo), my siblings, nieces, nephews and brother-in-law Ramón have been invaluable.

## Introduction

How do bilinguals integrate their two memory systems? Although early work in bilingual memory addressed this question under a one versus two memory systems perspective (e.g., Glanzer & Duarte, 1971; Kolers, 1963, 1966; Kolers & González, 1980; Paivio, Clark & Lambert, 1988), most recent work emphasizes memory processes rather than memory systems (e.g., Durgunoglu & Roediger, 1987). Moreover, current theoretical models of bilingual memory representation, such as the *hierarchical model* (Kroll & Sholl, 1992; Kroll & Stewart, 1994; Potter, So, Eckardt & Feldman, 1984) and the *distributed model* (De Groot, 1992a, 1992b, 1993), have replaced past ambiguous and poorly defined bilingual models that were difficult to test or were too general (Glucksberg, 1984; Kolers & Brison, 1984; Paradis, 1985). These present models specify lexical and conceptual representations and generate clear predictions regarding memory for concrete/abstract and cognate/noncognate words (e.g., the *distributed model*), and translations/semantic priming (e.g., the *hierarchical model*). Such specifications allow us to make theoretical comparisons between models and determine which models best explain bilingual memory representations.

The following sections review early formulations and controversies of bilingual memory findings. Two main paradigms are discussed, (a) the memory tradition introduced by Kolers (1963), and (b) the cross-language primed lexical decision domain introduced by Meyer and Rudy (1974). My aim here is to show that the interpretation of this research remains unclear due to its ambiguous theoretical specifications. After

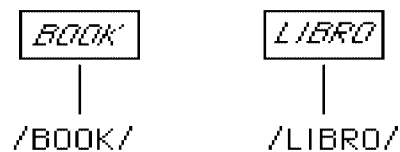
reviewing both the theoretical and empirical work in bilingual memory, I describe the *distributed model* and the *hierarchical model* of bilingual memory representation. I discuss the predictions generated by these models about how bilingual memory is organized. My purpose is to determine the effects of abstract and concrete words in bilingual memory by controlling for frequency and to discriminate between models of bilingual memory representation. Finally, I present three experiments controlling for factors found to influence bilingual memory and that directly address the above models. I begin by discussing and evaluating the original formulations by Weinreich (1953) and Ervin and Osgood (1954).

## Chapter 1

### Theoretical Formulations and Empirical Support

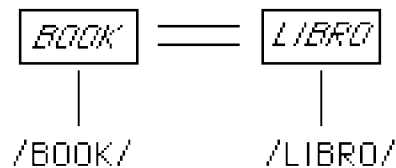
#### *Early Theoretical Formulation*

Weinreich (1953) made the first theoretical distinction between bilingual memory systems: *coexisting*, *merged*, and *subordinate*. In the coexisting system, bilinguals maintained two separate conceptual systems (See Figure 1). These systems were separate because of the bilingual's two cultural experiences. Thus for /book/ and /libro/ English-Spanish bilinguals were viewed as having two different representations.



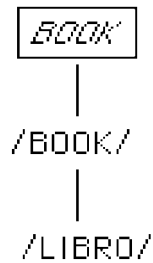
**Figure 1. The coexisting system**

The merged bilingual (See Figure 2), on the other hand, was viewed as interpreting two concepts with a single representation.



**Figure 2. The merged system**

For the subordinate system, the concept of the second language was a direct translation of the first language (See Figure 3).



**Figure 3. The subordinate system**

For instance, for the English speaker learning Spanish, /libro/ is a direct translation of /book/. It is important to note that Weinreich (1953) did not view these classifications as mutually exclusive. That is, it was possible for a subordinate system to develop into a merged system.

Ervin and Osgood (1954) formalized Weinreich's view into a psychological model. Weinreich's coexisting bilingualism became *coordinate bilingualism* and the merged bilingualism became *compound bilingualism*. In a coordinate system, both the linguistic concepts and responses appropriate to each language came to be associated with a unique set of representational processes. Thus, Ervin and Osgood viewed this system as two separate structures. Accordingly, this system develops in situations where the bilingual learns to speak each language in different settings (i.e., home vs. school environment). In short, coordinate bilinguals derive different or partially different meanings from words in their two languages (McLaughlin, 1984).

In a compound system, two sets of linguistic concepts, one appropriate to one language, and the other appropriate to the second language were associated with the same set of representational mediating processes. That is, compound bilinguals ascribe

identical meanings to corresponding words and expressions in their two languages. Thus for the English-Spanish bilingual the meaning for HORSE remains the same as CABALLO because both systems are coding the same representation. The child growing up in an environment where both languages are spoken interchangeably by the same people may develop this system.

Like Weinreich (1953), Ervin and Osgood (1954) argued that even with this system there would be interference between the two sets of processes, thus the coordinate system could influence a compound system and vice versa. A bilingual would not have to be entirely compound nor coordinate, but some concepts of the languages could be compounded while others not.

In sum, the way a second language was learned determined how the language would be stored. However, the lack of empirical support (e.g., Diller, 1974; Gekoski, 1980; Gekoski, Jacobson & Frazao-Brown, 1982; Lambert, Havelka & Crosby, 1958), and operational complexities (Paivio, 1991) for the coordinate-compound distinction led some researchers to reformulate it as *early vs. late bilingualism* (Paivio, 1991; Vaid, 1984). Paivio (1991) argues that the coordinate-compound distinction should be maintained for practical purposes (see also De Groot, 1992a, 1992b, 1993; De Groot & Nas, 1991; Dufour & Kroll, 1995).

#### *Kolers' Shared vs. Separate Systems*

Kolers (1963, 1966) re-introduced Ervin and Osgood's (1954) compound bilingualism into the *shared memory model* and the coordinate bilingualism into the *separate memory model*. The basic logic in this methodology was to have bilingual

subjects learn bilingual word pairs and then give them either a recall or a recognition task (e.g., Glanzer & Duarte, 1971). Language differences in retrieval were taken as evidence for a *separate memory* representation for bilinguals. Null effects in retrieval from the bilingual's two languages were taken as supporting the *shared memory model*. Kolers viewed the shared model as a supralinguistic characterization of representations in which concepts were stored in some sort of non-linguistic abstract form such as propositions (Keatley, 1992). In the separate memory model, Kolers viewed bilinguals as forming separate representations specific to each language. Like Ervin and Osgood, Kolers (1963) emphasized encoding and the situation where it was encoded, i.e., means specificity (Kolers & Roediger, 1984). The assumption was that representations of a word were formed specifically by means of the encoding experience. Indeed, Kolers' formulation introduced the organization issue into the research arena. The question of interest became whether bilinguals organized their two languages in one memory or two separate memory stores.

Whereas the original formulations by Weinreich (1953), Ervin and Osgood (1954) and Kolers (1963) emphasized the encoding situation, or how the languages were learned, later memory researchers viewed Kolers' dichotomization as involving abstract conceptual representations. Thus the issue revolved around whether bilinguals stored their two languages in one conceptual system subserving the two languages (Caramazza & Brones, 1980; López & Young, 1974), or whether the bilingual's two languages were stored in two separate linguistic systems with conceptual information in one language not

readily available to the other (López & Young, 1974; Kolers, 1966; for a review see, Heredia & McLaughlin, 1992).

Like the original formulations, the issue became controversial and the empirical data supported both models (e.g., Keatley, 1992; Lambert, 1992). Kolers (1966), Kolers and González (1980), López and Young (1974), and Mägiste (1979) concluded that even if experimental findings supported both hypotheses, the shared memory model explained some aspects of language, while the separate model was more appropriate for other aspects. Kolers (1966) and Kolers and González (1980) suggested that bilinguals had neither separate nor shared memories; some information was restricted to the language of encoding, while some was accessible to both linguistic systems (Durgunoglu & Roediger, 1987; Glucksberg, 1984; Kintsch, 1970; Kolers & Brison, 1984).

#### *Present View of Bilingual Memory*

The present status of bilingual memory, like general theories of memory, emphasizes processes rather than representations (Durgunoglu & Roediger, 1987; Heredia & McLaughlin, 1992; Smith, 1991). This approach is based on the distinctions between implicit vs. explicit memory (Graf & Schacter, 1985; Schacter, 1987, 1992), and data-driven vs. conceptually-driven processes (Blaxton, 1989; Jacoby, 1983; Roediger, 1990; Roediger, Weldon & Challis, 1989). According to this view, the mixed results are because previous research has not taken into account task demands (Durgunoglu & Roediger, 1987; Heredia & McLaughlin, 1992; Kintsch, 1970; Kolers & Brison, 1984; Smith, 1991).

Durgunoglu and Roediger (1987) and Heredia and McLaughlin (1992) argued that the evidence for the one- or two-model hypotheses depends upon the processing demands of the retrieval tasks. For instance, recall tasks that are sensitive to semantic and conceptual processes yield results consistent with the interdependence model. Support for this hypothesis comes from free recall experiments utilizing repetition and distance paradigms (e.g., Durgunoglu & Roediger, 1987; Glanzer & Duarte, 1971; Kolers & González, 1980; however, see Paivio et al., 1988; Tulving & Colotla, 1970 for different interpretations). On the other hand, tasks that are sensitive to perceptual processes (i.e., the similarity between the surface features of the study and test stimulus) generally produce results that show language-specific features, thus supporting the independence model (Durgunoglu & Roediger, 1987; Kirsner, Brown, Abrol, Chadha & Sharma, 1980; Kirsner, Smith, Lockhart, King & Jain, 1984; Sharma, 1984; Macnamara & Kushnir, 1971; Watkins & Peynircioglu, 1983; however see, Caramazza & Brones, 1980; Schwanenflugel & Rey, 1986, for results consistent with the shared view).

The general conclusion of this approach is that in studying bilingual memory, task requirements should be considered. The distinction between conceptually driven processes and data-driven processes suggests that bilingual memory tasks may measure two different processes. Conceptual tasks, such as recall tasks may measure the bilingual's semantic and conceptual word representation, thus supporting a one memory system view. Data-driven tasks, on the other hand, involve perceptual features (Watkins & Peynircioglu, 1983), and hence retrieval improves when the language of study matches

the language of test (Morris, Bransford & Franks, 1977; cf. Kolers & Brison, 1984; Kolers & Roediger, 1984).

Given Durgunoglu and Roediger (1987) and Heredia and McLaughlin (1992) and Smith's (1991) important findings about the processing nature of memory tasks, we can conclude that data-driven tasks measure the processes required to access the bilingual lexical organization--assuming there is a distinction between lexical and conceptual representation (e.g., Besner, Smith & MacLeod, 1990; Vitkovich & Humphreys, 1991). That is, data-driven processing can be thought as the processes required to access the lexical system (Smith, 1991). Conversely, conceptually driven tasks measure the processes required to access the overall general store knowledge of the two languages, or the general conceptual system.

However, the current emphasis on memory processes may be extreme and one-sided. As pointed out by Eysenck and Keane (1990), one cannot have memory structures without processes, nor memory processes without assuming some sort of memory structures. Indeed, a central criticism of the processes view is that it does not say much about memory representations (Schacter, 1992). Moreover, Altarriba (1992) and Paradis (1985) have suggested that traditional memory tasks, such as free recall, paired associates, word recognition and word association tasks may be biased toward processing (but see Kroll & Stewart, 1994). That is, the methodology used in memory research may not be sensitive enough to tell us about actual bilingual memory organization.

*Bilingual Memory Findings: An Illustration*

To illustrate some of the inconsistent interpretations by some of the leading theoretical positions in bilingual memory research (e.g., Durgunoglu & Roediger, 1987; Paivio et al., 1988), consider the findings in a free recall task utilizing a repetition paradigm. In the original study, Glanzer and Duarte (1971) gave subjects Spanish-English bilingual lists at different repetitions and lags. Their results showed that at massed repetitions, bilingual conditions were significantly better than monolingual conditions. At long lags, there were no significant differences between the monolingual repetitions and bilingual conditions. Both repetitions were equally effective; as lag increased, the probability of retrieval increased for both language conditions. Glanzer and Duarte did not interpret their results in support of either hypothesis (i.e., the shared vs. the separate hypotheses). However, Durgunoglu and Roediger (1987) interpreted their results as supporting the shared memory hypothesis. The lack of significant differences at long lags between bilingual and monolingual repetitions revealed the overlapping of the bilingual's two language systems. Significant differences between both conditions with massed repetitions and short lags were interpreted in terms of the encoding variability hypothesis (Madigan, 1969) or were attributed to processing the translation of a word more fully when the language or format (e.g., Casa-House) was altered (Durgunoglu &

Roediger, 1987; Dellarosa & Bourne, 1985), and not necessarily due to separate linguistic codes (for a similar account, see Heredia & McLaughlin, 1992)<sup>1</sup>.

Paivio et al. (1988) replicated Glanzer and Duarte's findings and interpreted their results as supporting the separate memory hypothesis--which they considered an extension of dual-coding theory. Paivio et al. concluded that greater retrieval at massed repetitions, more closely approximated additivity and independence of the two languages than did within-language repetitions. They argued that existing explanations of spacing effects such as the encoding variability hypothesis were compatible with their theory. Thus, language independence at massed repetitions supported the independence hypothesis or the dual-code theory.

Like this research, bilingual experiments utilizing lexical decision and semantic memory tasks were interpreted as supporting the distinction between lexical and conceptual structures or representations (e.g., Potter et al., 1984; Kroll & Stewart, 1994; Sholl, 1993). This interpretation contrasts with Durgunoglu & Roediger's (1987) interpretation of these same results as supporting the theoretical distinction between conceptually- and data-driven processes. How can we reconcile these contrasting ideas?

---

<sup>1</sup> A detailed description of dual-coding theory is beyond the scope of this discussion (for a review see Paivio, 1991; Paivio et al., 1988; Paivio & Desrochers, 1980). The central assumption is that bilinguals organize their languages in two separate but partly interconnected verbal systems and one imagery system. For some results challenging dual-coding theory, see De Groot (1992a).

Perhaps, it is imperative not to see these two views as mutually exclusive. In fact, Anderson (1978) has talked about the inclusion of processes in any theory of representation. Anderson argues that any argument for a representation theory must include a set of processes (p. 250). It may be possible that in order to access the conceptual system in memory, one must engage semantic processing; to access the lexical structure one must utilize lexical processing.

In summary, current memory research in bilingual memory stresses processes rather than representations, without addressing which representations would match those processes. When such representations are posited (e.g., memory structures), different authors use the same data to draw different conclusions. As argued later, what is needed in this area is to specify what is meant by bilingual memory. This issue is addressed in the next chapter.

## Chapter 2

### Lexical-Conceptual Models of Bilingual Memory

#### *Evidence for Lexical and Conceptual Representations*

In this chapter, I review empirical and theoretical evidence for the hierarchical models of bilingual memory representation. I first present evidence for the lexical-conceptual distinction. Second, I discuss Potter et al.'s (1984) *association*, and *concept mediation models*, providing experimental evidence. Third, I present Kroll and Stewart's (1994) revised *hierarchical model*, and finally, I discuss De Groot's *distributed model* of bilingual memory.

The cross language-primed lexical decision paradigm (Meyer & Rudy, 1974) and the lexical-conceptual memory approach (e.g., Potter et al., 1984; Altarriba, 1992; Chen, 1990; Chen & Leung, 1989; Chen & Ng, 1989; De Groot, 1992a, 1992b, 1993; De Groot & Nas, 1991; Kroll & Sholl, 1992; Kroll & Stewart, 1990, 1994; Schwanenflugel & Rey, 1986; see also, Besner, Smith & MacLeod, 1990; Potter, 1979; Potter & Falconer, 1975; Vitkovitch & Humphreys, 1991) focus on the bilingual lexical representation. More specifically, unlike earlier research that stressed the notion that bilingual memory was represented in one or two lexical systems (e.g., Kirsner et al., 1980; Kirsner et al., 1984; Scarborough, Gerard & Cortese, 1984), without specifying what each lexicon represented<sup>2</sup>, the lexical-conceptual perspective makes a further assumption about lexical

---

<sup>2</sup> Like early work in memory theory, the cross language-prime lexical decision paradigm focused on the idea that bilingual memory was represented in either one lexical or two

and conceptual representations in memory. The assumption is that bilinguals organize their languages in two separate lexicons, and one conceptual system subserving both languages.

Evidence supporting the assumption that bilinguals organize their languages in two lexicons comes from repetition priming tasks failing to produce priming across languages (e.g., Kirsner et al., 1980; Kirsner et al., 1984; Scarborough et al., 1984). For instance, on a lexical decision task, Scarborough et al. (1984) instructed Spanish-English bilinguals to respond positively to words from one language, and to treat words from the second language as nonwords. The experiment included actual nonwords with words from the non-target language. The results showed that bilinguals were able to treat words from the non-target language as nonwords. When bilinguals were told to treat English words as nonwords, they succeeded. Reaction times from the non-target language did not differ from the actual nonwords. These results showed that bilinguals could access one lexicon without accessing the lexical representation of the second language (for similar results, see Gerard & Scarborough, 1989).

---

lexical systems. Experiments demonstrating cross-linguistic priming were viewed as supporting shared lexical structures. Experiments failing to demonstrate priming across language were taken to support separate lexical structures for both languages. These interpretations are homologous to the *independent* vs. the *interdependent* view discussed earlier.

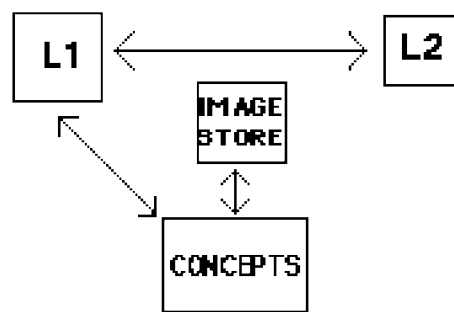
Moreover, evidence for a unitary bilingual conceptual representation comes from experiments involving between-language priming. Experiments in which a target word of one language is responded to faster when it is preceded by a semantically related word in the other language have been taken to suggest that the bilingual's two languages are integrated at the conceptual level. Between-language priming experiments have usually shown that two semantically related words do prime each other across languages (e.g., Meyer & Rudy, 1974; Caramazza & Brones, 1980; Chen, 1990; Chen & Ng, 1989; Schwanenflugel & Rey, 1986).

*Hierarchical Models : The Association and Concept Mediation Models*

The lexical-semantic perspective attempts to reconcile the above findings by assuming that bilingual memory is represented both at the lexical and at the conceptual level. According to this view, the conceptual system is hypothesized to be language-independent and to contain amodal conceptual information that is neither perceptual nor verbal (Potter, 1979, p. 41). Lexical entries are routes to the conceptual system in which ideas that correspond to words are stored (Potter, 1979). In addition to lexical and conceptual representations, a language independent image store is hypothesized to account for the general finding that word naming is faster than picture naming. Potter et al. (1984) proposed two models to explain bilingual memory.

In the *association model* Potter et al. proposed that bilingual memory was represented in two separate lexical systems. Words in the second language were viewed as directly connected with associated words in the first language, rather than with their underlying amodal concepts (see Figure 4). Access to or from a second language (L2)

word to a first language (L1) had to be accessed via the (L1) lexicon. Unlike monolinguals who accessed their conceptual system directly from the lexicon, bilinguals accessed the conceptual system via their first language (L1) lexicon. The assumption was that the L2 lexicon was much smaller than the L1 lexicon, at least during the beginning stages of bilingualism. Unlike the L2 lexicon, the image store<sup>3</sup> was postulated to have direct access to the conceptual system.



**Figure 4. The association model**

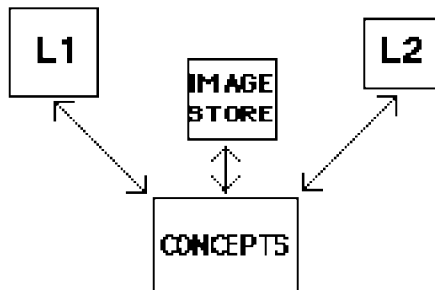
In the *concept mediation model*, Potter et al. postulated that the native and nonnative languages of a bilingual operated independently so that words were not associated interlingually, but instead they were associated with the nonlinguistic conceptual system common to both languages. The only connection between the two languages is via an underlying amodal conceptual system (see Figure 5).

It is important to note that Potter et al. allowed for the possibility that these two bilingual structures were due to the subjects' proficiency in their second language.

---

<sup>3</sup> Arrow length should not be interpreted as representing that some stores are closer to the conceptual store than others.

Accordingly, it was possible for a lexical-association representation to become conceptually mediated.



**Figure 5. The concept mediation model**

To test these two models, Potter et al. (1984) compared L1 to L2 translations to picture naming in L2. The comparison between L1 to L2 translations and L2 picture naming were based on the general finding that naming pictures took longer than naming L1 words. Accordingly, picture naming takes longer because it requires access to concepts prior to naming whereas word naming did not (Potter et al., 1984; Sholl, Sankaranarayanan & Kroll, 1995). Potter et al. employed proficient Chinese-English bilinguals (Experiment 1) and nonproficient English-French bilinguals (Experiment 2). In Experiment 1, subjects participated in an L2 picture-naming task and a translation task from L1 to L2.

With the assumption that picture naming required conceptual processing, the association and the concept mediation models make different predictions. The word association model predicted L2 picture naming to take longer than translating. According to Potter et al. naming an L2 picture involved, (1) recognizing the picture, (2) retrieving the concept of what the picture was, (3) retrieving the L1 word, (4) translating the L1

word into the L2, and (5) saying the word. Whereas, translating from L1 to L2 involved three steps, (1) recognizing the L1, (2) retrieving the L2 word, and (3) saying the L2.

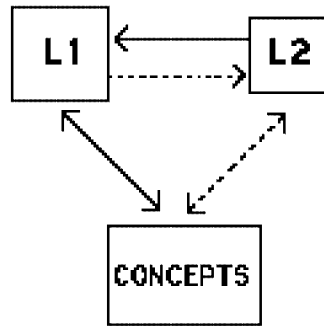
The concept mediation hypothesis, on the other hand, predicted no differences in L2 picture naming and translating from L1 to L2. Because the lexicons and the image store are in the same level, picture naming and word naming were hypothesized to require the same steps, (1) retrieve the image or word, (2) retrieve the concept, (3) retrieve the L2, and (4) say the L2 word.

The results revealed that when responding in L2, no differences were found in reaction time to name L2 pictures and L1 to L2 translations. In fact, L2 picture naming was slightly better than translating from L1 to L2. To eliminate proficiency as an alternative explanation for their results, Experiment 2 utilized less proficient English-French bilinguals. If bilingual representation depended on the subject's level of proficiency, Experiment 2 was expected to provide evidence for the association model. The results replicated Experiment 1. Subjects named pictures in L2 faster than they translated L1 to L2 words (English to French). In short, the evidence suggested that regardless of proficiency, the results supported the concept mediation model (see Kirsner et al., 1984; Tzelgov, Henik, & Lesier, 1990, for similar results). Potter et al., concluded that words of a second language were associated with corresponding words in the native language via a common conceptual system and not by direct associations between vocabulary items, even for nonfluent bilinguals.

*The Revised Hierarchical Model*

Although Potter et al.'s (1984) experiments provided evidence for the concept mediation model, Chen (1990), Chen and Ng (1989), Chen and Leung (1989), Kroll and Curley (1988) and Kroll and Stewart (1990) found differences between beginners and more fluent bilinguals, thus supporting both the concept mediation model and the association model. For example, Kroll and Curley (1988) compared translation and picture naming between English-speaking subjects learning German and experienced subjects in their second language. Translations from the subjects learning German supported the association model (Kroll & Sholl, 1992). That is, L1 to L2 translations were faster than L2 picture naming. Results from the experienced second language learners supported the concept mediation model. Naming L2 pictures took less time than translating from L1 to L2 (Kroll & Sholl, 1992). Kroll and Stewart (1990, 1994) reasoned that Potter et al. (1984) did not find differences between their beginning and fluent bilinguals because the beginning bilinguals were too advanced thus behaving more like fluent bilinguals (See also Chen, 1990).

Given that bilingual representation may be a function of second language proficiency, Kroll and Curley (1988), Kroll and Sholl (1992), Kroll and Stewart, (1990, 1994) and Sholl et al. (1995) incorporated both the association model and the concept mediation model into one general model of bilingual memory organization (see Figure 6).



**Figure 6. Hierarchical bilingual model**

In their revised hierarchical model (see Figure 6) Kroll and colleagues proposed that bilingual memory was organized into an L1 and an L2 lexicon. The L2 lexicon was hypothesized to be smaller than the L1. This difference in size was due to the assumption that bilinguals always know more words in their L1 than their L2. The lexicons were connected by unidirectional lexical links. Links from the L2 lexicon to the L1 lexicon were hypothesized to be stronger than lexical links from the L1 to the L2 lexicon. Conceptual links from the L1 to the L2 lexicon were stronger than conceptual links from the L2 to the L1 lexicon. Differences of strength between lexical links and conceptual links between the bilingual lexicons reflected the manner bilinguals learned their second language. Thus, stronger lexical links between the L2 to L1 lexicons reflected the bilingual's automaticity (i.e., well-practiced translation skills) to translate from their L2 to their L1 (e.g., Logan, 1988; Shiffrin & Schneider, 1977; Schneider & Shiffrin, 1977; see also Gernsbacher, 1990; McLaughlin, 1990). Alternatively, this asymmetry between lexical links might reflect a structural (i.e., lexical store) constraint in which every L2 word is represented in the L1 lexicon, but not every word in the L1 lexicon is represented in the L2 lexicon (Kroll & Stewart, 1994).

In addition to lexical connections between the bilingual's lexical system, each lexicon is linked to the conceptual store by conceptual links (see Figure 6). The link from the L1 lexicon to the conceptual system is said to be stronger than the link from the L2 lexicon to the conceptual store. Thus, in accessing the conceptual store, when exposed to an L2 word, a bilingual is much faster translating the L2 to the L1 than accessing the conceptual store from the L2 lexicon. It should be theoretically possible for native-like fluent bilinguals to develop a strong connection between the conceptual store and their L2 lexicon (cf. Logan, 1988; Shiffrin & Schneider, 1977; Schneider & Shiffrin, 1977; also Gernsbacher, 1990; McLaughlin, 1990). However, Kroll and colleagues argue that the link from the L2 lexicon to the conceptual system remains weak even with high fluent bilinguals (Kroll & Sholl, 1992; but see Dufour & Kroll, 1995). Thus given an option, bilinguals would probably opt for their stronger links (i.e., translate from L2 to L1).

To provide more direct evidence for the hierarchical model, Kroll and Stewart (1994) utilized a naming task, a translations task and manipulated the semantic context in which the task was performed. In both the naming and the translation tasks, subjects named (L1 or L2) or translated (L1 to L2 or L2 to L1) randomized and categorized words. The question of interest was whether L1 to L2 translations would be more affected by the change of semantic context (categorized vs. randomized lists) compared to L2 to L1 translations which were assumed to be lexically mediated. Because Experiments 1 and 2 demonstrated that picture naming--which required conceptual access-- in L1 produced category interference in categorized lists as compared to naming randomized words, Kroll and Stewart's objective was to generalize this finding to L1 to L2 translations.

Presumably, the locus of interference in categorized lists was due to the continuous access to related concepts (i.e., in the category) producing increased activation at the conceptual level, thus making it more difficult to select the best lexical entry that best matched the picture (Kroll & Stewart, 1990, 1994). In short, if L1 to L2 translations were indeed conceptually mediated as suggested by Potter et al. (1984) and Kroll and Stewart (1990, 1994) predicted L1 to L2 translations to behave similar to pictures, thus exhibiting category interference.

The results supported the predictions. L1 to L2 translations were influenced by the semantic context of the lists. It took 120 ms more to translate categorized L1 to L2 words than L1 to L2 randomized words. L2 to L1 translations were not affected by the type of list (categorized or randomized). More interestingly, L2 to L1 translations behaved similarly in both the naming and the translation tasks. However, in both categorized and randomized list conditions, L2 to L1 translations were faster than L1 to L2 translations. Moreover, the assumption that L1 to L2 translations are conceptually mediated was further validated when subjects participating in the naming and translation task received an incidental task. In general, recall was much better for the categorized L1 to L2 translations than the randomized L1 to L2 translations but in both conditions, L1 to L2 was recalled better than L2 to L1 translations<sup>4</sup>. More evidence supporting the

---

<sup>4</sup> A review of the bilingual literature employing free recall and recognition tasks shows no asymmetries between the subjects' L1 and L2 ( e.g., Dalrymple-Alford, 1982; Heredia & McLaughlin, 1992; Kolers & González,1980 ; O'Neill, Roy & Trembly, 1993).

assumption that L1 to L2 connections are more conceptually driven comes from cross-linguistic semantic priming in which L1 to L2 produce more semantic priming than L2 to L1 (e.g., Keatley, Spinks & Gelder, 1994; Kroll & Sholl, 1992; Sholl, 1993).

Other results supporting the hierarchical model comes from the distinction between cognates and noncognates (e.g., Kroll & Stewart, 1994; Sánchez-casas, Davis & García-Albea, 1992). Kroll and Stewart (1994) found that cognates behaved very similar to noncognates. That is, in a translation task that involved a randomized and a categorized list manipulation, both cognates and noncognates were affected by the category interference. Although cognates were translated faster, both cognates and noncognates revealed the L1 to L2 category interference, but L2 to L1 translations were not affected. To summarize, the revised-hierarchical model of bilingual memory representation seems to account for most of the findings in translation experiments and cross-linguistic semantic priming. Although Kroll and colleagues allow for the possibility that abstract and concrete words might be processed differently, up to now, this model does not distinguish between word type. However, its support is limited to

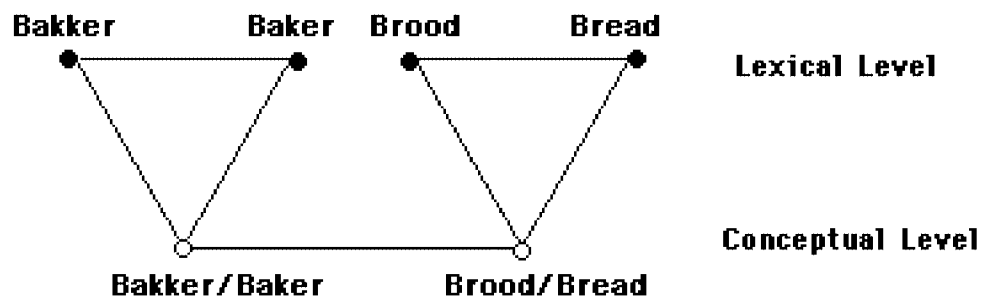
---

However, Glanzer & Duarte (1971) found asymmetries between Spanish-English (L1 to L2) and English-Spanish (L2 to L1) translations in a free recall task employing mixed randomized lists. L1 to L2 were recalled better than L2 to L1. Because these experiments did not compare between categorized and randomized lists, it is not clear what these results represent.

language asymmetries where L1 to L2 is more sensitive to conceptual manipulations, or produces more semantic priming.

*Bilingual Memory Representations at the Word Type Level*

In addition to hierarchical models of bilingual memory, De Groot and Nas (1991) attempt to explain bilingual memory organization at the word level (see Figure 7). De Groot and Nas distinguish between the organization of cognates (e.g., Dutch/English: bakker vs. baker) and noncognates (e.g., Dutch/English: jongen vs. boy). Specifically, cognates are conceived as stored in separate but connected lexical memories sharing a common conceptual memory store. These shared conceptual representations are connected to those of associatively related words at the same level. Between-language translations are viewed as represented at the lexical level. Word associations are seen as related at the conceptual level. Like Kroll and colleagues, De Groot and Nas conceive separate but interconnected lexicons.

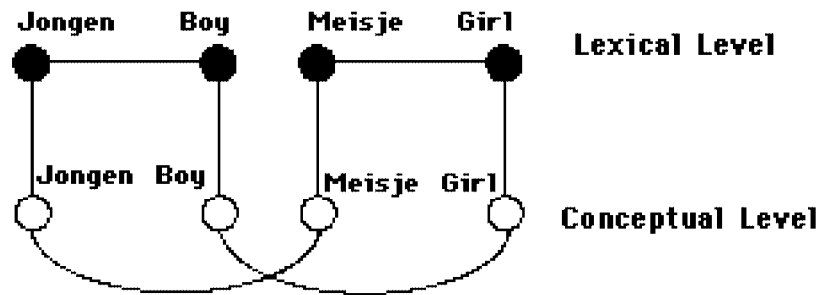


**Figure 7. Representations for cognates**

Noncognates (e.g., jongen vs. boy), at the lexical level, are viewed as represented in separate but connected lexicons (See Figure 8). At the conceptual level noncognates share separate memory nodes. The only connections between interlanguage noncognates

is via their respective lexicons. Thus at the conceptual level, associations within a language are directly connected. However, only within-language associations are directly connected (see Figure 8). Thus, in a cross-language associative priming experiment, (e.g., jongen-girl), a bilingual must first retrieve the lexical representation for “jongen,” access the conceptual representation for the same word, come up with the direct conceptual association “meisje.” Once the within-language association is retrieved at the conceptual level, it goes backward to its lexical representation where it is translated into its English equivalent “girl.” Once the translation occurs, the conceptual representation of “girl” is accessed. Notice that according to this model, for noncognates interlingual translations occur at the lexical level only.

Although these models are not directly supported, they were proposed to explain a series of results involving repetition and associative priming. De Groot and Nas (1991, Experiments 3 and 4) manipulated prime presentation, masked (e.g., see [MASK]-[PRIME]-[TARGET]) or unmasked (e.g., see [PRIME]-[TARGET]). They included a between-language cognate condition (Dutch/English: GROND-GROUND) and a noncognate condition (KOE-CALF). The within-language condition was similar to the between-language condition, except that it was in English. All stimuli were either repeated, associated or unrelated.



**Figure 8. Representations for noncognates**

In general, their results showed a greater repetition effect for within- than between-language conditions. Associative-priming effects were equally large in both language conditions. More important, the finding that the repetition effect was similar for both cognates and noncognates suggested that the bilingual lexical organization was interconnected (i.e.,  $L1 \leftrightarrow L2$ ) for both word types (i.e., lexicons are represented by solid circles in Figures 7 and 8). The lack of associative priming in the noncognate between-language condition led De Groot and Nas to suggest that representations of noncognates were separated at the conceptual level (see Figure 8) while cognates were connected at the conceptual level (see Figure 7).

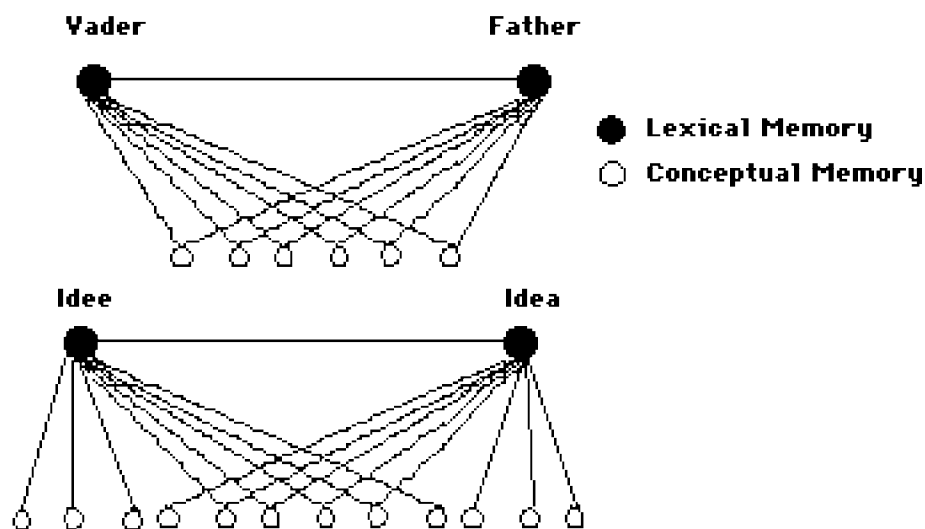
More recently, however, De Groot (1992a, 1992b, 1993) and De Groot, Dannenburg and Van Hell (1994) reject the idea of two separate language specific conceptual representations for noncognates. Instead, they argue that bilingual memory could be seen as a distributed (or mixed) system where some word concepts are shared by both linguistic systems (cognates/concrete words), and other word meanings share less overlapping (e.g., noncognates/abstract words) between the bilingual's two languages

(See Figure 9). Note that in comparing abstract and concrete words, the assumption is that these words are noncognates unless otherwise specified.

According to De Groot et al. bilingual memory is represented in two separate but connected lexicons. The lexicons are connected to conceptual nodes that store information about a particular concept. Each concept is represented by several conceptual nodes. The more similar two concepts are, the more nodes (meaning elements) they have in common. Likewise, the more dissimilar two concepts are, the less conceptual nodes they have in common (eg., Collins & Loftus, 1988; McNamara, 1992a, 1992b, but see McKoon & Ratcliff, 1992). The number of conceptual elements in these memory structures may determine their activation or translation performance. Notice that this bilingual structure would be similar for cognates/concrete and noncognates/abstract words (however, see Kroll & Stewart, 1994; Sánchez-Casas et al., 1992). Thus for concrete words this model predicts direct activation from lexical memory to conceptual memory and for abstract words this model predicts activation between lexical memory before accessing the conceptual representation (De Groot et al., 1994). In other words, concrete words can access the conceptual representation directly from their L1 and L2 lexicons, whereas abstract words can only access the conceptual system via the lexicons, depending on which language is more frequent or more active.

Although De Groot's distributed model of bilingual memory can potentially explain some of the findings, it has no direct support. However, De Groot (1992a) showed an interaction between word frequency (high and low) and imagery (high and low). Subjects were faster to translate L1 to L2 words in the high word frequency and

high word imageability conditions than the low word frequency and low word imageability conditions. De Groot explained these results by suggesting that high imagery/high word frequency L1 to L2 translations accessed the conceptual representation directly, whereas low imagery/low frequency words accessed the conceptual system via the lexical routes. Other evidence supporting this model comes from free association studies in which subjects are better in providing concrete word associations than abstract word associations (e.g., Kolers, 1963; Taylor, 1976; see also Winograd, Cohen & Barresi, 1976; Paivio et al., 1988).



**Figure 9. Distributed model of conceptual representations for concrete/noncognates (top) and abstract/cognates words (bottom)**

On a more general level, there is evidence supporting the theoretical distinction between concrete and abstract words (for a review of different theories attempting to explain the concreteness effect, see Schwanenflugel, 1991). In general, concrete words

provide more imagery (e.g., Paivio et al., 1988; Schwanenflugel, 1991; but see De Groot, 1992a), are more frequently used and learned earlier than abstract words (Gilhooly & Gilhooly, 1979; Schwanenflugel, 1991), and easier to retrieve available relevant contextual information from past experience, thus providing better retrieval accessibility. Other studies examining word concreteness suggest that concrete words contain more conceptual information than abstract words (e.g., De Groot, 1989) and that concrete words are easier to understand (Schwanenflugel, 1991; Schwanenflugel, Akin & Luhm 1992; Schwanenflugel, Harnishfeger & Stowe, 1988).

To summarize, I have reviewed current models of bilingual memory representation. I described early hierarchical models such as the association model, the concept mediation model and Kroll and colleagues revised hierarchical model. Also, I have discussed De Groot's and colleagues distributed models involving bilingual memory representation at the word level. Next I address general methodological problems in bilingual memory, and more specifically recent studies involving Kroll and colleagues' and De Groot's theoretical models.

### Chapter 3

#### **Relevance of Word type in Bilingual Memory Representations**

There are several methodological problems with current research on bilingual memory. Although some models of bilingual memory are beginning to appear (e.g., hierarchical vs. distributed models) these models often do not address each other. Though some of these models make specific predictions regarding word type, their predictions are not tested systematically with the competing model. Although the hierarchical model does not make explicit predictions regarding the representation of concrete and abstract words, the theoretical distinction between concrete and abstract words can be utilized to test some of the assumptions of this model. However, most of the studies addressing this model do not control for this factors (e.g., Kroll & Stewart, 1994; Dufour & Kroll, 1995) and when this factors are controlled (De Groot, 1992a; Paivio et al., 1988) the results are not interpreted in terms of this model (cf. De Groot et al., 1994). Word frequency is another factor that is not controlled. Most of the studies addressing this model confound low and high frequency words, thus their results cannot be generalized to other words.

When such factors are controlled, methodological constraints do not address some of the main issues of the competing models. For instance, De Groot (1992a) controlled high imagery/low imagery and word frequency, however, her subjects were required to perform L1 to L2 translations only.

Another important limitation is that usually these studies do not attempt to control word frequency for both L1 and L2 translations respectively. That is, L1 words are not

usually matched for frequency with their L2 translation, or at least it is not clear how the frequency of an L1 and its L2 translation differ or how the stimuli was chosen (De Groot, 1992a). When frequency is addressed, the assumption is that the subjects' L1 is more important than the subjects' L2 language (e.g., Kroll & Stewart, 1994). A further assumption is that the frequency of the L1 should be controlled more systematically than the frequency of the L2 word.

Finally, most of the present research addressing the hierarchical and the distributed models has utilized Dutch-English bilinguals and it is important to look at other bilinguals to determine the generality of these models to other languages. Most important of all, subjects in these studies are usually more dominant in their L1 than their L2, or at least, most of their formal education is in L1.

To summarize, the purpose of the present study is to determine the effects of abstract and concrete words in bilingual memory. The major assumption of the present study is that abstract and concrete words are fundamentally different. Specifically, this study is based on the general finding that concrete words are more readily accessible, and that they are faster to process (i.e., the concreteness effect).<sup>5</sup>

---

<sup>5</sup> This study is not concerned with nor attempts to test competing theories concerning the distinction between abstract and concrete words. The reader interested in this issues is referred to Schwanenflugel (1991) and De Groot (1989, 1992a, 1992b, 1993) and Kroll & Merves (1986) for a review of the different theoretical perspectives accounting for the concreteness effect.

The section below addresses some of the above methodological concerns and describes how the *revised hierarchical model* (Kroll & Stewart, 1994) and the *distributed model* (De Groot, 1992a, 1992b, 1993) can be related and their predictions tested and compared systematically. Specific predictions address the pattern of lexical processing and conceptual processing of high frequency abstract and concrete words in word naming, translation and translation-recognition tasks.

#### *The Revised Hierarchical Model*

*Specific Predictions.* Because this model does not say much about the representation of concrete and abstract words in bilingual memory, the most straightforward prediction is that concrete and abstract words will behave in the same manner. If bilingual memory is represented in the manner in which the L2 was learned as posed by this model, L1 to L2 translations should be slower than L2 to L1 translations because L2 to L1 translations have stronger links between the L1 lexicon and the L2 lexicon. Moreover, a statistical interaction is expected where concrete L1 to L2 translations should take longer to translate than concrete L2 to L1 translations. The same pattern of results are expected for the abstract condition. In general, L1 to L2 translations should be slower than L2 to L1 regardless of word type (abstract or concrete).

However, based on the general finding that concrete words are processed faster than abstract words because of a semantic code (e.g., imagery, contextual availability, see Schwanenflugel, 1991; De Groot, 1992a, 1992b, De Groot et al., 1994) that facilitates retrieval and processing, an alternative hypothesis is that because L1 to L2 translations are more sensitive to semantic processing, at least in the concrete condition, L1 to L2

translations should benefit more from the concreteness effect than L2 to L1 translations that are less sensitive to semantic processing<sup>6</sup>. However, in the abstract condition, L2 to L1 should be faster than L1 to L2 because there is a weaker semantic code to facilitate L1 to L2.

### *The Distributed Model*

*Specific predictions.* Unlike the hierarchical model, this model is more specific regarding concreteness effects (see Figure 9). If concrete words share semantic representation across languages and they are fundamentally the same across languages (see De Groot, 1992a, 1992b, 1993; De Groot et al., 1994; De Groot & Nas, 1991), translations for both L1 to L2 and L2 to L1 should not differ for concrete words because overlapping occurs at the conceptual level and not at the lexical level. Thus, L1 to L2 and L2 to L1 translations should not differ for concrete words.

Because abstract words share less semantic overlapping across languages, they are less likely to access the conceptual system directly. In this case abstract words should differ between Spanish and English translations because they have to be accessed via the

---

<sup>6</sup> By *semantic processing or semantic effects*, I am referring to processes affected by factors known to access knowledge-based information (e.g., translations, concreteness effects or contextual effects). Likewise, by *lexical processing or lexical effects*, I am referring to processes affected by factors known or assumed to be sensitive to such effects as orthographic form or tasks like naming tasks that are assumed to be less sensitive to semantic processing.

lexical links. Unlike Kroll et al., this model does not say much about translation asymmetries, however it suggests that the lexical strength between L1 and L2 lexicons would depend on which language is more dominant or more frequently used, or the type of bilingual. This is a major problem, because it is difficult to classify bilingual subjects into either compound or coordinate (see Paivio, 1991). Therefore, the real differences between the hierarchical model and this model are in the concrete condition<sup>7</sup>.

---

<sup>7</sup> Notice that it is important to assume that the overlapping between concrete words across languages are the same, or at least that these words require the same processes. Without this assumption it would be impossible to test these two models being discussed. A. De Groot (Personal communication, November 12, 1994) argued that the representation of concrete words across-languages was similar but not the same. Although one cannot argue that an L1 word concept has a one-to-one correspondence to its L2 equivalent, one can argue that some words (e.g., concrete words) require the same processes across languages (cf. Schwanenflugel, Blount & Lin, 1991).

## **Chapter 4**

### **Effects of Concreteness on Lexical Processing**

#### **Experiment 1**

The purpose of Experiment 1 is to examine the effects of lexical processing in high frequency items (with a word frequency count over 40 occurrences per 1000,000) concrete and abstract words in L1 and L2. This experiment uses the naming task to determine whether concreteness can affect word naming. This experiment manipulates language of presentation (Spanish or English) and type of word (abstract or concrete). Subjects in this task pronounce Spanish and English abstract and concrete words, one at a time, and their naming latencies recorded to the nearest millisecond. All stimuli, both in Spanish and English, are matched for frequency. Some studies (e.g., Kroll & Stewart, 1994) do not control for the word frequencies of the first and second language systematically. The usual assumption is that the subject's L1 is more relevant to the study. This study assumes that both L1 and L2 are equally important in attempting to determine bilingual memory organization.

Language presentation was blocked by language conditions and concreteness was mixed within blocks. This design was utilized in order to prevent subjects from developing strategies such as trying to predict the next word or mentally generating translations before naming the stimuli.

The main purpose of experiment 1 is to explore the differences in L1 and L2 lexical processing involving concrete and abstract words. Moreover, the present experiment addresses the claim of the hierarchical model that the L2 lexicon is smaller

than the L1 lexicon (see Figure 6) because bilinguals know more words in their L1 than their L2 (Kroll & Sholl, 1992; Kroll & Stewart, 1994; Sholl, 1993). If this is true, bilingual subjects in the present experiment should be slower in naming L2 words than L1 words. In general, L2 words should take longer to name than L1 words. One objection to this prediction is that “balanced bilinguals” would be expected to name L1 and L2 word equally fast because their L1 and L2 lexicons would be the same size. Another objection is that regardless of whether the subjects are “balanced bilinguals” or not, naming words should be faster for the language subjects utilize more frequently. If this is the case, L2 should be named faster.

Like the hierarchical model, the distributed model assumes that the bilingual’s L1 lexicon is larger than the L2 lexicon (e.g., De Groot et al., 1994). Assuming that the subjects participating in the present experiment are “balanced bilinguals,” (see Table 1) there is no reason to expect naming latencies to differ in the concrete condition across languages. However, abstract conditions should exhibit naming differences because abstract words are more language specific. L1 abstract words should be named faster than L2 words because the bilinguals L1 lexicon is larger than the L2 lexicon.

## **Method**

### Subjects

Fifty-six psychology students from the University of California, Santa Cruz (UCSC) participated as subjects for class credit. Only subjects with Spanish as their L1 and English as their L2 participated in the experiment. This requirement eliminated three subjects who had English or other language as their first language. Three more subjects

withdrew from the experiment. Subjects were asked to rate their speaking proficiency, reading proficiency and ability to understand Spanish and English on a 1-7 scale (1= not fluent, 7=very fluent). Overall, 40 subjects qualified as fluent and proficient in English and Spanish. Table 1 summarizes language and background information for the 40 subjects. Table 1

Background Information for the Spanish-English Subjects

Variable	Mean/yrs.	Self-ratings <sup>a</sup>	
		Spanish	English
Age	19.3 (1.92)	-	-
Age L2 learned	6.72 (3.45)	-	-
Years in the U.S.	15.6 (4.64)	-	-
Speaking	-	6.25 (.707)	6.17(.813)
Reading	-	6.02 (.891)	6.22 (.947)
Understand	-	6.27 (.933)	6.27 (.905)

Note: means across languages are not significantly different from each other ( $p > .1$ ).

<sup>a</sup>Self-ratings are based on a 1-7 scale (1= not fluent, 7=very fluent)

As can be seen from Table 1, subjects' self-ratings on their ability to speak, read and understand both Spanish and English suggest that they were very proficient in their

two languages. To further assess reading and comprehension ability in written Spanish<sup>8</sup>, subjects read a short story that required them to choose the appropriate verb tenses (e.g., past, conditional and subjunctive tenses), article markers (e.g., “la,” “el,” “le” and “lo”) and prepositions to complete a fictitious story about a bull. Subjects were given 5 minutes to read and complete the story. Subjects' mean score for reading comprehension and written ability was  $M = .916$   $SD = .055$  (from a total of 44 questions). Subjects scoring less than 80% were excluded from the experiment. This constraint eliminated ten subjects. Seventy-five percent of the subjects reported speaking Spanish at home and 25% spoke either English or both. Moreover, 78% of the subjects reported learning English at school. Judging from the language background histories, their self-ratings and their reading and comprehension scores, these subjects were “balanced bilinguals.”

### Materials and Design

Test materials consisted of 340 high frequency word nouns. Half of the stimuli were in Spanish and half in English. Among the critical stimuli, 136 words were abstract and 136 were concrete. One hundred and seventy-six items served as targets and 96 items served as fillers. The critical stimuli were chosen the following way. Three hundred and forty high frequency English nouns were chosen from Francis and Kucera (1982) word frequency counts. Every English noun was matched with its Spanish translation

---

<sup>8</sup> Spanish-English bilinguals are more likely to experience difficulty in reading and writing in their L1. These difficulties are in part due to the lack of formal schooling in their L1. Most of the subject's formal education is usually in their second language.

(referent). Spanish words were high frequency words and were taken from Chang-Rodríguez (1962). English and their Spanish translations were then separated into abstract or concrete. Both concrete and abstract English-Spanish translations were randomized separately. For each condition, half of the randomized words became English-Spanish word pairs and the other half became Spanish-English word pairs. In short, the likelihood of a translation word pair to become Spanish-English or English-Spanish translation was the same for every word pair.

Language conditions were blocked. Abstractness and concreteness were mixed within blocks. Eight blocks were constructed. Each block contained 34 words. Four blocks made up the Spanish condition, and four made up the English condition. For each language condition, each block contained 11 concrete words, 11 abstract words, six concrete fillers, and six abstract fillers. For the 272 critical words, eight different blocks were required to counter balance the design. Words were chosen randomly for each block. Each block was rotated across subjects in such a way that if one subject was exposed to blocks 1, 2, 3, 4, etc., the next subject was exposed to blocks 2, 3, 4 and so on. Language conditions were alternated throughout the eight blocks in such a way that if one block one was in English, the next block was in Spanish. For example, block 2 was always the same set of English items, but across Subjects the order in which it was presented was rotated through the eight block positions<sup>9</sup>. Eight subjects were needed to

---

<sup>9</sup> This counterbalancing is referred to as cyclic counterbalancing by Keppel (1982) and could be particularly problematic for more complex designs, however, this counter

fully counterbalance the design. Two additional blocks served as practice trials. These two blocks contained 68 items and were constructed following the same procedures as the critical words. Every subject was exposed to the same items. The overall design conformed to a 2 (language: Spanish vs. English) X 2(concreteness: concrete vs. abstract) within-subjects design.

English word frequencies were obtained from Francis and Kucera (1982) printed word frequency counts. Spanish word frequencies were obtained from Juilland and Chang-Rodríguez (1964) printed word frequency dictionary of Spanish words. Types instead of tokens were chosen. Types include all possible uses of a noun such as singular or plural (e.g., car + cars = one type). Types were chosen in order to include the singular (e.g., car) and plural usages (e.g., cars) of a noun. For instance, the item “car” has a printed frequency of 270 and the plural “cars” has a printed frequency of 112.

Nouns with a frequency of 30 occurrences per 1,000,000 were included as part of the overall stimuli. Although it is generally recommended to define high frequency words as printed frequencies greater than 65 occurrences per 1,000,000, this recommendation was difficult to follow given the constraints of the present experiment. Some constraints in selecting these materials were that all words must be nouns and orthographically or graphemically dissimilar both in Spanish and English. High

---

balancing is unlikely to affect the outcomes of the present study because subjects in the present experiment were given enough practice (68 trials) prior to the experimental conditions.

frequency words were therefore defined as words with a frequency greater than 30 (cf. Carreiras, Alvarez & De Vega, 1993).

In preparing the stimuli for the experiment, 340 English words and their Spanish translation nouns were selected. Every English noun was matched to its Spanish translation (e.g., house-casa), providing that either one had a printed word frequency of 30 occurrences per 1,000,000 or greater. However, there were 23 cases in which an English or Spanish word would have a printed frequency less than 30 and its translation would have a printed frequency greater than 40 (e.g., wealth = 22 and riqueza = 84). These 23 cases were part of the critical stimuli. In matching Spanish and English words for frequency, only words that appeared as translations in two highly regarded Spanish/English, English/Spanish dictionaries ( De Gámez, 1973; González, 1985) were selected. In cases where a word had more than one possible translation (e.g., attorney vs. lawyer, and abogado vs. licenciado), the word with the highest word frequency value was chosen as the translation.

From the 340 word pairs (translations) half were utilized for the Spanish and half for the English conditions. In this naming task, Spanish and English words were utilized. It is important to note that English nouns came from a corpus of 1,000,000 words, whereas the Spanish frequencies came from a sample of 500,000 words. For the purpose of clarity and for later calculations, the Spanish word frequencies were multiplied by two. The assumption was that both Spanish and English frequencies were from a sample of 1,000,000 words. For instance, a Spanish word that had a frequency of 30 (e.g., juez) was multiplied by two and the new frequency became 60.

Words were also classified as either abstract or concrete. Abstract and concrete word norms were selected from Toggia, Battig, Barrow, Cartwright, Posnansky, Pellegrino, Moore and Camili (1978), Paivio, Yuille and Madigan (1968), Friendly, Franklin, Hoffman and Rubin (1982), and Gilghooly and Logie (1980a, 1980b). These norms were based on subjects' ratings on a scale from 1 to 7 (abstract to concrete). Abstract words were defined as nouns with a concreteness rating less than 3.90, and concrete words were defined as words with a concreteness rating greater than 3.90 (Kroll & Merves, 1986). These are from English norms. There are no known concreteness norms for Spanish. Based on the matchings between the English and Spanish as translations, it was assumed that if an English word was a concrete item, its Spanish translation was a concrete word as well.

To assure that word frequencies were the same across language and across concrete and abstract conditions, the mean frequencies for Spanish/concrete, Spanish/abstract, English/concrete and English/abstract were analyzed separately. Word frequencies for English abstract words ( $M=123.55$ ,  $SD=124.8$ ), English concrete words ( $M=157.8$ ,  $SD=152.4$ ), Spanish abstract words ( $M=150.7$ ,  $SD=215.4$ ) and Spanish concrete words ( $M=171.7$ ,  $SD=196.4$ ) were not statistically different from each other (all  $p$ 's  $> .1$ ). In short, word frequencies were similar across languages and conditions. The complete set of words utilized in this experiment are provided in Appendix A.

### Apparatus

The experiment was run on an IBM PS 2 micro computer. Stimuli were presented in black lowercase, 12 font letters against a light-grey background. A C++ computer program controlled the stimulus presentation and the RT. A microphone that activated a voice operated switch registered the subjects' responses. Another microphone activated a cassette tape recorder that recorded the subjects' response latencies. Subjects were asked to wear a pair of modified head phones with an extended wire close to their mouths to more accurately record their responses. A tie-clip microphone with a mini amplifier was attached to a wire. The experimenter sat to the left of the subject monitoring the subject's responses and tape recorder.

### Procedure

Prior to the experiment, subjects read the instructions from the computer screen. The instructions were in English. Subjects were instructed that upon presentation of a Spanish or English word, they would name it aloud and into the microphone. They were asked to name each word as fast and as accurately as possible. Subjects were instructed to abstain from making noises such as saying "um," coughing, tapping their fingers or breathing too loud. They were told that if they made a mistake they did not have to worry and do not try to correct it. Subjects were also told that breaks would be provided regularly by the computer. Subjects were instructed to take two five-minute breaks. The breaks were offered after the third and sixth blocks.

Each trial started by pressing the ENTER KEY. Item presentation was self-paced, such that subjects controlled how fast they wanted to proceed. After starting each trial,

subjects named the target word and to start a subsequent trial, they pressed the ENTER KEY with their right hand finger.

After assuring that subjects understood the instructions, the experiment began by asking subjects to press the ENTER KEY. Prior to the stimulus, a fixation asterisk appeared on the middle of the screen for 1000 ms. Inter-stimulus-interval (ISI) between the fixation and the target stimulus was 20 ms. The target remained on the screen until the voice switch registered the onset of the subject's response or any other noise. RT was measure from the onset of the stimulus to the onset of the subjects' response. There was a 5000 ms limit. If subjects failed to respond after the 5000 ms limit, the message "Please be faster in your response" appeared in the middle of the screen reminding subjects to respond faster. In case of no response, the computer program recorded the response as zero. To continue to the next trial, subjects pressed the ENTER KEY. The experimenter took note of mispronunciations and other sounds (e.g., door slams, stuttering, cough, and sneeze) triggering the computer voice activated microphone.

### **Results and Discussion**

Three independent judges listened to the subject's responses. Two of the judges were unaware of the research hypothesis. Overall, the judges agreed on all mispronunciation (99%). All errors such as mispronunciations (e.g., stuttering, pauses) and other noises (laugh, cough/sneeze and door slams) were removed from the analyses. These errors constituted 3.1% of all responses. Subjects experienced more mispronunciation errors in Spanish (2.4 %) than English (.68 %). Moreover, responses that fell above (1000 ms) or below two standard deviations (300 ms) from the subject's

RT grand mean were also removed from the overall RT analysis. This mean cutoff resulted in the removal of 4.7% of all responses. Seventy-one percent of the removed outliers were from the Spanish conditions and 29% were from the English condition. The resulting mean naming latencies and percentage of accuracy to name words for each condition is presented in Table 2.

Although the experiment included items with printed frequencies of 30 or less occurrences per 1000,000, only frequencies greater than 40 are included in the analysis. This was done because frequencies below 40 occurrences per 1000,000 were too variable. This further constraint eliminated 23 words (11 English words, and 13 Spanish words. These items are analyzed separately).

Table 2

Mean Naming Latencies (ms) and Mean Percentage Accuracy to Perform the Naming Task as a Function of Word Type and Language.

Word type	Language	
	English	Spanish
Abstract (Accuracy %)	612 (99.0)	636 (93.7)
Concrete (Accuracy %)	602 (99.0)	635 (98.1)

A 2X2 (language x word type) mixed ANOVA was performed on the subject's naming latencies and the items as a random factor revealed a word type significant main effect,  $F_1(1, 39) = 5.18$ ,  $Mse = 7653.788$ ,  $p < .028$  by subjects. However, the main effect by items was not significant  $F_2(1, 153) = .429$ ,  $Mse = 1286.1245$ ,  $p > .10$ . The main effect of word type where concrete words were named 5.32 ms faster than abstract words replicates the well known concreteness effect (e.g., De Groot, 1993; Schwanenflugel, 1991) where concrete words are processed faster than abstract words for English but not for Spanish conditions.

There was a language main effect both by subjects,  $F_1(1, 39) = 13.11$ ,  $Mse = 88824.62$ ,  $p < .0008$ , and by items,  $F_2(1, 153) = 17.29$ ,  $MSe = 1286.12$ ,  $p < .0001$ . In general, this main effect shows that subjects were 29 ms faster in naming L2 words than L1 words. This finding is inconsistent with Kroll and Stewart's (1994) finding that subjects are faster in naming responses in their L1 than their L2. This difference could be due to the fact that most of the subjects reported more formal education in their L2 than their L1 even if Spanish is the language of choice and spoken at home. In other words, English was stronger for the subjects participating in this experiment.

There was a significant interaction by subjects  $F_1(1, 39) = 5.57$ ,  $MSe = 5159.74$ ,  $p < .0234$ , but not by items,  $F_2(1, 153) = 1.27$ ,  $MSe = 1286.12$ ,  $p > .10$ . The data in Table 2 and Figure 10 summarize the interaction by subjects. Planned multiple comparisons<sup>10</sup>

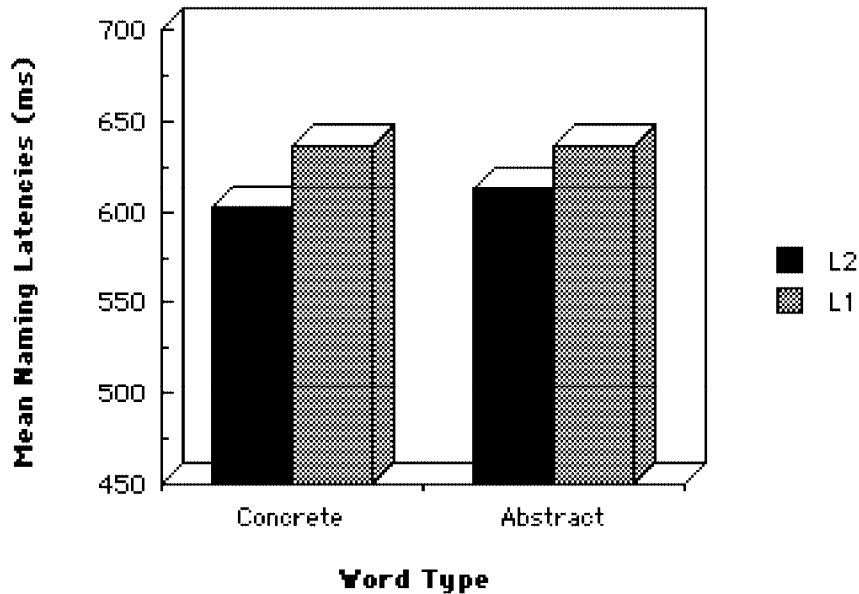
---

<sup>10</sup> Throughout the present study, Least Significant Differences (LSD) multiple comparisons are utilized to make the appropriate comparisons between means only when

revealed that concrete English words were named 10 ms faster than abstract English words. More interestingly, naming latencies did not differ between concrete and abstract words in Spanish. Although the present experiment does not directly address the prediction by the hierarchical model that L1 to L2 translations are more sensitive to semantic effects than L2 to L1, the lack of differences between Spanish concrete and abstract words suggests the L1 can be affected by lexical processing. That is, L1 seemed to be more sensitive to the visual code that activated the orthographical representation of the Spanish words without accessing its meaning. On the other hand, L2 seems to be less sensitive to the lexical effects of the naming task and more sensitive to the concreteness effect. Issues regarding the hypothesized conceptual nature of L1 to L2 translations and the lexical nature of L2 to L1 translations are addressed later in the general discussion.

---

the interactions are significant (Cohen & Cohen, 1983, pp. 166-176; Klockars & Sax, 1986). All comparisons are made at the .05 level of significance.



**Figure 10.** Mean naming latencies (ms) as a function of word type and language.

On other important comparisons, English concrete words were named 33.4 ms faster than Spanish concrete words. Similarly, English abstract words were named 21 ms faster than Spanish abstract words. Again, the fact that English abstract and concrete words were named faster than abstract and concrete words in Spanish counters the assumption that the bilinguals' L2 lexicon is smaller than the L1 lexicon, or at least the assumption that the L2 lexical link (see Figure 6) is lexically mediated. Indeed, these results suggest that the L2 lexical could be sensitive to semantic effects.

As hypothesized by the distributed model, the interaction between word type and language suggests that concrete and abstract words have differential effects on bilingual

memory. The assumption that concrete words behave similarly across languages is not supported by the present results at least at the lexical access level.

The data were also analyzed for accuracy to name abstract and concrete words as a function of language (see Table 2). Note that there was no evidence of speed-accuracy trade-off. Concrete words were named more accurately than abstract word by subjects,  $F_1(1,39) = 21.65$ ,  $MSe = .03229110$ ,  $p < .0001$ , and by items,  $F_2(1,153) = 5.142$ ,  $MSe = .0028$ ,  $p < .025$ . Accuracy was higher for naming English than Spanish words by subjects,  $F_1(1,39) = 25.05$ ,  $MSe = .05539381$ ,  $p < .000$ , and by subjects,  $F_2(1,153) = 9.762$ ,  $MSe = .0028$ ,  $p < .002$ . The interaction was significant by subjects,  $F_1(1,39) = 27.44$ ,  $MSe = .02543590$ ,  $p < .0001$ , and by items,  $F_2(1,153) = 8.195$ ,  $MSe = .0028$ ,  $p < .005$ . Multiple comparisons for both subjects and items demonstrated that subjects experienced more difficulty naming Spanish abstract words than all other words. Other comparisons were not significantly different from each other ( $p$ 's  $> .05$ ).

To summarize, unlike previous findings (e.g., Kroll & Stewart, 1994)<sup>11</sup> this experiment shows that L2 words can be named faster than L1 words. This finding, contrary to the hierarchical model, suggests that the L2 lexical links can be affected by semantic factors such as the concreteness effect.

However, the null effects between Spanish concrete and Spanish abstract words (i.e., not exhibiting the concreteness effect) compared to the English abstract and

---

<sup>11</sup> Kroll and Stewart (1994) did not control for word frequencies. Their stimuli ranged from 0 to 413 word occurrences per 1000,000. Clearly, word frequency was confounded. Moreover, Kroll and Stewart did not obtain naming differences between categorized and randomized lists ( $p$ . 160).

concrete conditions suggests an alternative explanation. These results suggest that whereas the English conditions were sensitive to the semantic codes of the concrete words, subjects in the Spanish conditions were not taking advantage of these codes. In other words, it seems that the Spanish condition was more sensitive to the grapheme-to-phoneme correspondence of Spanish. It could be that subjects were accessing their L1 lexicon via a “rule” route by which they named Spanish words without accessing their meaning. Because English is a nonorthographically regular language, it could be that in naming L2 words subjects utilized a “lexical” route by which a pronunciation is looked up directly in the lexicon (e.g., Carreiras et al., 1993; Job & Peresotti, 1994 ; Kawamoto & Zemblidge, 1992; Lukatela & Turvey, 1990). In fact, Tabossi and Laghi (1992) conclude that language characteristics (i.e., regular vs. irregular orthography) sometimes determine strategies that subjects may adopt in naming tasks. Alternatively, this null concreteness effect in Spanish could be due to a high frequency effect (e.g., Carreiras et al. 1993; Job & Peresotti, 1994).

Because the items utilized in the present experiment included 23 items with word frequencies below 40, it was possible to explore whether the concreteness effect could be obtained with low frequency words. Means for the English abstract (M= 20, SD= 11.7), English concrete (M= 24.5, SD= 8.9), Spanish abstract (M= 23.3, SD= 10.2) and Spanish concrete (M= 25.5, SD= 9.0) words were not significantly different from each other. That is, that the lack of the concreteness effect in the Spanish condition could be a frequency effect. An ANOVA with just these 23 items revealed that English words were named 53 ms faster than Spanish by subjects,  $F_1(1,39) = 37.57$  ,  $MSe = 12986.976$ ,  $p < .0001$ , and

by items,  $F_2(1,19) = 5.83$ ,  $MSe = 3291.434$ ,  $p < .026$ . Concrete words were also named faster than abstract words only by subjects,  $F_1(1,39) = 7.24$ ,  $MSe = 4778.653$ ,  $p < .0104$ .

The interaction was also significant but only by subjects,  $F_1(1,39) = 37.57$ ,  $MSe = 7975.840$ ,  $p < .0001$ . Multiple comparisons revealed that concrete Spanish words ( $M=654.12$ ) were 47 ms faster than Spanish abstract words (Mean= 701). The 17 ms difference for English concrete words ( $M=633$ ) and English abstract ( $M=615$ ) words was not significant. In addition, in both abstract and concrete conditions, English words were named 86 ms and ms faster than Spanish abstract and concrete words, respectively. Indeed, this analysis for low frequency words revealed the concreteness effect for Spanish concrete and Spanish abstract words, thus suggesting that the lack of the concreteness effect for Spanish high frequency words was due to a word high frequency effect. Although suggestive, this analysis for low frequency words should be interpreted carefully because of the small number of items.

In sum, the results of the present experiment suggest the importance of taking into account language effects--namely, language characteristics (i.e., regular vs.irregular orthography) that may determine the strategies subjects utilize in task performance. This may explain why Kroll and Stewart (1994) did not obtain differences in naming (Experiment 3) L1 randomized and L1 categorized lists (p. 160, Figure 5). The same trends were evident in the L2 conditions. It may be that their results could be explained by the language effects exhibited by English and Dutch. These issues are addressed in future work and in the general discussion.

## Experiment 2

The purpose of this experiment was to test for word effects in bilingual memory more directly. This experiment is different from Experiment 1 because it requires subjects to generate translations (e.g., see *casa*, generate its translation, *house*), and word translations require subjects to know the meaning of a word in order to translate it (De Groot, 1992a, 1992b; Potter et al., 1984; Snodgrass, 1984, 1993; however, see Kroll, 1993; Kroll & Stewart, 1994). Thus, this task should serve as a direct test for both the hierarchical and distributed models.

The predictions for the present experiment are straightforward. If L1 to L2 translations are fundamentally different as expected by the hierarchical model, a language main effect should be expected where L2 to L1 are faster to translate than L1 to L2. This main effect would reveal the general language asymmetry found by previous research (Kroll & Stewart, 1994; Sholl, 1993). More important, if L1 to L2 translations are indeed conceptually oriented and L2 to L1 translations are lexically oriented, L1 to L2 translations should be more sensitive to the concreteness effect and thus benefit more than L2 to L1. That is, L1 to L2 translations should be faster than L2 to L1 because L1 to L2 translations are semantically oriented and L2 to L1 are lexically oriented. However, in the abstract condition, L2 to L1 translations should be faster than L1 to L2 because there is less semantic code to facilitate L1 to L2 translations.

Alternatively, if L1 to L2 and L2 to L1 translations are not affected by the concreteness effect, L2 to L1 translations should be faster than L1 to L2 translations in both concrete and abstract conditions. In general, language translations in the abstract

condition are expected to take longer to translate than translations in the concrete condition. Note that his prediction is unreasonable because it goes against the main assumption of the hierarchical model that L1 to L2 translations are conceptually mediated. In the context of concreteness effect, this result would suggest that contrary to Kroll's assumption L2 to L1 translations are conceptually mediated.

If bilingual memory is organized in terms of word type, according to the distributed model, where concrete words share similar representations across languages, then, regardless of language, concrete words should behave very similarly. That is, an interaction is expected where L1 to L2 and L2 to L1 translations in the concrete condition would not differ from each other, but, in the abstract condition, L1 to L2 and L2 to L1 translations should exhibit reliable differences. This model is not clear in terms of which translation direction will be faster in the abstract condition. However, from the assumption that the bilingual's L1 lexicon is larger than the L2 lexicon, L1 to L2 translations should be faster because subjects are more familiar with their L1 than their L2. A main effect showing that L2 to L1 is faster than L1 to L2 and reliable differences between language translation at the concrete level would not support this model.

## **Method**

### Subjects

The same subjects from Experiment 1 participated in the present experiment. After completing Experiment 1, subjects took a 10 to 15 minute break and started with Experiment 2. For a description of subject's proficiencies in English and Spanish, please see Experiment 1.

### Materials and Design

Test materials and design were the same as that used in Experiment 1, except that new stimuli were constructed and randomized. The same Spanish and English words presented in Experiment 1, were presented in this Experiment. The complete set of words utilized in this experiment are provided in Appendix A.

### Apparatus

The apparatus used in this experiment was identical to that used in Experiment 1.

### Procedure

The presentation of stimuli was identical to Experiment 1. The only difference was that subjects were told that they would be presented with a series of Spanish/English words and that their objective was to provide a translation in Spanish or English as the word was presented on the screen. Thus, subjects were told that if a Spanish word appeared on the screen, they would have to provide the English equivalent and vice versa. As in Experiment 1, subjects were told to respond out loud into the microphone as quickly and as accurately as possible. They were also told to remain silent if they did not know the stimulus word presentation. To assure that subjects understood the instructions, they were given 68 trials before the experiment begun.

## **Results and Discussion**

Three independent judges, two of whom were unaware of the research hypothesis, listened to the subjects' responses and took note of mispronunciation errors (e.g., stuttering, pauses) and other noises (laugh, cough/sneeze and door slams). Overall, the judges agree on all mispronunciation and errors (99%). Subject's responses were

considered correct translations if they appeared in two highly regarded Spanish/English dictionaries, Collins, Marcos & Chang-Rodríguez (1989) and De Gámez (1973).

Because of previous experience with subjects having difficulty in translating, items that were mispronounced or missed by more than 45% of the subjects were deleted from the overall analysis. This criterion eliminated ten abstract and eight concrete English items and three abstract and three concrete Spanish words. These items represented 15% of the overall data. For the analysis of subject's translations, responses that fell above 3.25 (4500 ms) or below 1.08 standard deviations (300 ms) from the subject's RT grand mean were considered outliers. The upper limit of subject's responses was 3500 ms higher than Experiment 1 because translating is much slower than naming words. Dufour & Kroll (1995) utilized an upper limit cutoff of 4000 ms, however, they utilized a categorization task. The cutoff limits of 300 and 4500 ms resulted in the removal of 8.6% of the responses (adopting a 4000 ms upper limit cutoff would result in an additional 1.25 % of removed responses). Three percent of the removed outliers were from the English abstract and 2.3 % were from the English concrete condition. In the Spanish conditions, 2.0 % of the abstract and 1.22 % of the concrete items were deleted. Overall, 5.2 % of the outliers were from the English conditions and 3.13 were from the Spanish conditions. Moreover, from the removed outliers, 7.5% were responses where subjects did not provide a response (English = 4.7 % and Spanish = 2.3%). The resulting mean naming latencies and percentage accuracy to perform translations as a function of language and word type are presented in Table 3.

A 2X2 (language x word type) mixed ANOVA was performed on the subject's translating latencies ( $F_1$ ) and the items ( $F_2$ ) as a random factor revealed a word type significant main effect by subjects,  $F_1(1, 39) = 72.19$ ,  $Mse = 521763.53$ ,  $p < .0001$  and by items  $F_2(1, 129) = 10.60$ ,  $Mse = 126274.78$ ,  $p < .001$ . Concrete words were translated approximately 200 ms faster than abstract words. This effect replicates the well known concreteness effect where concrete words are processed faster than abstract words (see De Groot, 1993; Schwanenflugel, 1991, for a summary).

The language main effect was not significant both by subjects,  $F_1(1, 39) = .31$ ,  $MSe = 1238359.75$ ,  $p > .10$ , and by items,  $F_2(1, 129) = .051$ ,  $MSe = 126274.78$ ,  $p > .10$ . Contrary to the predicted asymmetries by the hierarchical model, the 18 ms advantage for L1 to L2 translations ( $M = 1478$ ) was not significantly different than L2 to L1 translations ( $M = 1496$ ). Thus the present results do not replicate the general L2 to L1 translation advantage over L1 to L2 translations.

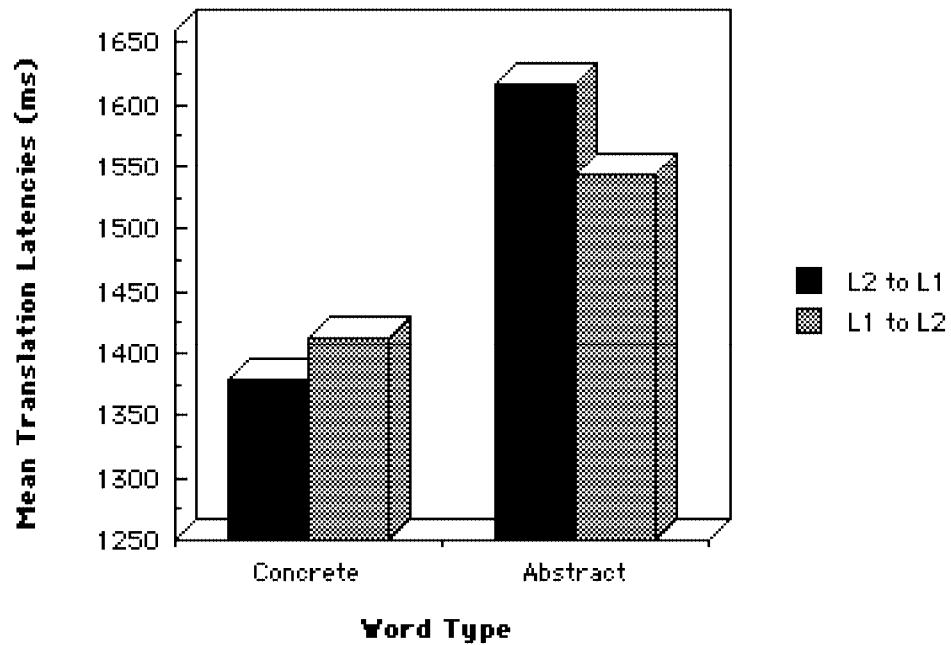
Table 3

Mean Translation Latencies (Ms) and Mean Percentage Accuracy to Perform Translations as a Function of Word Type and Language.

Word type	Language Translation	
	L2 to L1	L1 to L2
Abstract (Accuracy %)	1615 (95.6)	1543 (97.4)
Concrete (Accuracy %)	1378 (96.4)	1413 (97.4)

There was a significant interaction by subjects  $F_1(1,34) = 6.96$ ,  $MSe = 457368.21$ ,  $p < .011$ , but not by items,  $F_2(1,129) = .479$ ,  $MSe = 126274.78$ ,  $p > .10$ . The data in Figure 11 present the overall means and Table 3 summarizes the interaction by subjects.

The interaction by subjects addresses Kroll's hierarchical and De Groot's distributed models of bilingual memory. Contrary to the prediction by the hierarchical model, L1 to L2 translations did not differ from L2 to L1 translations. Multiple comparisons on the interaction (see Figure 11 and Table 3) show that the 45 ms advantage for L2 to L1 concrete translations was not significantly different than concrete L1 to L2 translations. Thus it appears that the assumption that L1 to L2 are semantic oriented did not hold. L1 to L2 translations did not benefit from the semantic code of concrete words.



**Figure 11.** Mean translation latencies (ms) as a function of word type and language.

The expected asymmetry for the abstract condition did not hold either. Because L2 to L1 translations are assumed to be lexically oriented and because there is less semantic code in abstract words as to not facilitate semantic processing, L2 to L1 translations did not benefit. The 72 ms advantage for L1 to L2 translations was significantly different from the L2 to L1 in the abstract condition. As can be seen from Figure 11 and Table 3, the asymmetry for abstract words went the opposite direction of that for concrete words. Translating from L1 to L2 was faster than translating from L2 to L1. Contrary to the hierarchical model, it seems that the assumption that L1 to L2 translations are semantically oriented does not hold.

In general, L1 to L2 and L2 to L1 concrete translations were faster ( 120 ms and 227 ms, respectively) than their equivalent abstract translations. Thus, both language conditions exhibited the well known concreteness effect where concrete items are processed faster than abstract words.

The results of the present experiment support the distributed view of bilingual memory. As predicted by this model, it seems that concrete words behave similarly across languages. Abstract words appear to behave differently across languages.

The data were also analyzed on accuracy to perform translations as a function of language (L1 to L2 vs. L2 to L1) and word type (abstract vs. concrete words). The analysis by subjects showed a main effect by language,  $F_1(1,39) = 4.62$ ,  $MSe = .0497474$ ,  $p < .05$ , where L1 to L2 translations were more accurate (97.4 %) than L2 to L1 translations (95.9 %). All other effects by subjects and items did not reach significance ( $p > .05$ ). In general, this analysis shows that subjects were better to perform L1 to L2 translations than L2 to Spanish L1. However, this analysis is misleading because most of the errors in which subjects failed to provide a translation were eliminated by the cutoff criterion (i.e., upper and lower cutoff limits). In fact translation omissions, or responses where subjects did not provide a translations accounted for 7.5 percent of the total removed outliers. A second analysis was performed that included outliers and words that were missed more than 45% by subjects. Table 4 summarizes the overall percentage accuracy to perform translations as a function of language and word type for all removed items.

There was a language main effect by subjects,  $F_1(1,39)=71.03$ ,  $MSe=.30878$ ,  $p < .0001$ , where L1 to L2 translations were more accurate (86.8 %) than L2 to L1 (75.9 %). The main effect by items was also significant,  $F_2(1,157)=12.53$ ,  $MSe=.0403$ ,  $p < .0001$ . Accuracy was much higher for concrete translations (85.4 %) than for abstract translations (77.3 %) by subjects,  $F_1(1,39)=44.42$ ,  $MSe=.142928$ ,  $p < .0001$ , and by items,  $F_2(1,157)=7.76$ ,  $MSe=.0403$ ,  $p < .006$ . The interaction was significant by subjects,  $F_1(1,39)=4.04$ ,  $MSe=.092514$ ,  $p < .05$ , but not by items ( $p > .1$ ). As can be seen from Table 4, multiple comparisons show that the accuracy to perform translations was much higher for both Spanish conditions than the English conditions. However, subjects were more accurate translating from L1 to L2 than L2 to L1 abstract translations. Thus, subjects had the most difficulty with L2 to L1 abstract conditions.

Table 4

Mean Percentage Accuracy to Perform Translations as a Function Word Type and Language.

Word type	Language Translation	
	L2 to L1	L1 to L2
Abstract	71.1	83.5
Concrete	80.7	90.1

Taken together, the findings from the present study and Experiment 1 do not support the assumptions of the hierarchical model. The hierarchical model predicts L1 words to be named faster because they can access the conceptual system directly and L2 words to be named slower because they are less likely to access the conceptual system directly. More important, Experiment 2 failed to reveal the predicted advantage for L2 to L1 translations over L1 to L2 and the predicted facilitation of L1 to L2 translations in the concrete condition.

However, to better assess the relationship between Experiment 1 and 2, one may want to consider bilingual translations in terms of information processing. That is, translations can be viewed as a more general process composed of more than one independent process (i.e., a naming process + the actual translation process) that can be mapped and decomposed into its components (see Massaro, 1989, chap. 7, for a full discussion of the subtractive method). Thus, it could be possible to subtract the naming component of translations from Experiment 1 and Experiment 2. Note that this analysis involves partialing out the naming response time from the translation time. In a sense, this analysis is an extension of Analysis of Covariance (ANCOVA).

For these analyses, response times from Experiment 1 were subtracted from Experiment 2 response times by items and across subjects. Response times less than -260 and greater than 3600 were deleted from the analysis. This cutoff was 3.0 standard deviations above the grand mean for subjects' responses. The overall analysis excluded all RTs less than 0. Accuracy performance has been already discussed, so it is not address any further in this analysis. Table 5 and Figure 12 describes the overall results.

The 2 (Language: L1 to L2 vs. L2 to L2 translations)X 2 (word type: abstract vs. concrete words) random-factor ANOVA performed on subjects' translation responses revealed a main effect of language by subjects,  $F_1(1,39) = 3.89$ ,  $MSe = 1177768.77$ ,  $p = .055$ , but not by items  $F_2(1,129) = .982$ ,  $MSe = 103616.48$ ,  $p > .1$ . L1 to L2 translations were 66 ms faster than L2 to L1 translations. The main effect of word type was significant by subjects,  $F_1(1,39) = 64.12$ ,  $MSe = 418044.75$ ,  $p < .0001$ , and by items,  $F_2(1,29) = 9.703$ ,  $MSe = 103616.48$ ,  $p < .002$ . Concrete translations were approximately 150 ms faster than abstract translations. The interaction was significant by subjects,  $F_1(1,39) = 10.06$ ,  $MSe = 362573.26$ ,  $p < .003$ , but not by items  $F_2(1,129) = .596$ ,  $MSe = 61778.441$ ,  $p > .1$ . Table 5 summarizes the overall mean differences from Experiment 1 and Experiment 2.

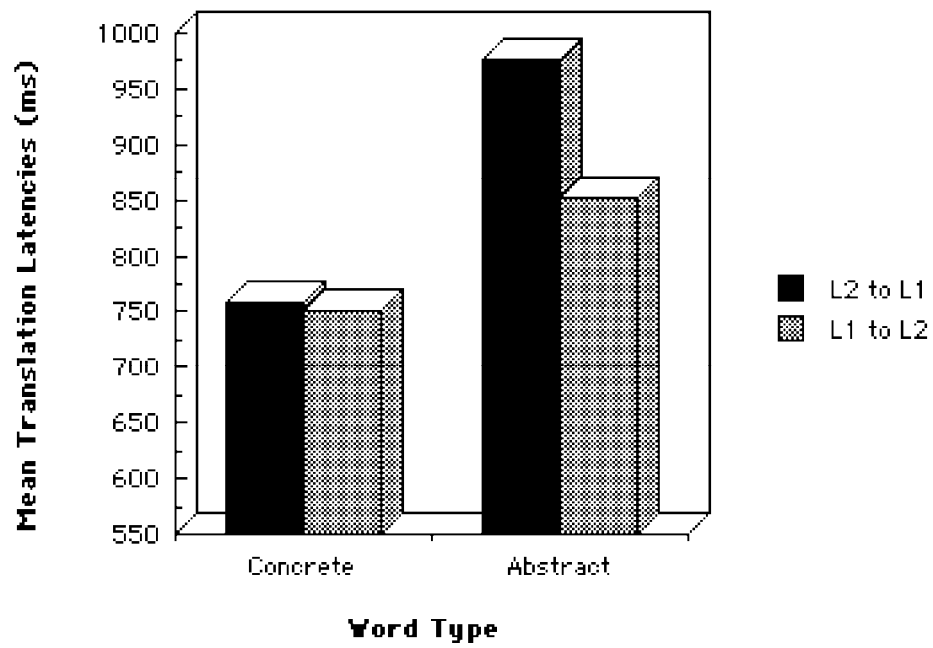
Table 5.

Mean Translation Latency (ms) differences between Experiment 1 and Experiment 2 as a Function of Word Type and Language.

Word type	Language Translation	
	L2 to L1	L1 to L2
Abstract	975.5	851.5
Concrete	758.5	751.4

As can be seen from Table 5 and Figure 12, after subtracting the naming production component of the translation task, the results showed that L1 to L2 and L2 to L1 translations were both equally sensitive to concreteness effects. Likewise, contrary to the hierarchical model, L2 to L1 were slower than L1 to L2 translations.

Overall, Experiment 1 and 2 do not support the main assumptions of the hierarchical model and most important of all, the interaction of concreteness of language translations do not support the predicted translation asymmetries or the assumption that L1 to L2 are conceptually oriented. However judging from the subjects' difficulty translating L2 to L1 in both abstract and concrete conditions, it could be that the present results are due to the fact that the task was too difficult and the subject's proficiency in English was not as high as it was assumed. To rule out this possibility, the next experiment attempts to replicate the results of the present study by utilizing a translation recognition task. In this task, subjects are asked to decide whether word pairs are direct translations of each other.



**Figure 12.** Mean translation latency (ms) differences between Experiment 1 and Experiment 2 as function of word type and language.

### Experiment 3

The previous two experiments demonstrated the differential effects of concreteness in bilingual memory. Experiment 1 showed that L1 was more sensitive to lexical effects whereas L2 was more sensitive to conceptual processing judging from the concreteness effect observed in L2 and not in L1. Experiment 2 failed to show the predicted L1 to L2 and L2 to L1 asymmetries. Contrary to the predictions of the hierarchical model, L1 to L2 translations did not benefit from the concreteness effect or at least they were shown to be more sensitive to the semantic code of concrete words than L2 to L1 translations. It seems that both language conditions were equally affected. However, to better understand the effects of lexical processing and conceptual processing in bilingual memory and word type, it is important to compare the results of Experiment 2 with a more equivalent task involving L1 to L2 and L2 to L1 translations and at the same utilize a task that is both sensitive to lexical and conceptual processing.

The present task utilizes a translation-recognition task (De Groot, 1992a). This task requires subjects to recognize and make decision as to whether word pairs are translation equivalents (casa-house) or non translations (casa-tire). Unlike the translation task that requires subjects to retrieve and produce a translation, thus requiring more conceptual processing, this task appears to be more sensitive to lexical processing because subjects are provided with the translation. That is, according to De Groot (1992a), this task by-passes the translation-retrieval process required in the translation production.

Provided that this task is sensitive to both lexical and semantic processing and based on the results of Experiment 1 that L1 appeared to be more sensitive to the lexical processing demands of the naming task, the expected outcomes of the present experiment are straightforward. If L1 to L2 translations are semantically oriented as assumed by the hierarchical model, the results of the present experiment should replicate the results of Experiment 2. Recognizing concrete L1 to L2 translations should be faster than recognizing abstract L1 to L2 translations. In short, these results should be similar to the results of Experiment 2. However, if L1 to L2 translations are not conceptually mediated as proposed by Kroll and colleagues, recognizing concrete L1 to L2 translations should not benefit from the concreteness effect and L1 to L2 abstract and concrete conditions should not differ.

## **Method**

### Subjects

The same 40 subjects from Experiment 1 and Experiment 2 participated in this Experiment. After completing Experiment 1 and Experiment 2, subjects were told to return a week later. Also, after completing the first two experiments, subjects were told not to look on any dictionaries and not to discuss the experiment with anyone.

### Materials and Design

Test materials design and counterbalancing were the same as that used in Experiment 1 and Experiment 2 except that in this experiment English-Spanish (e.g., horse-caballo), and Spanish-English (e.g., casa-house) translations were utilized. A set of 160 (59%) translations and a set of 112 (41%) nontranslation items (e.g., book-**día**) were

generated in eight different blocks and in both language conditions. The translations and nontranslations were chosen the following way: from the 272 critical English and Spanish words from Experiment 1 and 2, 112 words were chosen at random to become the nontranslations. Half of these words were Spanish (half concrete and half abstract) and half English (half concrete and half abstract). These words were then paired with a Spanish or English nonequivalent word (e.g., book-**día**). Each word that composed the nontranslation condition (right hand word) was from a separate list of 56 high frequency English-Spanish and 56 high frequency Spanish-English translations matched for concreteness and chosen the same way the original English and Spanish conditions were constructed. Four blocks were made up of Spanish-English (caballo-horse) translations and nontranslations and the other half made up the English-Spanish condition (table-casa). Each block was made up of ten concrete translations, ten abstract translations, seven concrete nontranslations, and seven abstract nontranslations. Language conditions were blocked. Each translation and nontranslation pair was matched by frequency, abstractness and concreteness. This constraint was not always possible. There were times in which the translation of a high frequency word had a frequency of less than 30 occurrences per 1000,000. This was true for 30 items (11%). Two practice blocks (68 trials) followed the same procedure as the critical stimuli. a frequency of 30 (e.g., juez) was multiplied by two and the new frequency became 60.

To assure that word frequencies were the same across language and concrete and abstract conditions, two different analyses were performed. Because the words utilized in Experiment 1 and 2 were already analyzed, this second analysis examines the translations

of those words. The second analysis combines both the words of Experiment 1 and their translations and analyzes them as if they were different words. For instance, if the word “CASA” was utilized in Experiments 1 and 2, the first analysis examines its translation “HOUSE,” and the second analysis treats both words as if they were two different words (i.e., hose and Casa) because both words have different frequency counts. The mean frequencies for Spanish/concrete, Spanish/abstract, English/concrete and English/abstract were  $M = 205$ ,  $SD = 307.6$ ;  $M = 134.9$ ,  $SD = 238.0$ ;  $M = 200.0$ ,  $SD = 191.3$ ;  $M = 158.0$ ,  $SD = 238.0$ , respectively (for all group comparisons,  $p$ 's  $> .1$ ). For the second analyses, the mean frequencies for Spanish/concrete, Spanish/abstract, English/concrete and English/abstract were  $M = 188$ ,  $SD = 257.7$ ;  $M = 144.1$ ,  $SD = 228.0$ ;  $M = 179.1$ ,  $SD = 173.3$ ;  $M = 138.8$ ,  $SD = 184.2$ , respectively). Note that all language and concreteness comparisons were not significantly different from each other ( $p > .1$ ) except the Spanish/concrete condition was marginally significant ( $p = .06$ ) from the English abstract condition. However, this difference disappeared when frequencies less than 30 occurrences were deleted from the analysis. The complete set of words utilized in this experiment are provided in Appendix B.

#### Apparatus and Procedure

The experiment was run on an IBM PS 2 micro computer. Stimuli were presented in black lowercase, 12 font letters against a light-grey background. A C++ computer program controlled the stimulus presentation and the response times. A key (A) on the left side of the computer was assigned as the YES response, and a key (‘) on the left side of the computer was assigned as the NO response. All other keys except the return key

were disabled. Subjects were told to utilize their left-hand index finger to press the YES response key and the right-hand index finger to press the NO response key. Moreover, subjects were told to keep their fingers on the appropriate keys throughout the experiment. After each trial, subjects pressed the RETURN key to start the next trial. They were also told to always keep their eyes fixated on the asterisk (\*) and not to turn their head as they decided about the translations. In addition, they were told to respond as quickly and as accurately as possible.

Prior to the experiment, subjects received 68 trials. Half of the trials were in Spanish-English and half were in English-Spanish. During the practice trials, the experimenter monitored the subject's responses. After assuring that subjects understood the instruction, the experimenter left the experimental setting.

Test items were displayed in the middle of the screen. Each trial started when an asterisk appeared on the middle of the screen for 1000 ms, slightly to the left of where the target (translation or nontranslation) word was to appear. Twenty ms after the offset of the fixation stimulus, a Spanish or English word appeared for 240 ms. Then, there was a blank screen for 40 ms and the translation or nontranslation followed. The translation or nontranslation (target) appeared in the center of the screen slightly below where the preceding word had appeared. Depending on the subject's response the words "Correct," "Wrong" appeared on the screen for 2000 ms three lines below the center where the target was. "Please be faster in your response" was shown when the response exceeded 3000 ms deadline. This feedback remained on the screen for 2000 ms. Immediately after finishing one trial, and to start a new trial, the message "Please Enter Key" appear on the

screen two lines below where the target was. Trial presentations were self-paced. Finally, subjects were instructed to take two five minute breaks at the third and sixth blocks.

### **Results and Discussion**

As expected, subjects performed better than in the translation task in Experiment 2 that required subjects to generate a translation. For the analysis, all responses less 300 and greater than 2500 ms were removed from the analysis. This cutoff criterion was -1.4 standard deviations below the grand mean and the upper limit was 2.8 standard deviations above the grand mean and resulted in the removal of 1.25 % of the data. The upper limit cutoff was 2000 ms less than the one utilized in Experiment 2 because subject's responses in this task are faster than the standard translation task. De Groot (1992a) utilized this same task and employed an upper cutoff of 1400 ms. However a cutoff of 1400 would have resulted in the removal of an additional 2.0 % of observations. Moreover, errors in which subjects incorrectly decided that a translation pair was not a translation, were removed from the response time analysis. These errors comprised of 7.6 % of all subject's responses and are analyzed separately in terms of accuracies. Table 6 presents the mean response times and percentage accuracy to perform the translation recognition task.

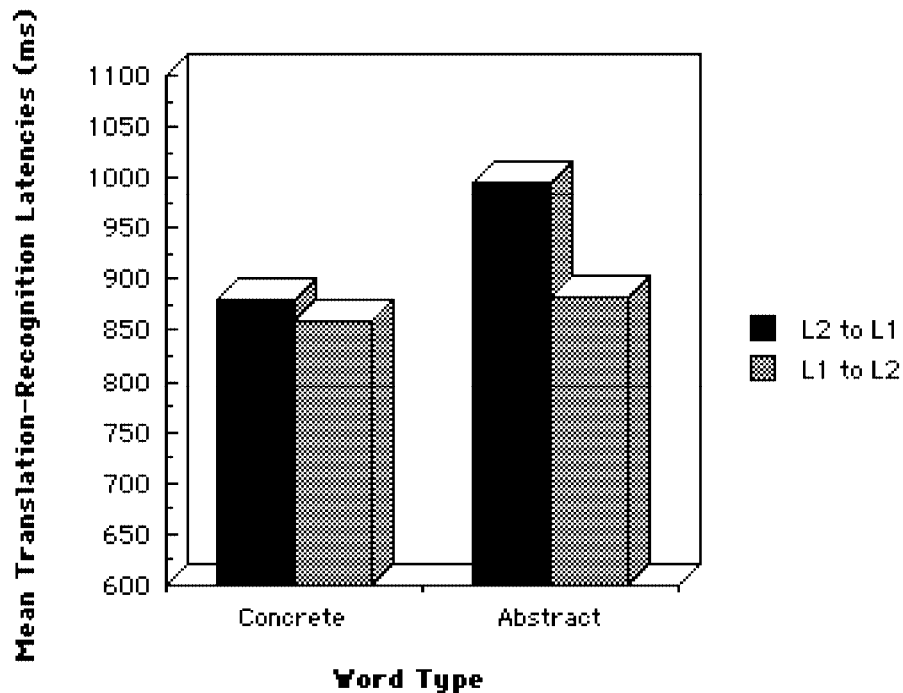
Table 6.

Mean Translation-Recognition Latencies (ms) and Mean Percentage Accuracy to Recognize Translations as a Function of Word Type and Language for Experiment 3.

Word type	Language Translation	
	L2 to L1	L1 to L2
Abstract (Accuracy %)	995 (85.3)	883 (96.4)
Concrete (Accuracy %)	881 (93.2)	859 (94.8)

A 2X2 (language x word type) mixed ANOVA was performed on the subject's translating latencies ( $F_1$ ) and the items ( $F_2$ ) as random factors revealed a word type significant main effect by subjects,  $F_1(1, 39) = 43.46$ ,  $Mse = 138471.44$ ,  $p < .0001$  and by items  $F_2(1, 138) = 12.246$ ,  $Mse = 29958.93$ ,  $p < .001$ . Concrete words were translated 78 ms faster than abstract words. The language main effect was significant both by subjects,  $F_1(1, 39) = 50.37$ ,  $MSe = 111012.32$ ,  $p < .0001$ , and by items,  $F_2(1, 138) = 10.03$ ,  $Mse = 29958.93$ ,  $p < .002$ . L1 to L2 translation were 67 ms faster than L2 to L1 translations. Again, this results replicate those of Experiment 2. Thus in general, the predicted asymmetry by the hierarchical model was not revealed. In addition, there was an interaction by subjects,  $F_1(1, 34) = 29.57$ ,  $MSe = 85392.84$ ,  $p < .0001$ , and marginally

significant by items,  $F_2(1,138)=3.308$ ,  $MSe=29958.93$ ,  $p=.071$ . The data in Figure 13 and Table 6 summarize the interaction by subjects.



**Figure 13.** Mean translation-recognition latencies (ms) as a function of word type and language.

Indeed, these results both by subjects and items replicate the results of Experiment 2 (see Figures 11 and 12). Again, these results are not predicted by the hierarchical model. More specifically, the predicted asymmetry where L2 to L1 translations are faster than translations from L1 to L2 is not supported by the present experiment in both abstract and concrete word conditions. Unlike the predictions of the hierarchical model, translations from L1 to L2 were faster than translations from L2 to L1.

Multiple comparisons on the interaction (see Table 6 and Figure 13) by subjects showed no differences between concrete L1 to L2 translations and L2 to L1 translations. That is, the 22 ms advantage for L1 to L2 was not significantly reliable. However, L1 to L2 translations for abstract words were significantly 112 ms faster than L2 to L1 translations. Again, this finding counters the expected prediction that L2 to L1 would be more sensitive to lexical processing and thus faster than L1 to L2 translations.

Unexpectedly, the concreteness effect was only evident in the L2 to L1 condition. L2 to L1 concrete translation were 114 ms faster than L2 to L1 abstract translations. L1 to L2 concrete translations did not differ from L1 to L2 abstract conditions. Like experiment 1, the lack of the concreteness effect in the L1 to L2 translations suggests that this condition was sensitive to some lexical code and that somehow subjects were not engaged in semantic processing.

Because the experimental stimuli included some cases in which a word and its translation did not match in high frequency (i.e., one word being of high frequency and the translation being of low frequency), a second analysis was possible. This analysis included only word frequencies that were greater than 40 occurrences per 1000,000 for both word pairs (house-casa). There was a significant main effect of word type by subjects,  $F_1(1,39) = 16.83$ ,  $MSe = 94406.07$ ,  $p < .0001$ , and by items,  $F_2(1,156) = 15.89$ ,  $Mse = 31314.14$ ,  $p < .0001$ , where concrete words were faster 44 ms faster than abstract words. L1 to L2 translations were 58 ms faster than L2 to L1 translations both by subjects,  $F_1(1,39) = 39.55$ ,  $MSe = 125094.83$ ,  $p < .0001$ , and by items,  $F_2(1,156) = 5.373$ ,  $MSe = 31314.14$ ,  $p < .022$ . However, the interaction was significant by subjects,  $F_1($

1,39)= 12.33,  $\underline{MSe}$ = 94410.58,  $p < .001$ , but not by items ( $p > .1$ ). Indeed, this analysis replicated the above results. Multiple comparisons showed no difference between L1 to L2 (M=860) and L2 to L1 (M=886) at the concrete level. However, L1 to L2 (M=872) was 91 ms faster than L2 to L1 (M=963) at the abstract level. More interestingly was the fact that the L2 to L1 was more sensitive to the concreteness effect. Concrete L2 to L1 translations were 77 ms faster than L2 to L1 abstract translations. L1 to L2 concrete translations did not differ from L1 to L2 abstract translations.

The data were also analyzed on accuracy to perform translations (See Table 6). A 2X2 mixed ANOVA was performed on the subjects' responses as a function of language translations (L1 to L2 vs. L2 to L1) and word type (abstract vs. concrete words). The analysis by subjects showed a main effect by language,  $\underline{F}_1(1,39)= 114.61$ ,  $\underline{MSe}$ = .04776849,  $p < .001$ , where L1 to L2 translations were more accurately (95.6 %) recognized than L2 to L1 translations (89.3 %), and by items,  $\underline{F}_2(1,138)= 8.541$ ,  $\underline{MSe}$ = .0164,  $p < .004$ . Concrete items were also more accurately recognized (93.9 %) than abstract words (90.9 %) by subjects,  $\underline{F}_1(1,39)= 20.60$ ,  $\underline{MSe}$ = .06163206,  $p < .0001$ , and marginally significant by items,  $\underline{F}_2(1,138)= 3.48$ ,  $\underline{MSe}$ = .0164,  $p = .064$ . Language and word type interacted both by subjects,  $\underline{F}_1(1,39)= 98.77$ ,  $\underline{MSe}$ = .03098890,  $p < .001$ , and by items,  $\underline{F}_2(1,39)= 4.198$ ,  $\underline{MSe}$ = .0164,  $p < .001$ . Planned multiple comparisons showed high accuracy rates in recognizing L1 to L2 translations in both concrete and abstract conditions ( $p < .05$ ). There was a higher accuracy to recognize L1 to L2 concrete translations than abstract conditions ( $p < .05$ ). Similarly, L2 to L1 concrete translations were more accurately than L2 to L1 abstract translations.

The noncritical stimuli (i.e., nontranslations) were analyzed as well. In general, it took longer for abstract nontranslations to be recognized ( $M= 1162$ ) than concrete nontranslations ( $M= 1021$ ),  $F_1(1,39)= 156.85$ ,  $MSe= 120223.91$ ,  $p < .0001$ . L1 to L2 nontranslations ( $M= 1063$ ) were recognized 57 ms faster than L2 to L1 nontranslations ( $M=1120$ ). The interaction was not reliable ( $F < 1$ ). In terms of accuracy to recognize non translations, subjects were more accurate recognizing concrete nontranslations (94.9 %) than abstract nontranslations (90.7 %),  $F_1(1,39)= 32.78$ ,  $MSe= .05817321$ ,  $p < .0001$ . Subjects were also more accurate recognizing L1 to L2 (93.6 %) nontranslations than L2 to L1 translations (91.9 %),  $F_1(1,39)= 4.11$ ,  $MSe= .08213194$ ,  $p < .05$ .

The most obvious conclusion of the present experiment is that the present experiment did not support the predictions of the hierarchical model. At least by subjects, L1 to L2 translations are not slower than L2 to L1 translations. Concerning the assumption that L1 to L2 are semantically sensitive, however, it seems that at least at the concrete condition, both L1 to L2 and L2 to L1 translations took advantage of the semantic code inherent in concrete words. More important, however, was the finding that L1 to L2 concrete translations did not differ from L1 to L2 abstract translations. This finding, like in Experiment 1, suggests that L1 to L2 conditions can be sensitive to lexical processing.

## Chapter 5

### General Discussion

The three experiments reported in the present study clearly demonstrate the differential effects of abstract and concrete words in bilingual memory organization. The purpose of the present study was to test the revised hierarchical and the distributed models of bilingual memory. Overall, the results from the present three experiments, controlling for concreteness and for high word frequency, suggest that the processes underlying concrete words are fundamentally similar across languages, and that the processes for abstract words are different across languages. Unlike previous research in bilingual memory, the present study shows the importance of experimentally controlling for word type and word frequency. As pointed out earlier, past research has confounded word frequency and concreteness. This is the most systematically experimentally controlled experiment to date.

#### *Evidence for the hierarchical model*

The results of the present experiments did not support the main assumptions of the hierarchical model shown in Figure 6. First, the assumptions that L1 to L2 translations are lexically oriented and that L2 to L1 translations are conceptually oriented did not hold in Experiment 2, the more conceptually oriented task, and Experiment 3, the less conceptually oriented task. Specifically, L1 to L2 did not take advantage of the semantic code of concrete words as it should have if L1 to L2 were semantically oriented as predicted by the hierarchical model. In fact, both L1 and L2 and L2 to L1 translations seemed to benefit from this code. More important however, was the finding that L2 to L1

translations did not show the expected advantage in the abstract condition. That is, because L2 to L1 translations are hypothesized to be lexically oriented, and L1 to L2 translations to be conceptually oriented, the prediction that L2 to L1 would benefit was not revealed. Contrary to this prediction, L1 to L2 translations were faster than L2 to L1 condition. This result is inconsistent with the hierarchical model because it suggests that even if there is no semantic code to facilitate L1 to L2 translations, L1 to L2 translations are faster than L1 to L2 translations, thus suggesting that L1 to L2 is both sensitive to lexical processing.

The analysis of Experiment 3 further supports the finding of Experiment 2. Although Experiment 3 showed that L1 to L2 translations were equivalent to L2 to L1 translations, the fact that L1 to L2 concrete translations did not differ from L1 to L2 abstract translations qualifies the finding of Experiment 2 that in the abstract condition L1 to L2 was more sensitive to the lexical nature of the translation-recognition task. In fact, this same effect was observed in the naming task and later confirmed by Experiment 3. Thus Experiments 1 and 3 clearly demonstrate the lexical effects on L1 to L2 translations. Note that De Groot et al. (1994) has also questioned the assumption that L1 to L2 are conceptually oriented and L2 to L1 are lexically oriented. Specifically, De Groot et al. (1994) performed a series of regression analysis (Experiment 1) and found that L2 to L1 translations were sensitive to semantic factors such as imageability and context availability. However, their overall analysis (Experiments 1 and 2) demonstrated that semantic factors played a slightly more important role in L1 to L2 translations. Thus, the results of the present study present more direct evidence for De Groot et al's claim. More

specifically, the present study further showed that both translations (L1 to L2 and L2 to L2) are equally sensitive to semantic facilitation in the concrete condition. It should be noted in contrast with the present study, De Groot et al's. (1994) study involved a between-subjects translation condition. That is, one group of subjects participated in the L1 to L2 translation and another group participated in the L2 to L1 translation condition. This difference in methodology may account for the differences between the present study and De Groot et al's. Study with regard to the importance of semantic factors in L1 to L2 translations.

Another assumption of the hierarchical mode not supported by the present study is the assumption that the conceptual link from the L2 lexicon to the conceptual system is weak. Experiment 2 provides evidence against this hypothesis. Specifically, the fact that concrete translations did not differ in both translation conditions suggests that subjects were accessing the conceptual system directly via the conceptual links. In fact, Dufour and Kroll (1995) have also find evidence for this claim. In a categorization task, they compared highly fluent and less fluent English-French bilinguals. They found that the more highly fluent bilinguals show no differences regardless of the language condition (i.e., within- vs. between-language). On the other hand, less-fluent bilinguals were faster to categorize when the language of the category matched the language of the target word. In other word, less-fluent bilinguals were slower to categorize in the between-language conditions. Thus, assuming that the subjects in the present study were fluent enough, the present results support that claim.

The present results also failed to show a very important prediction by the hierarchical model. That is, in Experiment 1 L1 failed to show the expected advantage over L2 because the subjects' L1 supposedly has more words than the subjects L2. This result was further supported by Experiment 2 and 3. In fact, Experiment 2 failed to show a significant main effect of language condition. Moreover, subjects' performance translating was better for L1 to L2 translations than L2 to L1 translations. This finding was qualified by Experiment 3 which revealed faster recognition for L1 to L2 translations and higher accuracy to recognize L1 to L2 translations. More important was the finding that the noncritical stimuli (translation-nontranslation) showed the same pattern of results. L1 to L2 nontranslations were recognized faster and were more accurately recognized as nontranslations than L2 to L1 translations.

*Evidence for the distributed model*

The present results support the main assumptions of the distributed model--i.e., that concrete items are fundamentally similar across languages. Indeed, the data showed no significant differences between L1 to L2 and L2 to L1 conditions in the concrete conditions. Moreover, the differences in translations in the abstract conditions were also expected by this model. These differences were revealed in Experiment 2 and 3. Although Experiment 1 did not show equivalent lexical effects across languages, Experiment 2 and 3 revealed strong support for this model. More specifically, the lack of language differences in the concrete conditions and significant differences in the abstract conditions suggest that concrete and abstract words have differential effects in bilingual memory. These results were qualified of the translation performance accuracies by the

subjects. As expected by this model, overall, subjects experienced more difficulty in the abstract condition in both L1 to L2 and L2 to L1 translations (see Experiment 2, Table 5) and more difficulties in the L2 to L1 translation-recognition experiment (see Experiment 3, Table 6).

Thus, as hypothesized by De Groot (1992a, 1992b, 1993) and De Groot et al. (1994), it seems that concrete words have direct access to the conceptual system, whereas abstract words are required to access the conceptual systems via the lexical links. Notice however, that by accessing the conceptual system via the lexical system it does not mean that subjects have to resort to translations. Perhaps, a reasonable explanation could be that because abstract words are more language specific they have to be activated directly from the bilingual's two lexicons before accessing the conceptual system. On the other hand, concrete words can access the conceptual system directly because these words are very similar across languages and subjects do not have to access their lexicons individually.

*Implications for models of bilingual memory representations*

Although the present results did not support the assumptions of the hierarchical model, the hierarchical model cannot be rejected because it is still able to explain the findings that concrete L1 to L2 and L2 to L1 translations are conceptually mediated. Specifically, this model can be modified to account for the present findings (see also Dufour & Kroll, 1994). Because this model allows for the possibility for a stronger conceptual link from the subjects' L2 to the conceptual system (see Figure 6), it is possible that the strength from this link is as strong and easily activated as the L1 to the

conceptual link at least for concrete words and for highly “balanced” bilinguals (for a similar argument see Dufour & Kroll, 1994). However, the challenge for this model would be to explain the results of the abstract words. Notice that a further assumption could be introduced to explain the results of the abstract conditions in the present experiment. This assumption would be to assume that at least for highly fluent bilinguals, the translations differences would depend on the subjects’ more dominant or more frequently used language. However, this assumption would make the hierarchical model indistinguishable from De Groot’s distributed or mixed model latest modification.

Although the distributed or mixed model, in its current version, predicts the processing differences between concrete and abstract words, it is somewhat ambiguous in terms of its predictions regarding differences in abstract words. A major limitation of this model is that even if it distinguishes between the size of L1 and L2 lexicons, unlike the hierarchical model, it is not very clear regarding potential differences or asymmetries between languages (i.e., abstract words, cognates vs. noncognates). That is, this model predicts that language differences or asymmetries would depend on whether the bilingual has a coordinate or compound structure (e.g., Ervin & Osgood, 1954). It is difficult to determine whether learning L1 and L2 in a different setting fosters separate or similar bilingual structures. In fact, the compound-coordinate distinction was abandoned for lack of empirical support and theoretical complexities (e.g., Diller, 1974; Gekoski, 1980; Gekoski, et al., 1982; Lambert et al., 1958; Paivio, 1991). For instance, consider the findings in the present study. Subjects in the present experiment (see Table 2) rated themselves as “fully proficient” in both reading, writing and reading comprehension in

their two languages. However, in Experiment 1 (the naming task) subjects were slower in naming Spanish words and were less accurate as well. In Experiments 2 and 3, the same subjects were better in translating or recognizing L1 to L2 than L2 to L1 abstract translations. How can the distributed model reconcile these differences? Moreover, this model cannot explain later finding suggesting that cognates and noncognates show L1 to L2 and L2 to L1 asymmetries as predicted by the hierarchical model (e.g., De Groot et al., 1994; Dufour & Kroll, 1995; Kroll & Stewart, 1994; see also, Keatley et al., 1994).

Indeed, the assumption that language asymmetries depend on the subjects more dominant language or which language is utilized more frequently can be tested systematically. Thus according to the distributed model, one would expect that controlling for fluency, L1 to L2 translations should be faster for nonfluent Spanish-English bilinguals than L2 to L1 translations. More fluent bilinguals would exhibit similar differences in L1 to L2 and L2 to L1 translations.

#### *Implications for future work*

The present discussion has only considered concreteness effects in high items effects. The reasons for this emphasis is that the predictions of both the hierarchical and distributed models were relatively easy to test. However, given the results of Experiment 1 and 2 where naming concrete Spanish words and recognizing concrete L1 to L2 concrete translations did not differ from the abstract conditions, respectively, it is important to consider language effects. That is, one reason that the concreteness effect was not evident for the Spanish condition in the naming task and L1 to L2 translation-recognition in Experiment 3 could be that subjects in Experiment 1 were pronouncing

words in Spanish without knowing the meaning of Spanish words. That is, subjects could have engaged in some sort of “rule” of grapheme-to-phoneme representation given that Spanish has a shallow (regular orthography) and the results of both the naming and the translation-recognition tasks may have been obscured by this language and high frequency effect.

Unlike previous studies (e.g., De Groot, 1992a; De Groot et al., 1994; Kroll & Stewart, 1994; Sholl, 1993) the present study utilized more fluent bilinguals in their L2. More important, the bilinguals in the present study were more active in their L2 and most of their education was in their L2. This difference could account for the present results because most of the recent research has utilized Dutch-English (De Groot, 1992a; De Groot et al., 1994; Kroll & Stewart, 1990, 1994; Sholl, 1993) and English-French bilinguals (Dufour & Kroll, 1995), who were not as fluent in their L2 and/or not use it as actively.

## References

- Altarriba, J. (1992). The representation of translation equivalents in bilingual memory. In R. Harris (Ed.), Cognitive processing in bilinguals (pp. 157-174). North-Holland: Elsevier Science Publishers.
- Anderson, J. R. (1978). Arguments concerning representations for mental imagery. Psychological Review, *85*, 249-277.
- Besner, D., Smith, M. C., & MacLeod, C. M. (1990). Visual word recognition: A dissociation of lexical and semantic processing. Journal of Experimental Psychology: Learning, Memory, and Cognition, *16*, 862-869.
- Blaxton, T. A. (1989). Investigating dissociations among memory measures: Support for a transfer-appropriate processing framework. Journal of Experimental Psychology: Learning, Memory, and Cognition, *15*, 657-668.
- Caramazza, A., & Brones, I. (1980). Semantic classification by bilinguals. Canadian Journal of Psychology, *34*, 77-81.
- Carreiras, M., Alvarez, C. J., & De Vega, M. (1993). Syllable frequency and visual word recognition in Spanish. Journal of Memory and Language, *32*, 766-780.
- Chen, H-C. (1990). Lexical processing in a non-native language: Effects of language proficiency and learning strategy. Memory & Cognition, *18*, 279-288.
- Chen, H-C., & Leung., Y-S. (1989). Patterns of lexical processing in a nonnative language. Journal of Experimental Psychology: Learning, Memory, and Cognition, *15*, 316-325.

Chen, H-C., & Ng, M-L. (1989). Semantic facilitation and translation priming effects in Chinese-English bilinguals. Memory & Cognition, 17, 454-462.

Cohen, J., & Cohen, P. (1983). Applied multiple regression/correlation analysis for the behavioral sciences (2nd ed.). Hillsdale, NJ: Lawrence Erlbaum Associates, Publishers.

Collins, A. M., & Loftus, E. F. (1988). A spreading-activation theory of semantic processing. In A. Collins & S. E. Edward (Eds.), Readings in cognitive science: A perspective from psychology and artificial intelligence (pp. 126-136). San Mateo, CA: Morgan Kaufmann Publishers, Inc.

Collins, S., Marcos, M. B., & Chang-Rodríguez, E. (Eds.). (1989). Harper Collins, Spanish/English, English/Spanish dictionary (2nd. Ed.). Spain: Ediciones Grijalbo.

Dalrymple-Alford, E. C. (1982). Associations of bilinguals to synonyms and translation-equivalent words. Current Psychological Research, 2, 181-185.

Dellarosa, D., & Bourne, L. E. (1985). Surface form and the spacing effect. Memory & Cognition, 13, 529-537.

Diller, K (1974). "Compound" and "coordinate" bilingualism: A conceptual artifact. Word, 26, 254-261.

Dufour, R., & Kroll, J. F. (1995). Matching words to concepts in two languages: A test of the concept mediation model of bilingual representation. Memory & Cognition, 23, 166-180.

Durgunoglu, A. Y., & Roediger, H. L. I. (1987). Test differences in accessing bilingual memory. Journal of Memory and Language, 26, 377-391.

Ervin, S., & Osgood, C. (1954). Psycholinguistics: A survey of theory and research problems. In C. Osgood & T. Seboek (Eds.), Psycholinguistics (pp. 139-146). Baltimore, MA: Waverly Press.

Eysenck, M. W., & Keane, M. T. (1990). Cognitive psychology: A student's handbook. United Kingdom: Lawrence Erlbaum Associates, Ltd.

Francis, W. N., & Kucera, H. (1982). Frequency analysis of English usage. Providence, RI: Brown University Press.

Friendly, M., Franklin, P. E., Hoffman, D., & Rubin, D. C. (1982). The Toronto word pool: Norms for imagery, concreteness, orthographic variables, and grammatical usage for 1,080 words. Behavior Research Methods & Instrumentation, 14, 375-399.

Gómez, T. De (Ed.). (1973). Simon and Schuster's international dictionary, English/Spanish, Spanish/English. New York, NY: Simon and Schuster.

Gekoski, W. L. (1980). Language acquisition context and language organization in bilinguals. Journal of Psycholinguistic Research, 9, 429-449.

Gekoski, W. L., Jacobson, Z. J., & Frazao-Brown, A. P. (1982). Visual masking and linguistic independence in bilinguals. Canadian Journal of Psychology, 36, 108-116.

Gerald, L. D., & Scarborough, D. L. (1989). Language-specific lexical access of homographs by bilinguals. Journal of experimental psychology: Learning, Memory, and Cognition, 15, 305-315.

- Gernsbacher, M. A. (1990). Language comprehension as structure building. Hillsdale, NJ.: L. Erlbaum, 1990.
- Gihooly, K. J., & Gilhooly, M. L. (1979). Age-of-acquisition effects in lexical and episodic tasks. Memory & Cognition, 7, 214-223.
- Gilhooly, K. J., & Logie, R. H. (1980a). Age-of-acquisition, imagery, concreteness, familiarity, and ambiguity measures for 1,944 words. Behavior Research Methods & Instrumentation, 12, 395-427.
- Gilhooly, K. J., & Logie, R. H. (1980b). Meaning-dependent ratings of imagery, age of acquisition, familiarity, and concreteness for 387 ambiguous words. Behavior Research Methods & Instrumentation, 12, 428-450.
- Glanzer, M., & Duarte, A. (1971). Repetition, between and within language in free recall. Journal of Verbal Learning and Verbal Behavior, 10, 625-630.
- Glucksberg, S. (1984). Commentary: The functional equivalence of common and multiple codes. Journal of Verbal Learning and Verbal Behavior, 10, 625-630.
- González, M. (Ed.). (1985). Webster's new world Spanish dictionary, Spanish-English, English-Spanish. New York : Simon and Schuster.
- Graf, P., & Schacter, D. L. (1985). Implicit and explicit memory for new dissociations in normal amnesic subjects. Journal of experimental psychology: Learning, Memory, and Cognition, 11, 501-518.
- Groot, A. M. B. De (1989). Representational aspects of word imageability and word frequency as assessed through word association. Journal of Experimental Psychology: Learning, Memory, and Cognition, 15, 824-845.

Groot, A. M. B. De (1992a). Determinant of word translation. Journal of Experimental Psychology: Learning, Memory, and Cognition, 18, 1001-1018.

Groot, A. M. B. De (1992b). Bilingual lexical representation: A closer look at conceptual representation. In R. Frost & L. Katz (eds.), Orthography, phonology, morphology, and meaning (pp. 389-412). Amsterdam: Elsevier Science Publishers.

Groot, A. M. B. De (1993). Word-type effect in bilingual processing tasks: Support for a mixed representational system. In R. Schreuder & B. Weltens (Eds.), The bilingual lexicon (pp. 28-51). Amsterdam/Philadelphia: John Benjamins.

Groot, A. M. B. De, Dannenburg, L., & Van Hell, J. G. (1994). Forward and backward word translation by bilinguals. Journal of Memory and Language, 33, 600-629.

Groot, A. M. B. De & Nas, G. L. J. (1991). Lexical representation of cognates and noncognates in compound bilinguals. Journal of Memory and Language, 30, 90-123.

Heredia, R. R., & McLaughlin, B. (1992). Bilingual memory revisited. In R. J. Harris (Ed.), Cognitive processing in bilinguals (pp. 91-103). North-Holland: Elsevier Science Publishers.

Jacoby, L. L. (1983). Remembering the data: Analyzing interactive processes in reading. Journal of Verbal Learning and Verbal Behavior, 17, 649-667.

Job, R., & Peressotti, F. (1994, November). Lexical effects in naming pseudowords in Italian. Poster session presented at the annual meeting of the Psychonomic Society, St. Louis, Missouri.

Jullian, A., & Chang-Rodríguez, E. (1964). Frequency dictionary of Spanish words. La Haya: Mouton.

Kawamoto, A. H., & Zemplidige, J. H. (1992). Pronunciation of homographs. Journal of Memory and Language, 31, 349-372.

Keatley, C. W. (1992). History of bilingualism research in cognitive psychology. In R. Harris (Ed.), Cognitive Processing in Bilinguals (pp. 157-174). North-Holland: Elsevier Science Publishers.

Keatley, C. W., Spinks, J. A., & De Gelder, B. (1994). Asymmetrical cross-language priming effects. Memory & Cognition, 22, 70-84.

Keppel, G. (1982). Design and analysis: A researcher's handbook. New Jersey: Prentice Hall.

Kintsch, W. (1970). Recognition Memory in bilingual subjects. Journal of Verbal Learning and Verbal Behavior, 9, 405-409.

Kirsner, K., Brown, H., Abrol, S., Chandra, N., & Sharma, K. (1980). Bilingualism and lexical representation. Quarterly Journal of Experimental Psychology, 32, 585-594.

Kirsner, K., Smith, M. C., Lockhart, R. S., King, M., & Jain, M. (1984). The bilingual lexicon: Language-specific units in an integrated network. Journal of verbal Learning and Verbal Behavior, 23, 519-539.

Klockars, A. J., & Sax, G. (1986). Multiple comparisons. In M. S. Lewis-Beck (Ed.). Series: Quantitative applications in the social sciences. Newbury Park: Sage Publications.

Kolers, P. A. (1963). Interlingual associations. Journal of verbal Learning and Verbal Behavior, 2, 291-300.

Kolers, P. A. (1966). Interlingual facilitation of short-term memory. Journal of Verbal Learning and Verbal Behavior, 5, 314-319.

Kolers, P. A., & Brison, S. J. (1984). Commentary: On pictures, words, and their mental representations. Journal of Verbal Learning and Verbal Behavior, 23, 105-113.

Kolers, P. A., & González, E. (1980). Memory for words, synonyms, and translations. Journal of Experimental Psychology: Human Learning and Memory, 6, 53-65.

Kolers, P. A., & Roediger, H. L. (1984). Procedures of mind. Journal of Verbal Learning and Verbal Behavior, 23, 425-449.

Kroll, J. F. (1993). Accessing conceptual representations for words for words in a second language. In R. Schreuder & B. Weltens (Eds.), The bilingual lexicon (pp. 54-81). Amsterdam/Philadelphia: John Benjamins.

Kroll, J. F., & Curley, J. (1988). Lexical memory in novice bilinguals. The role of concepts in retrieving second language words. In M. Grunenber, P. Morris, & R. Sykes (Eds.), Practical aspects of memory, (Vol. 2, pp. 389-395). London: John Wiley & Sons.

Kroll, J. F., & Merves, (1986). Lexical access for concrete and abstract words. Journal of Experimental Psychology: Learning, Memory, and Cognition, 12, 92-107.

Kroll, J. F., & Sholl, A. (1992). Lexical and conceptual memory in fluent and nonfluent bilinguals. In R. Harris (Ed.), Cognitive Processing in Bilinguals (pp. 157-174). North-Holland: Elsevier Science Publishers.

- Kroll, J. F., & Stewart, E. (1990). Concept mediation in bilingual translation. Paper presented at the meeting of the Psychonomic Society, (pp. 1-7). New Orleans, LA.
- Kroll, J. F., & Stewart, E. (1994). Category interference in translation and picture naming: Evidence for asymmetric connections between bilingual memory representations. Journal of Memory and Language, 33, 149-174.
- Lambert, W. E. (1992). Challenging established views on social issues. American Psychologist, 47, 533-542.
- Lambert, W. E., Havelka, J., & Crosby, C. (1958). The influence of language-acquisition contexts on bilingualism. Journal of Abnormal Social Psychology, 56, 239-244.
- Logan, G. D. (1988). Toward an instance theory of automatization. Psychological Review, 95, 492-527.
- López, M., & Young, R. K. (1974). The linguistic interdependence of bilinguals. Journal of experimental Psychology, 102, 981-983
- Lukatela, G., & Turvey, M. T. (1990). Phonemic similarity effects and prelexical phonology. Memory & Cognition, 18, 128-152.
- Macnamara, J., & Kushnir, S. L. (1971). Linguistic independence of bilinguals: The input switch. Journal of Verbal Learning and Verbal Behavior, 10, 480-487.
- Madigan, S. (1969). Intraserial repetition and coding processes in free recall. Journal of Verbal Learning and Verbal Behavior, 8, 828-835.

Mägiste, E. (1979). The competition language systems of the multilingual: A developmental study of decoding and encoding process. Journal of Verbal Learning and Verbal Behavior., 18, 79-89.

Massaro, D.W. (1989). Experimental psychology: An information processing approach (pp. 129-139). San Diego, CA: Hartcourt Brace Jovanovich, Inc.

McKoon, G., & Ratcliff, R. (1992). Spreading activation versus compound cue accounts of priming: Mediated priming revisited. Journal of Experimental Psychology: Learning, Memory, and Cognition, 18, 1155-1172.

McLaughlin, B. (1984). Second-language acquisition in childhood. Vol. 1: Preschool children. Hillsdale, NJ: Lawrence Erlbaum Associates.

McLaughlin, B. (1990). Restructuring. Applied Linguistics, 11, 113-128.

McNamara, T. P. (1992a) Priming and constraints it places on theories of memory and retrieval. Psychological Review, 99, 650-662.

McNamara, T. P. (1992b). Theories of priming: I. Associative distance and lag. Journal of Experimental Psychology: Learning, Memory, and Cognition, 18, 1173-1190.

Meyer, D. E., & Ruddy, M. G. (1974). Bilingual word-recognition: Organization and retrieval of alternative lexical codes. Paper presented to the Eastern Psychological Association, Philadelphia.

Morris, C. D., Bransford, J. D., & Franks, J. J. (1977). Levels of processing versus transfer appropriate processing. Journal of Verbal Learning and Verbal Behavior 16, 519-533.

O'Neill, W., Roy, L., & Tremblay, R. (1993). A translation-based generation effect in bilingual recall and recognition. Memory & Cognition, 21, 488-495.

Paivio, A. (1991). Mental representations in bilinguals. In A. G. Reynolds (Ed.), Bilingualism, multiculturalism, and second language learning : The McGill conference in honour of Wallace E. Lambert. Hillsdale, NJ. : Erlbaum Associates.

Paivio, P., Clark, J. M., & Lambert, W. E. (1988). Bilingual dual-coding theory and semantic-repetition effects. Journal of Experimental Psychology: Learning, Memory, and cognition, *14*, 163-172.

Paivio, A., & Desrochers, A. (1980). A dual-coding approach to bilingual memory. Canadian Journal of psychology, *34*, 388-399.

Paivio, A., Yuille, J. C., & Madigan, S. A. (1968). Concreteness, imagery, and meaningfulness values for 925 nouns. Journal of Experimental Psychology: Monograph Supplement, *76*, 1-25.

Paradis, M. (1985). On the representation of two languages in one brain. Language Sciences, *7*, 1-39.

Potter, M. C. (Ed.). (1979). Mundane symbolism: The relations among objects, names, and ideas. Hillsdale, NJ: Erlbaum Associates.

Potter, M. C., & Falconer, B. A. (1975). Time to understand pictures and words. Nature, *253*, 437-438.

Potter, M. C., So, K., Eckardt, V., & Feldman, L. (1984). Lexical and conceptual representation in beginning and proficient bilinguals. Journal of Verbal Learning and Verbal Behavior, *23*, 23-38.

Roediger, H. L. I. (1990). Implicit memory: Retention without remembering. American Psychologist, *45*, 1043-1056.

Roediger, H. L., Weldon, M. S., & Challis, B. H. (1989). Explaining dissociations between implicit and explicit measures of retention: A processing account. In I. H. L. Roediger III & F. I. M. Craik (Eds.), Varieties of memory and consciousness, (pp. 3-41). Hillsdale, NJ: Erlbaum.

Sánchez-Casas, R., M., Davis, C. W., & García-Albea, J. E. (1992). Bilingual lexical processing: Exploring the cognate/noncognate distinction. European Journal of Cognitive Psychology, *4*, 293-310

Scarborough, D. L., Gerard, L., & Cortese, C. (1984). Independence of lexical access in bilingual word recognition. Journal of Verbal Learning and Verbal Behavior, *23* 84-99.

Schacter, D. L. (1987). Implicit memory: History and current status. Journal of Experimental Psychology: Learning, Memory, and Cognition, *13*, 501-518.

Schacter, D. L. (1992). Understanding implicit memory. American Psychologist, *47*, 559-569.

Schneider, W. & Shiffrin, R. M. (1977). Controlled and automatic human information processing: I. Detection, search, and attention. Psychological Review, 84, 1-66.

Schwanenflugel, P. J. (1991). Why are abstract concepts hard to understand? In P. J. Schwanenflugel (Ed). The psychology of word meanings (pp. 223-250). Hillsdale, NJ: Erlbaum.

Schwanenflugel, P. J., Akin, C., & Luh, W-M. (1992). Context availability and the recall of abstract and concrete words. Memory & Cognition, 20, 96-104.

Schwanenflugel, P. J., Blount, B. G., & Lin, P-J. (1991). Cross-cultural aspects of word meaning. In P. J. Schwanenflugel (Ed). The psychology of word meanings (pp. 71-90). Hillsdale, NJ: Erlbaum.

Schwanenflugel, P. J., Harnishfeger, K. K., & Stowe, R. W. (1988). Context availability and lexical decisions for abstract and concrete words. Journal of Memory and Language, 27, 499-520.

Schwanenflugel, P. J., & Rey, M. (1986). Interlingual semantic facilitation: Evidence for a common representational system in the bilingual lexicon. Journal of Memory and Language, 25, 605-618.

Sharma, N. K. (1984). Bilingualism and the representation of linguistic information in memory. Psycho-lingua, 14, 19-34.

Shiffrin, R. M., & Schneider, W. (1977). Controlled and automatic human information processing: II. Perceptual learning, automatic attending, and a general theory. Psychological Review, 84, 127-190.

Sholl, A. (1993). Memory performance following bilingual translation: Lexical and conceptual determinants of cross-language transfer. Unpublished master's thesis, University of Massachusetts.

Sholl, A., Sankaranarayanan, A., & Kroll, J. F. (1995). Transfer between picture naming and translation: A test of asymmetries In bilingual memory. Psychological Science, *6*, 45-49.

Smith, M. C. (1991). On the recruitment of semantic information for word fragment completion evidence from bilingual priming. Journal of experimental Psychology: Learning, Memory, and Cognition, *17*, 234-244.

Snodgrass, J. G. (1984). Concepts and their surface representations. Journal of Verbal Learning and Verbal Behavior, *23*, 3-22.

Snodgrass, J. G. (1993). Translating versus picture naming. In R. Schreuder & B. Weltens (Eds.), The bilingual lexicon (pp. 83-114). Amsterdam/Philadelphia: John Benjamins.

Tabossi, P., Laghi, L. (1992). Semantic priming in the pronunciation of words in two writing systems: Italian and Spanish. Memory & Language, *20*, 303-313.

Taylor, I. (1976). Similarity between French and English words: A factor to be considered in bilingual language behavior. Journal of Psycholinguistic Research, *5*, 85-94.

Toglia, M. P., Battig, W. F., Barrow, K., Cartwright, D. S., Posnansky, C. J., Pellegrino, J. W., Moore, T. J., & Camili, G. A. (1978). Handbook of semantic norms. Hillsdale, NJ: Lawrence Erlbaum Associates, Ltd.

Tulving, E., & Colotla, U. (1970). Free recall of trilingual lists. Cognitive Psychology, 1, 86-98.

Tzelgov, j., Henik, A., & Leiser, D. (1990). Controlling stroop interference: Evidence from a bilingual task. Journal of experimental Psychology: Learning, Memory, and Cognition, 16, 760-771.

Vaid, J. (1984). Visual, phonetic, and semantic processing in early and late bilinguals. In M. Paradis & Y. Lebrun (Eds.), Early bilingualism and child development. Lisse: Swet & Zeitlinger.

Vitkovich, M., & Humphreys, G. W. (1991). Perseverant responding in speeded naming of pictures: It's in the links. Journal of Experimental Psychology: Learning Memory, and Cognition, 17, 234-244.

Watkins, M. J., & Peynircioglu, Z. F. (1983). On the nature of word recall: Evidence for linguistic specificity. Journal of Verbal Learning and Verbal Behavior, 22, 336-394.

Weinreich, U. (1953). Languages in contact. New York: The Linguistic Circle of New York.

Winograd, E., Cohen, C., & Barresi, J. (1976). Memory for concrete and abstract words in bilingual speakers. Memory & Cognition, 4, 323-329.

## Appendix A

Stimuli used in Experiments 1 and 2. Words are in alphabetical order by Language condition (English vs. Spanish), concreteness (1-7 rating scale) and by Frequency. The concreteness ratings were taken from different sources. Please refer to the methods section of Experiment 1 for more information. The word frequencies are the number of times per million occurrences in printed English (Francis & Kucera, 19982) and Spanish (Juilland & Chang-Rodríguez, 1964).

Language	Word	Concreteness	Frequency
E	advice	3.06	52
E	age	3.57	275
E	agreement	2.93	121
E	anger	3.80	48
E	appeal	3.31	72
E	approach	3.20	125
E	arrangement	3.03	72
E	award	4.00	60
E	background	3.63	74
E	bath	5.90	31
E	battle	5.60	91
E	bay	6.11	60
E	beard	5.76	31
E	beginning	3.14	92
E	behavior	2.89	100
E	bit	3.88	105
E	board	5.39	285
E	body	5.45	342
E	bread	6.18	41
E	bridge	6.60	117
E	budget	3.69	62
E	business	3.56	412
E	call	3.80	76
E	castle	6.70	12
E	cat	6.30	42

E	century	3.03	254
E	choice	2.80	121
E	class	2.76	292
E	command	3.73	74
E	customer	5.26	69
E	danger	2.97	94
E	date	5.45	120
E	death	3.96	284
E	device	4.47	92
E	discover	3.26	55
E	doubt	2.36	115
E	drive	3.88	60
E	dust	5.23	70
E	edge	4.34	114
E	employee	5.56	109
E	evil	1.64	42
E	expenditure	4.04	55
E	eye	6.28	524
E	fashion	3.31	70
E	feature	3.80	105
E	floor	5.55	170
E	foot	6.38	361
E	friend	4.40	294
E	front	4.20	153
E	god	3.61	31
E	growth	3.86	156
E	guest	5.15	99
E	gun	6.08	142
E	hat	5.97	71
E	head	6.16	449
E	height	3.80	58
E	hell	3.42	86
E	hour	4.19	325
E	house	6.21	662
E	key	6.08	71
E	lack	3.07	97
E	lady	5.58	122
E	left	3.37	67
E	lie	3.00	9
E	life	2.96	772
E	load	4.35	52
E	love	3.20	179
E	luck	2.66	48

E	magazine	5.91	65
E	mass	3.83	110
E	maturity	2.20	40
E	money	5.77	275
E	month	3.20	327
E	mother	5.47	280
E	mouth	5.64	113
E	need	3.10	253
E	neighbor	5.37	59
E	newspaper	6.17	104
E	noise	5.23	43
E	occurrence	3.08	40
E	owner	4.09	72
E	page	5.85	102
E	pain	4.22	102
E	peace	3.05	198
E	power	3.32	404
E	press	4.44	107
E	prince	5.38	40
E	procedure	1.00	140
E	profit	3.60	46
E	purpose	2.71	239
E	queen	5.05	51
E	race	4.59	120
E	relation	2.56	126
E	resource	4.50	81
E	rest	3.48	140
E	right	3.57	204
E	risk	2.83	47
E	road	5.65	262
E	roof	5.82	64
E	row	3.76	48
E	safety	3.29	48
E	search	3.74	59
E	season	4.69	125
E	shame	2.62	21
E	share	3.88	100
E	sheet	6.43	71
E	skill	3.46	79
E	skin	6.31	53
E	smile	5.19	56
E	space	3.64	144
E	square	5.15	121

E	station	5.56	195
E	step	4.91	228
E	summer	4.51	151
E	sun	6.23	117
E	surprise	3.23	49
E	table	6.09	242
E	tale	3.58	41
E	tiredness	3.40	3
E	tooth	6.15	123
E	trade	3.64	138
E	trust	2.49	32
E	turn	3.40	96
E	understanding	2.59	83
E	war	4.86	492
E	wave	4.88	95
E	wealth	3.66	22
E	week	3.79	425
E	weight	4.58	101
E	welfare	3.25	53
E	whole	2.71	52
E	window	6.27	172
E	winter	4.97	82
E	world	5.37	832
E	wound	5.89	24
E	writer	4.80	151
S	acero	5.82	26
S	actitud	2.66	110
S	ala	5.91	52
S	alcalde	4.82	50
S	alegría	2.86	126
S	alma	3.17	340
S	amenaza	3.22	40
S	amistad	3.34	76
S	ansia	1.63	46
S	año	3.44	1216
S	aumento	3.11	38
S	ausencia	3.70	28
S	ayuda	2.86	48
S	baile	4.98	74
S	barco	6.25	106
S	boda	4.11	78
S	bolsillo	5.59	46
S	bondad	2.66	72

S	cárcel	6.02	64
S	calle	5.84	470
S	calor	4.84	58
S	cama	6.68	82
S	capítulo	5.50	158
S	cargo	3.79	82
S	carne	5.80	114
S	carta	5.31	206
S	célula	5.09	80
S	cena	5.38	18
S	comentario	3.71	56
S	conde	3.47	88
S	cosa	3.46	1078
S	cuarto	5.45	172
S	cuello	5.83	52
S	cuidado	3.38	124
S	debilidad	2.46	30
S	declaración	3.83	66
S	desarrollo	3.06	102
S	deseo	2.48	144
S	éxito	2.88	84
S	edificio	6.00	94
S	ejército	5.24	122
S	enfermedad	5.10	98
S	escuela	5.49	200
S	esfuerzo	3.06	140
S	esperanza	3.05	76
S	estancia	3.25	52
S	existencia	2.30	160
S	extranjero	5.11	64
S	extraño	4.54	140
S	fe	1.46	118
S	fiesta	5.70	132
S	fin	3.16	464
S	finca	6.16	42
S	fondo	5.30	252
S	fuego	6.13	132
S	género	3.19	132
S	gente	5.51	348
S	grado	4.14	130
S	gusto	4.60	196
S	hierro	5.55	64
S	hueso	5.84	58

S	humo	5.23	40
S	juego	4.72	116
S	juez	4.63	60
S	juicio	2.49	112
S	junta	3.41	106
S	labio	6.93	106
S	lado	3.90	358
S	leche	6.66	38
S	lector	5.12	188
S	libertad	2.50	152
S	libro	6.09	604
S	lluvia	5.85	60
S	maestro	5.54	260
S	mancha	4.77	48
S	medida	3.50	112
S	medio	3.09	256
S	mejor	3.23	64
S	mercado	5.97	56
S	miedo	3.22	128
S	milagro	2.25	40
S	mirada	3.74	136
S	movimiento	3.68	204
S	muchacha	6.05	138
S	mujer	5.76	1168
S	nacimiento	4.73	54
S	novia	5.28	46
S	número	3.76	320
S	odio	3.00	60
S	oído	3.57	36
S	otoño	4.05	44
S	pájaro	5.94	54
S	padre	5.90	542
S	país	4.54	442
S	palabra	3.92	576
S	pared	5.85	106
S	pasado	2.89	156
S	pérdida	3.34	40
S	pelo	6.49	90
S	pensamiento	3.24	254
S	perdón	1.80	42
S	perro	5.84	82
S	pobre	3.17	106
S	préstamo	3.74	16

S	pregunta	3.91	92
S	primavera	2.00	66
S	profundidad	3.80	40
S	pueblo	5.52	770
S	puerta	6.04	306
S	raíz	5.54	86
S	rango	3.20	14
S	rato	2.00	122
S	razón	3.06	396
S	respeto	2.80	98
S	respuesta	3.85	62
S	resumen	3.94	50
S	rey	5.62	244
S	río	5.83	240
S	salud	3.67	70
S	significado	2.80	24
S	silla	6.12	54
S	sombra	4.69	166
S	sueldo	4.39	20
S	suposición	2.48	12
S	tarde	4.14	350
S	tío	5.79	78
S	título	3.89	64
S	tienda	6.36	40
S	trabajo	3.98	486
S	trama	3.37	12
S	trato	3.43	50
S	ventaja	2.25	56
S	verdad	2.72	652
S	vista	3.75	280
S	voz	5.03	254
S	vuelo	4.73	42

---

## Appendix B

Stimuli used in Experiment 3. Words are in alphabetical order by Language condition (English vs. Spanish), concreteness (1-7 rating scale) and by Frequency. The concreteness ratings were taken from different sources. Please refer to the methods section of Experiment 3 for more information. The word frequencies are the number of times per million occurrences in printed English (Francis & Kucera, 19982) and Spanish (Juilland & Chang-Rodríguez, 1964). TARGET represents the condition in which WORD2 is a translation of WORD1 (CASA-HOUSE: **YES**) or a nontranslation (CASA-HORSE: **NO**). Note that the concreteness ratings are not given for the nontranslations.

---

LANG	WORD1	FREQ1	CONC	WORD2	FREQ2	TARGET
E	advice	52	3.06	resistencia	50	NO
E	age	275	3.57	edad	210	YES
E	agreement	121	2.93	broma	74	NO
E	anger	48	3.80	hallazgo	56	NO
E	appeal	72	3.31	consulta	32	YES
E	approach	125	3.20	cariño	70	NO
E	arrangement	72	3.03	arreglo	39	YES
E	award	60	4.00	premio	46	YES
E	background	74	3.63	anterior	14	YES
E	bath	31	5.90	ambiente	126	NO
E	battle	91	5.60	batalla	50	YES
E	bay	60	6.11	caballo	90	NO
E	beard	31	5.76	mar	266	NO
E	beginning	92	3.14	principio	222	YES
E	behavior	100	2.89	comportamiento	66	YES
E	bit	105	3.88	pieza	86	NO
E	board	285	5.39	viento	82	NO
E	body	342	5.45	cuerpo	320	YES
E	bread	41	6.18	playa	38	NO
E	bridge	117	6.60	puente	42	YES

---

E	budget	62	3.69	presupuesto	46	YES
E	business	412	3.56	negocio	96	YES
E	call	76	3.80	tiempo	1008	NO
E	castle	12	6.70	castillo	44	YES
E	cat	42	6.30	campo	304	NO
E	century	254	3.03	segundo	64	NO
E	choice	121	2.80	resultado	116	NO
E	class	292	2.76	categoría	80	YES
E	command	74	3.73	mando	54	YES
E	customer	69	5.26	cliente	42	YES
E	danger	94	2.97	lugar	388	NO
E	date	120	5.45	esposa	68	NO
E	death	284	3.96	sentido	314	NO
E	device	92	4.47	aparato	132	YES
E	discover	55	3.26	mente	60	NO
E	doubt	115	2.36	llegada	46	NO
E	drive	60	3.88	creencia	62	NO
E	dust	70	5.23	hijo	560	NO
E	edge	114	4.34	orilla	50	YES
E	employee	109	5.56	brazo	230	NO
E	evil	42	1.64	mal	78	YES
E	expenditure	55	4.04	gasto	60	YES
E	eye	524	6.28	hombre	1882	NO
E	fashion	70	3.31	moda	50	YES
E	feature	105	3.80	ánimo	43	NO
E	floor	170	5.55	suelo	218	YES
E	foot	361	6.38	pie	258	YES
E	friend	294	4.40	amigo	440	YES
E	front	153	4.20	traje	86	NO
E	god	31	3.61	orgullo	54	NO
E	growth	156	3.86	crecimiento	32	YES
E	guest	99	5.15	visita	92	YES
E	gun	142	6.08	pistola	28	YES
E	hat	71	5.97	sombrero	58	YES
E	head	449	6.16	compañero	124	NO
E	height	58	3.80	altura	72	YES
E	hell	86	3.42	belleza	104	NO
E	hour	325	4.19	hora	622	YES
E	house	662	6.21	casa	1082	YES
E	key	71	6.08	llave	60	YES
E	lack	97	3.07	cambio	238	NO
E	lady	122	5.58	árbol	148	NO
E	left	67	3.37	manera	256	NO

E	lie	9	3.00	mentira	80	YES
E	life	772	2.96	vida	1496	YES
E	load	52	4.35	carga	38	YES
E	love	179	3.20	patrón	20	NO
E	luck	48	2.66	suerte	134	YES
E	magazine	65	5.91	guía	40	NO
E	mass	110	3.83	misa	42	YES
E	maturity	40	2.20	voluntad	140	NO
E	money	275	5.77	agua	312	NO
E	month	327	3.20	venta	40	NO
E	mother	280	5.47	madre	438	YES
E	mouth	113	5.64	boca	154	YES
E	need	253	3.10	manejo	50	NO
E	neighbor	59	5.37	vecino	66	YES
E	newspaper	104	6.17	dedo	62	NO
E	noise	43	5.23	corriente	134	NO
E	occurrence	40	3.08	suceso	92	YES
E	owner	72	4.09	precio	96	NO
E	page	102	5.85	página	144	YES
E	pain	102	4.22	dolor	140	YES
E	peace	198	3.05	paz	160	YES
E	power	404	3.32	poder	192	YES
E	press	107	4.44	prensa	94	YES
E	prince	40	5.38	dirección	142	NO
E	procedure	140	1.00	procedimiento	80	YES
E	profit	46	3.60	término	204	NO
E	purpose	239	2.71	personaje	156	NO
E	queen	51	5.05	reina	62	YES
E	race	120	4.59	jardín	122	NO
E	relation	126	2.56	pariente	28	YES
E	resource	81	4.50	recurso	46	YES
E	rest	140	3.48	descanso	30	YES
E	right	204	3.57	derecho	206	YES
E	risk	47	2.83	riesgo	30	YES
E	road	262	5.65	camino	384	YES
E	roof	64	5.82	techo	40	YES
E	row	48	3.76	fila	28	YES
E	safety	48	3.29	través	122	NO
E	search	59	3.74	busca	44	YES
E	season	125	4.69	caja	46	NO
E	shame	21	2.62	vergüenza	48	YES
E	share	100	3.88	parte	946	YES
E	sheet	71	6.43	hoja	102	YES

E	skill	79	3.46	talento	76	YES
E	skin	53	6.31	piel	92	YES
E	smile	56	5.19	cocina	46	NO
E	space	144	3.64	sistema	172	NO
E	square	121	5.15	cuadro	112	YES
E	station	195	5.56	puesto	88	YES
E	step	228	4.91	viaje	212	NO
E	summer	151	4.51	noche	540	NO
E	sun	117	6.23	sol	244	YES
E	surprise	49	3.23	sorpresa	46	YES
E	table	242	6.09	mesa	160	YES
E	tale	41	3.58	equality	12	NO
E	tiredness	3	3.40	cansancio	44	YES
E	tooth	123	6.15	espalda	76	NO
E	trade	138	3.64	comercio	78	YES
E	trust	32	2.49	confianza	72	YES
E	turn	96	3.40	vuelta	90	YES
E	understanding	83	2.59	entendimiento	26	YES
E	war	492	4.86	escalera	44	NO
E	wave	95	4.88	onda	40	YES
E	wealth	22	3.66	sabiduría	26	NO
E	week	425	3.79	semana	122	YES
E	weight	101	4.58	peso	48	YES
E	welfare	53	3.25	bienestar	18	YES
E	whole	52	2.71	íntegro	20	YES
E	window	172	6.27	ventana	146	YES
E	winter	82	4.97	invierno	54	YES
E	world	832	5.37	marido	218	NO
E	wound	24	5.89	herida	40	YES
E	writer	151	4.80	día	1392	NO
S	acero	26	5.82	church	451	NO
S	actitud	110	2.66	attitude	105	YES
S	ala	52	5.91	shoulder	112	NO
S	alcalde	50	4.82	task	89	NO
S	alegría	126	2.86	joy	47	YES
S	alma	340	3.17	soul	73	YES
S	amenaza	40	3.22	threat	57	YES
S	amistad	76	3.34	friendship	31	YES
S	ansia	46	1.63	punishment	23	NO
S	año	1216	3.44	year	1661	YES
S	aumento	38	3.11	increase	155	YES
S	ausencia	28	3.70	absence	56	YES
S	ayuda	48	2.86	affair	117	NO

S	baile	74	4.98	dance	94	YES
S	barco	106	6.25	ship	126	YES
S	boda	78	4.11	marriage	122	YES
S	bolsillo	46	5.59	pocket	59	YES
S	bondad	72	2.66	goodness	17	YES
S	cárcel	64	6.02	jail	24	YES
S	calle	470	5.84	street	323	YES
S	calor	58	4.84	ground	227	NO
S	cama	82	6.68	child	620	NO
S	capítulo	158	5.50	rock	91	NO
S	cargo	82	3.79	errand	7	NO
S	carne	114	5.80	meat	57	YES
S	carta	206	5.31	letter	260	YES
S	célula	80	5.09	name	365	NO
S	cena	18	5.38	dinner	100	YES
S	comentario	56	3.71	remark	75	YES
S	conde	88	3.47	novel	71	NO
S	cosa	1078	3.46	other	325	NO
S	cuarto	172	5.45	point	493	NO
S	cuello	52	5.83	neck	80	YES
S	cuidado	124	3.38	memory	91	NO
S	debilidad	30	2.46	weakness	52	YES
S	declaración	66	3.83	knowledge	145	NO
S	desarrollo	102	3.06	development	377	YES
S	deseo	144	2.48	desire	88	YES
S	éxito	84	2.88	mercy	20	NO
S	edificio	94	6.00	building	187	YES
S	ejército	122	5.24	army	152	YES
S	enfermedad	98	5.10	disease	72	YES
S	escuela	200	5.49	school	687	YES
S	esfuerzo	140	3.06	effort	272	YES
S	esperanza	76	3.05	hope	136	YES
S	estancia	52	3.25	grief	10	NO
S	existencia	160	2.30	being	66	YES
S	extranjero	64	5.11	face	379	NO
S	extraño	140	4.54	stranger	50	YES
S	fe	118	1.46	fact	534	NO
S	fiesta	132	5.70	party	283	YES
S	fin	464	3.16	end	423	YES
S	finca	42	6.16	land	232	YES
S	fondo	252	5.30	nose	65	NO
S	fuego	132	6.13	brother	135	NO
S	género	132	3.19	envy	4	NO

S	gente	348	5.51	people	902	YES
S	grado	130	4.14	degree	148	YES
S	gusto	196	4.60	priest	33	NO
S	hierro	64	5.55	iron	46	YES
S	hueso	58	5.84	bone	53	YES
S	humo	40	5.23	star	58	NO
S	juego	116	4.72	shape	104	NO
S	juez	60	4.63	track	48	NO
S	juicio	112	2.49	judgement	88	YES
S	junta	106	3.41	jelousy	5	NO
S	labio	106	6.93	furniture	39	NO
S	lado	358	3.90	side	476	YES
S	leche	38	6.66	milk	49	YES
S	lector	188	5.12	reader	84	YES
S	libertad	152	2.50	freedom	133	YES
S	libro	604	6.09	chest	57	NO
S	lluvia	60	5.85	light	306	NO
S	maestro	260	5.54	teacher	152	YES
S	mancha	48	4.77	spot	85	YES
S	medida	112	3.50	size	148	YES
S	medio	256	3.09	research	172	NO
S	mejor	64	3.23	improvement	60	YES
S	mercado	56	5.97	market	185	YES
S	miedo	128	3.22	sin	67	NO
S	milagro	40	2.25	failure	93	NO
S	mirada	136	3.74	heaven	110	NO
S	movimiento	204	3.68	pressure	222	NO
S	muchacha	138	6.05	girl	374	YES
S	mujer	1168	5.76	woman	467	YES
S	nacimiento	54	4.73	servant	41	NO
S	novia	46	5.28	bride	40	YES
S	número	320	3.76	number	658	YES
S	odio	60	3.00	item	127	NO
S	oído	36	3.57	hearing	56	YES
S	otoño	44	4.05	city	521	NO
S	pájaro	54	5.94	flower	78	NO
S	padre	542	5.90	father	240	YES
S	país	442	4.54	hand	717	NO
S	palabra	576	3.92	length	139	NO
S	pared	106	5.85	wall	224	YES
S	pasado	156	2.89	duty	61	NO
S	pérdida	40	3.34	loss	132	YES
S	pelo	90	6.49	hair	160	YES

S	pensamiento	254	3.24	thought	157	YES
S	perdón	42	1.80	forgiveness	10	YES
S	perro	82	5.84	dog	147	YES
S	pobre	106	3.17	childhood	55	NO
S	préstamo	16	3.74	loan	78	YES
S	pregunta	92	3.91	question	378	YES
S	primavera	66	2.00	guilt	33	NO
S	profundidad	40	3.80	depth	72	YES
S	pueblo	770	5.52	corner	144	NO
S	puerta	306	6.04	dream	88	NO
S	raíz	86	5.54	picture	227	NO
S	rango	14	3.20	rank	41	YES
S	rato	122	2.00	example	345	NO
S	razón	396	3.06	reason	340	YES
S	respeto	98	2.80	attempt	102	NO
S	respuesta	62	3.85	answer	145	YES
S	resumen	50	3.94	review	52	YES
S	rey	244	5.62	couple	136	NO
S	río	240	5.83	bill	133	NO
S	salud	70	3.67	source	182	NO
S	significado	24	2.80	meaning	138	YES
S	silla	54	6.12	shop	75	NO
S	sombra	166	4.69	shadow	54	YES
S	suelo	20	4.39	wage	95	YES
S	suposición	12	2.48	assumption	61	YES
S	tarde	350	4.14	afternoon	122	YES
S	tío	78	5.79	uncle	58	YES
S	título	64	3.89	struggle	57	NO
S	tienda	40	6.36	store	102	YES
S	trabajo	486	3.98	work	680	YES
S	trama	12	3.37	plot	40	YES
S	trato	50	3.43	feeling	192	NO
S	ventaja	56	2.25	law	387	NO
S	verdad	652	2.72	truth	130	YES
S	vista	280	3.75	view	217	YES
S	voz	254	5.03	voice	265	YES
S	vuelo	42	4.73	flight	60	YES

---