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Do Bilinguals Access a Shared or Separate Conceptual Store? Creating False Memories in a Mixed-Language Paradigm

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Abstract

A central focus of bilingualism research is the representation of two language systems in memory. The Revised Hierarchical Model (Kroll & Stewart, 1994) predicts that bilinguals access conceptual information from both languages simultaneously. To test this hypothesis, the present study attempted to create false memories across languages. Twenty-two Spanish-English bilinguals participated in a mixed language associative list paradigm. False recognition of target words was significantly higher than false recognition of control words, both within and between languages. These results provide evidence for a shared conceptual store and parallel activation of languages, supporting the Revised Hierarchical Model.

Do Bilinguals Access a Shared or Separate Conceptual Store: Creating False

Memories in a Mixed-Language Paradigm

The majority of the world's population speaks two or more languages.

Despite this, the majority of psychological research into language has focused on

monolinguals. Recently, however, there has been a surge of interest in bilingualism.

A central issue in current bilingual research concerns the representation of languages

in memory. Specifically, are two languages stored together, or separately?

Additionally, how are these two languages activated?

These questions form the basis for two competing models of bilingual

language processing. The *independence hypothesis* proposes that there are distinct

and separate memory stores for each language, such that processing in one language

does not affect processing in the other. In contrast, the *interdependence hypothesis*

maintains that there is a single integrated memory store (see Gerard & Scarborough,

1989). The goal of the present study is to examine each of these models and address

the questions raised earlier, the first of which is how two languages are accessed, or

activated.

Definitions

The terminology used in the bilingual literature varies considerably, and so it

is helpful to have precise operational definitions. First, what constitutes

bilingualism? Definitions of bilingualism can range anywhere from informal

experience with two or more languages to near-native fluency in two languages. As

Francis (1999) suggests, a middle ground must be found between these two extremes.

Thus, for the purposes of this paper, bilinguals are those who are able to

communicate, at some level, in more than one language. This definition is admittedly very broad and simple. However, a narrow definition incorrectly excludes many people who would consider themselves bilingual. For instance, some people can speak a language yet are unable to read or write in a language. At the same time, there are many people who are able to read or write in a language but are unable to speak the language (this is particularly common if the language was learned in a school setting). In addition, many people in the United States are native English speakers who can neither read nor write and may not speak with "proper" grammar, yet are native English speakers nonetheless. Because of this varied nature of language proficiency and use, broad definitions of bilingualism are inevitable.

It is also important to define the terms *lexical* and *conceptual*. A lexicon, defined herein, is a collection of lexical entries, or knowledge about a particular word that includes orthographic, phonologic, morphologic, syntactic, and semantic properties (Francis, 1999). The use of *lexicon* and *lexical* varies greatly among studies and models, and so the present paper uses a broad definition to incorporate a greater range of literature.

The conceptual level of representation concerns the meanings of words. There is some disagreement in the literature between the terms *semantic* and *conceptual*, as some researchers will use them interchangeably while other studies differentiate between the terms (Francis, 1999). Herein, the two terms are used interchangeably unless otherwise noted. Both are used to refer to meaning-level information.

Activation of Languages

How is information retrieved from the bilingual lexicon? When presented with a word, do bilinguals activate one lexicon at a time, both at the same time, or do they use cues to activate only the appropriate lexicon? Beauvillain and Grainger (1987) and Grainger and Dijkstra (1992) suggest that there is an initial activation of both languages, and that language selection occurs at a later stage. Several studies provide evidence for such parallel activation of lexicons.

The Stroop effect is interference that occurs when attempting to name an item with incongruent meaning and form(e.g., the word *blue* printed in yellow ink). While this effect has been well established in monolinguals (c.f. MacLeod, 1991), do bilinguals experience this same interference when the printed words are in one language (language A) and color naming is in another language (language B)? Chen and Ho (1986) hypothesized that if only one language is activated at a time, then there will be no Stroop effect because there is no lexical activation of the printed words in language B and therefore no lexical information to interfere with color naming. However, interference in this condition was comparable to interference in conditions where both the printed words and color naming were in the same language. Thus, lexical information was available from both languages, supporting the parallel activation hypothesis (for a further review of bilingual Stroop experiments, see Smith, 1997).

Further support for parallel lexical activation comes from Nas (1983). In a lexical decision task, Nas instructed Dutch-English bilingual subjects to only respond *yes* to English words and *no* to anything else, including Dutch words. If only one

lexicon is available at a time, then in a language specific task there should be no interference from the other language. However, participants were slower to respond to non-English words if the stimulus was either a Dutch word or sounded like a Dutch word. This interference is evidence that both lexicons are activated simultaneously.

Finally, a series of eyetracking experiments reveal that bilinguals activate both languages in parallel (Spivey & Marian, 1999; Marian, Spivey, & Hirsch, 2003; Marian & Spivey, 2003). Russian-English bilinguals were asked in one language to pick up one of four objects placed in front of them and their gaze was followed with an eye tracker. When asked to pick up the target object, the participants' gaze briefly shifted to an interlingual distractor object whose name in the irrelevant language was phonetically similar to the target object (Spivey & Marian, 1999; Marian, Spivey, & Hirsch, 2003). For example, when participants were told in Russian to pick up the stamp ("marku"), their gaze fixated upon the marker, the distractor object. The English word "marker," phonetically similar to "marku," should not have been distracting had only the Russian lexicon been available. However, because it was distracting (significantly moreso than the other two objects), these results suggest that bilinguals activate both languages in parallel. Additionally, it appears that the irrelevant language cannot be deactivated while in a completely monolingual context (Marian et. al, 2003). In another eyetracking experiment, Marian and Spivey (2003) compared Russian-English bilinguals with English speaking monolinguals. While both bilinguals and monolinguals experienced within-language competition (i.e., English distractor items and English target objects), only bilinguals experienced between-language competition (i.e. Russian distractor items and English target items).

This difference in performance provides further support for the parallel activation of languages.

Representation of Languages in Memory

There is much debate over the nature of bilingual language representation. Do bilinguals have one lexicon for both languages or two discreet lexicons? Likewise, what is the nature of conceptual representation in bilingual memory? A review of the literature on the debate suggests that the majority of the evidence supports the existence of separate lexicons and a shared conceptual store (Francis, 1999); thus, the present study focuses specifically on this evidence.

Evidence for separate lexicons

Is lexical information in bilinguals stored in one shared lexicon or two separate lexicons? The literature on the subject suggests that the bilingual has two distinct lexical representations in memory, one for each language (for a review, see Smith, 1997; Gollan & Kroll, 2001). In a fragment completion task, Durgunoğlu and Roediger (1987) found that the only variable to significantly affect completion rates was language overlap between study and test sections of the test. If the participants studied the list of words in the same language as the completion task, they had higher rates of completion, suggesting that the participants were accessing language-specific lexicons. Using a lexical decision task, Gerard and Scarborough (1989) found no cross-language facilitation from repetition priming among noncognate translations, though they did find cross-language facilitation of cognates and homographic noncognates where the words in each language share an orthographic pattern. If the participants had been accessing a shared lexicon, then there would be facilitation

among noncognate translations as well as cognates and homographic noncognates. Therefore, the results are consistent with the hypothesis that lexical information is language-specific.

Evidence for a shared conceptual representation

The body of literature on conceptual representations in bilinguals points to a common (or at least partially shared) conceptual-level episodic representation (for a review of this literature, see Francis, 1999). From a neuropsychological standpoint, it is generally believed that the two languages of a bilingual are stored in shared, not separate, anatomical areas (Paradis, 1997). Altarriba (1992) found greater priming effects for translation equivalents than for unrelated words (e.g., *table* might have a stronger priming effect for *silla* [chair] than *ventana* [window]). Because the priming occurs across languages on a semantic level, this suggests that the two languages share a conceptual-level representation. Likewise, Fox (1996) found significant negative priming (inhibition) of an attended target word when unattended semantically related words or translation equivalents were presented in parafoveal vision, or outside the "spotlight" of attention. In this experiment, Fox (1996) first presented a number and required participants to respond as to whether or not the number was even or odd. At the same time, an unattended flanker prime was presented in parafoveal vision. Then participants were asked to perform a lexical decision task (i.e. "is this letter string a word?"). If the unattended prime was semantically related to the target, then response times for the lexical decision task were slower. For example, if *cat* is presented in parafoveal vision during the number task, then participants are slower at deciding *perro* (dog) is a word. Fox (1996) also

found inhibition for translation equivalent target-prime pairs. This negative priming for translation equivalents and semantically related words is evidence that conceptual information from both languages is available simultaneously, suggesting that bilinguals access a shared conceptual representation.

Models of Lexical/Conceptual Representation

A central question in bilingual memory research concerns the modeling of bilingual cognitive structure. There are several extensive reviews of models of conceptual/lexical level episodic representation (e.g., Dudsic, 1999; Kroll, 1993; Kroll & De Groot, 1997). Therefore, each model will only be briefly reviewed.

Weinreich (1953) presented the first of these models. He proposed three types of relationships between the two languages of a bilingual: coordinate, compound, and subordinate. In coordinate bilingualism, each language has both a distinct lexical and a distinct conceptual representation. In compound bilingualism, each language independently accesses a single conceptual representation. In subordinate bilingualism, the second language (L2) is dependent on the first language (L1) to access concepts. Weinreich's outline of bilingual language representations provided much of the basis for subsequent models (Dudsic, 1999).

The Word Association model

The Word Association model is similar to the subordinate model. In the Word Association model, L2 accesses concepts through the lexicon of L1 (see Figure 1). When presented with a word in L2, a bilingual will translate the word into L1 and access the conceptual representation for that word. Naming a picture in L2 should be a five-step process: (1) recognize image; (2) retrieve concept; (3) retrieve L1 word;

(4) retrieve L2 word; (5) say L2 word. Following this, picture naming should take considerably longer than translating a word from L1 to L2 because translation has fewer steps [(1) recognize L1 word; (2) retrieve L2 word; (3) say L2 word]. Potter, So, Eckardt, and Feldman (1984) tested this hypothesis and found that latencies in both tasks were not significantly different. Therefore, it takes approximately the same amount of time to name a picture in L2 as it does to translate a word from L1 to L2. This result implies that both L1 and L2 lexicons access the conceptual store directly. This led Potter et al. (1984) to propose the Concept Mediation model.

Insert Figure 1 about here

The Concept Mediation model

The Concept Mediation model is similar to Weinreich's (1953) compound model. It proposes that bilinguals mediate concepts directly between the separate lexicons and the conceptual store (see Figure 2). Because each language has direct access to the conceptual store, picture naming and translation require the same number of processing steps, and so Potter et al.'s (1984) results are consistent with this model of representation. However, is the representational system static, or does it change over time?

Insert Figure 2 about here

The developmental hypothesis

The developmental hypothesis states that, initially, bilingual cognitive architecture is represented by the Word Association model, and as proficiency in the L2 increases, there is a shift towards a Concept Mediation model (Dudsic, 1999; Kroll and Sholl, 1992; Chen, 1992). Dufour and Kroll (1995), using a sentence verification task similar to that of Smith, Shoben, and Rips (1974), observed that more fluent bilinguals were able to successfully use conceptual links in within- and cross-language conditions while less fluent bilinguals were more dependent upon their L1. As proficiency increases, there is a shift from translation strategies towards direct concept mediation. A number of studies have found that the amount of interference in a Stroop task is positively correlated with proficiency, suggesting a developmental shift in processing (Chen & Ho, 1986; Mägiste, 1984; Mägiste, 1985). Because the developmental shift is gradual rather than abrupt (Chen, 1992), there is a period where bilinguals use both translating and conceptual mediation strategies. Therefore, evidence for the developmental hypothesis also lends support for a mixed representational system. However, do bilinguals who are fluent in their L2 still use translating strategies? According to the developmental hypothesis, once strong conceptual links are established bilinguals will only use direct conceptual mediation and lexical links will deteriorate. However, this does not seem to be the case. Cross-language experiments provide evidence that lexical links are maintained by high proficiency bilinguals. Studies have found that translation from L2 to L1 is faster than translation from L1 to L2 for bilinguals of all proficiency levels (Kroll, 1993; Dudsic, 1999). Thus, Kroll and Stewart (1994) proposed a mixed representational model of conceptual/lexical level episodic representations, the Revised Hierarchical

Model (RHM).

The Revised Hierarchical Model

The RHM is a hybrid of the Word Association and Conceptual Mediation

models. It posits that both lexical and conceptual-level links exist (see Figure 3). In

this model, there is a shared conceptual store and language-specific lexicons, and both

translation and conceptual mediation strategies are used. It takes into account

evidence for a developmental shift, since bilinguals rely heavily on their L1 for

retrieving concepts while they are acquiring their L2. However, as they become more

proficient, they rely less on translation and are more able to access concepts directly.

A central aspect of the RHM is its asymmetrical structure. This model assumes that

as a result of the way in which second languages are learned, all L2 words connect to

L1 words, but all L1 words do not necessarily connect to L2 words (Kroll & Stewart,

1994). Thus, there is a stronger lexical link from L2 to L1 (explaining why

backwards translation is faster than forwards translation), and a stronger conceptual

link between the conceptual store and the L1 lexicon (for a review of the RHM, see

Kroll & De Groot, 1997). The asymmetry of the model is supported by numerous

cross-language priming studies that found faster information transfer from L1 to L2

than from L2 to L1 (e.g., Dudsic, 1999; Kroll and Stewart, 1994; Hartsuiker,

Pickering, & Veltkamp, 2004).

Insert Figure 3 about here

Problems with the Revised Hierarchical Model

A key concern with the RHM is its asymmetric nature. The RHM assumes that forward translation is largely conceptually mediated while backward translation is not conceptually mediated. However, there is evidence that both forward and backward translation are conceptually mediated (e.g., Bloem & La Heij, 2003; La Heij, Hooglander, Kerling, Van der Velden, 1996). Additionally, the RHM cannot account for evidence indicating that bilingual memory is a dynamic representational system, and that effects of translation direction are not fixed characteristics (Heredia, 1997). L1 can fall in strength and L2 can become the dominant language. Likewise, if L1 and L2 fluency are comparable, then priming effects will be symmetrical (Kotz, 2001). Thus, translation direction effects are dependant upon proficiency, which is a dynamic variable.

In addition, the RHM does not take into account the full representational and processing variation within the bilingual individual (Grosjean, 1998). Each bilingual individual varies greatly from the next, and any static representational model is going to have trouble accounting for this variation. Kim, Relkin, Lee, and Hirsch (1997) found that in Broca's area, second languages are spatially separated when acquired in adulthood, but not separated when acquired during an early language acquisition stage of development. Therefore, when the second language is acquired can have an effect on the representation of languages. Moreover, a high motivation level can eliminate translation direction effects (Luna & Perachio, 2002). Motivation level and age of acquisition are just two of the variables that can influence the language processing of bilinguals. Heredia (1997) suggests that rather than referring to

languages in representational models as L1 and L2, it might be better to "describe bilingual memory as a function of language dominance" (p. 38).

Finally, there is evidence that not all words are represented identically in the conceptual store and that translation equivalents do not always activate the same concept. De Groot (1993) reviews several studies that indicate word-type effects in processing tasks among bilinguals. While translation times for concrete words are consistent with the RHM, translation times for abstract words are contrary to what the RHM would predict (see also Heredia, 1997). According to the RHM, all words should be represented similarly. However, representation is not independent of concreteness. The RHM cannot explain such word-type effects. Furthermore, Blot, Zarate, and Paulus (2003) suggest that switching to L1 from L2 not only permits strong activation of concepts, but also activation of new concepts. This indicates that the two languages of a bilingual do not always access the same concepts, contrary to what the RHM predicts. Instead, Blot et al. (2003) propose a system that incorporates differentiated concepts rather than simply a common conceptual store.

The distributed conceptual feature model

The distributed conceptual feature model accounts for word type effects and differentiated concepts. It proposes that each lexicon accesses a set of conceptual features, or meaning elements (De Groot, 1992). The meanings of translations do not always completely overlap. For instance, the English word *play* is a very general term, which can encompass playing a sport, a board game, or an instrument. However, the Spanish word *jugar* can mean, "to play," but is used to refer to playing a sport or a board game, while *tocar* is used to refer to playing an instrument. Each of

these meaning elements would be represented by a different node (see Figure 4), and

so the conceptual representations of *play* and *jugar* only partially overlap.

Additionally, concrete translations, cognates, and nouns often share more meaning

elements than abstract words, noncognates, and verbs (Van Hell & De Groot, 1998).

The distributed conceptual feature model accounts for word-type effects and the

differentiation of concepts. However, recent literature has pushed for the inclusion of

a third level of representation, the lemma level, to make a distinction between

semantic and conceptual representations (Grosjean, 1998; Pavlenko, 1999; Hartsuiker

et al., 2004).

Insert Figure 4 about here

The final model of conceptual/lexical level episodic representation is the

distributed conceptual/lexical feature model (Kroll & De Groot, 1997). In this model,

lexical features are distributed in a similar manner as conceptual features and it

incorporates a lemma level (see Figure 5). The lemma level of representation in this

context includes syntactic and semantic information, and the lexicon includes

orthographic information and other physical properties of a word. It is meant to

"represent the patterns of activation between word forms and meanings…that may

allow the bilingual's two languages to be influenced by one another and to share

access to a common pool of lexical and conceptual features but, at the same time,

enable functional autonomy when only one language is active" (Kroll & De Groot,

1997, p. 191). Thus, if the bilingual is in a monolingual context, then the lemma will

weight activation of the relevant language accordingly. This model, like the distributed conceptual model, accounts for word-type effects and the differentiation of concepts. However, because it also includes a distributed lexical representation, the level of facilitation or interference is not only a function of conceptual overlap, but also of consistency between word forms.

Insert Figure 5 about here

Roediger and McDermott (1995)

To test the predictions made by the RHM and distributed models, many researchers have begun replicating classic cognitive psychology experiments (e.g., Stroop task) in a mixed-language paradigm. One such experimental task is the Deese-Roediger-McDermott task (DRM). This task, first employed by Deese in 1959, was used by Roediger & McDermott (1995) to explore the creation of false memories. The task consists of presenting participants with an auditory list of words that are highly semantically or conceptually related to a critical non-presented target word (CNW). For example, *table, sit, legs, seat,* and *couch* are presented (along with ten other associates), all of which are highly associated with the CNW, *chair.* Participants then complete a recognition task, indicating whether the test item has been presented earlier in one of the study lists. Test items fall into one of three categories: presented words, non-presented words, and CNWs.

In the DRM paradigm, CNWs have a substantially higher rate of false recognition than non-presented words. Furthermore, the false recognition rate for

CNWs was comparable to the hit rate for presented words, suggesting that participants "were unable to distinguish items actually presented from the critical lures [CNWs] that were not presented" (Roediger & McDermott, 1995, p. 808). Roediger and McDermott (1995) explained these results by suggesting that false recognition is produced through the activation of implicit associative responses. False recognition occurs at encoding, as items associated with the presented object are activated (e.g., when *table* and *seat* are presented, *chair* is activated). They also asked participants to make a *remember* vs. *know* judgment for items presented in the recognition task. A remember judgment is when "the subject can mentally relive the experience (perhaps by recalling its neighbors, what it made them think of, what they were doing when they heard the word, or physical characteristics associated with its presentation)" (Roediger & McDermott, 1995, p. 807). In contrast, a know decision is "made when subjects are confident that the item occurred on the list but are unable to reexperience (i.e., remember) its occurrence" (p. 807). Contrary to what had been expected, they found that participants remembered, rather than knew, the presentation of the CNWs, indicating that "conscious recollection" can create false memories.

Presenting lists of highly associated words can create false memories. In essence, these false memories of the CNWs are created through conceptual activation of associates. Roediger and McDermott (1995) were looking at monolingual activation of a single lexicon. However, one would predict that if bilinguals activate a single conceptual store, then false recognition should occur across languages. That is, if the study lists are in one language and the recognition task in other, CNWs

should still be incorrectly remembered more frequently than other non-presented words.

Kawasaki-Miyaji, Inoue, & Yama (2003) tested this prediction, using a cross-language DRM paradigm to create false memories across two languages. They presented lists in either English or Japanese, and then gave a mixed-language recognition test. Recognition of presented words was better when the language was matched. CNWs were falsely recognized at approximately the same rate as correct recognition of presented items. Thus, even when the study and test languages are different, there is still a high rate of false recognition. This result appears to support the interdependent storage hypothesis, as conceptual information is being activated and then accessed in both languages. However, Kawasaki-Miyaji et al. (2003) interpret their results as supporting neither the independent or interdependent storage hypotheses. They maintain that if the interdependent hypothesis is accurate, then language congruency between study lists and test items should have no effect. In other words, one would not expect to find a greater performance on test items when the study word and test word were presented in the same language. Since they found a language congruency effect, they concluded that their data did not support the interdependence hypothesis.

There are two chief concerns with the Kawasaki-Miyaji et al. (2003) study. The first is their interpretation of the results. The higher correct recall rate for matched-language words is not necessarily evidence against the interdependence hypothesis. The recognition of the presented words is not entirely on a conceptual level, but instead is largely on a lexical level. . In matched-language presented

words, there are not only conceptual memory cues, but also lexical cues. The presence of lexical cues in one condition and not in the other led to asymmetrical activation of lexical information. One would only expect recognition rates between matched-language and non matched-language words to be the same if lexical information was available in both conditions. However, because bilinguals to not access a single lexical store for both languages, lexical information is not going to be available in the non matched-language conditions. Therefore, any difference in recognition rates is more likely evidence that there are two separate lexicons than evidence against a shared conceptual store. Kawasaki-Miyaji's (2003) results are in fact congruent with most current models of bilingual memory representation that propose separate lexicons and a shared conceptual store, such as the Revised Hierarchical Model (Kroll & Stewart, 1994).

The second concern is with their methodology. They presented each study list in one language, and the recognition list also in a single language. They failed to take into account what Grosjean (1998) termed "language mode." Grosjean (1998) suggests that there are differences in performance depending on what language mode a bilingual person is in at that moment. If the participants are in a bilingual mode, then information from both languages may be more readily available than if they are in a monolingual mode. Because Kawasaki-Miyaji et al.'s (2003) study lists were in one language (e.g., the list for *chair* would either be entirely in English or entirely in Japanese), it is plausible that their participants were in a monolingual mode during encoding and this might have had an effect on their results. Instead, what the present study will do is present lists in English only, Spanish only, and in both English and

Spanish combined (e.g., the list for *chair* includes items in English and items in Spanish; see Appendix A). The goal of presenting the words in a mixed language list is to explore any language mode effects. If both languages are present during encoding, then the participants should be in a bilingual language mode. Likewise, if the study list is English only or Spanish only then participants should be in a monolingual mode. Thus, if false recognition is greater for mixed lists, then this would be evidence for the presence of a language mode effect.

The goal of the present study was to examine the nature of conceptual-level episodic representation in Spanish-English bilinguals. In addition to exploring language mode effects, I also hope to provide further illumination of the independent-interdependent debate. To test whether conceptual information is activated in both languages simultaneously, I employed a DRM false memory task in a cross-language paradigm. If false recognition of the CNWs were significantly more frequent than false recognition of non-presented words, then this would support the interdependence hypothesis. Furthermore, the Revised Hierarchical Model (Kroll & Stewart, 1994) predicts asymmetrical rates of false recognition. More specifically, words studied in the L1 should have higher rates of false recognition. This asymmetry is the result of greater conceptual mediation in the L1. Similarly, I predict that there will be a positive correlation between rate of false recognition and language proficiency. As L2 proficiency increases, conceptual mediation should increase (as is congruent with the developmental hypothesis); thus, conceptual activation of the critical lure is greater and should result in higher rates of false recognition.

Method

Participants

Twenty-two undergraduates from Macalester College participated in a half-hour experiment for five dollars. Fifteen women and seven men participated in the study. Participants were Spanish and English bilinguals with varying proficiency levels. As mentioned earlier, bilinguals are defined as those who are able to communicate, at some level, in more than one language, in this case English and Spanish.

Each participant's proficiency was measured in both English and Spanish using a Curriculum Based Measurement (CBM). Originally used to assess reading skill, it has been adapted to measure language proficiency (for a review of CBMs, see Marston, 1989; Hasbrouck & Tindal, 1992). I also gave participants a language use questionnaire that gathered information about the language profile of each participant (e.g., when they learned each language and how proficient they feel in each language). There were 16 native English speakers, 7 native Spanish speakers, and 1 native Albanian speaker (this participant felt more proficient in English than in Spanish).

Materials

I used E-prime software (Psychology Software Tools, 1995-2000) on computers running Pentium IV processors to present stimuli and gather data. The present study used 18 lists from the appendix of Roediger and McDermott (1995). Six lists were dropped from the original 24 due to translation difficulties (this matter will be addressed later). Roediger and McDermott created these lists from Russell and Jenkin's word association norm study in 1954. The 18 study lists were

arbitrarily divided into three groups: Spanish only, English only, and a mixed English and Spanish group. There were three versions of the experiment with different list ordering to provide counterbalancing.

Each list consisted of the 15 most common associates of the target word (CNW). For example, the list for the target word *chair* is *table, sit, legs, seat, couch, desk, recliner, sofa, wood, cushion, swivel, stool, sitting, rocking,* and *bench.* The only exception is the list for Spider, which included 14 words after *feelers* was removed because there was no translation equivalent in Spanish. The words were presented visually on a computer screen in sequential order, and were on the screen for a duration of two seconds. In between each list participants were asked to complete math questions. The math questions were difficult algebraic questions where the participant needed to solve for X.

Because the stimuli were presented visually, the present study's design deviates from Roediger and McDermott's (1995) original design that presented auditory stimuli.

Gallo, McDermott, Percer, and Roediger (2001) found that auditory presentation of the study lists led to greater false recognition than visual presentation. However, visual modalities still create high rates of false recognition (Gallo et al., 2001; Kawasaki-Miyaji et al., 2003); thus, I would not predict any modality effects to confound the results.

The lists for the Spanish and mixed language conditions were translated into Spanish by four different native speakers of Spanish. The first coder translated English lists into Spanish. The second coder then translated this back into English.

The third coder translated the original English lists into Spanish again in order to provide a second set of Spanish lists. The final coder resolved any discrepancies between the first three coders. The finalized lists were compiled by comparing the translations of the first and second coders. If the forward and backward translations matched, then I accepted the translation. If the forward and backward translations did not match, then I sent the first and third coder's translations to the fourth coder to resolve the discrepancy. I first asked the fourth coder to translate each word from Spanish to English. I then asked which word would be a more accurate translation of the English word. In total, there were 9 words which were sent to the fourth coder, and all except *feelers* (as mentioned earlier, this was removed from the list) were successfully resolved.

The recognition task list consisted of 144 words, 72 studied and 72 non-studied. The studied words were drawn from the 1st, 6th, 10th, and 13th serial positions from each list (this is consistent with the selection method used by Roediger & McDermott, 1995). Half of the "studied" test items were translation equivalents of the original word in the study list (i.e., the "studied" words were tested in either the same or different language as they had been studied). Of the 72 studied test items, 36 were in the same language and 36 were in the other language.

The 72 non-studied words consisted of 18 critical lures and 54 non-studied, non-target words. Half of the critical lures were in Spanish and half were in English. There were three critical lures in each language for all three conditions (Spanish only, English only, and mixed). The 54 non-studied test items were never identical to or

semantically related to the words in the study lists. Half of the non-studied test items were in English and half were in Spanish.

Design

The experiment used a 3 (study list language in English, Spanish, or mixed) by 2 (test language of English or Spanish) within-subjects design. The dependent variables were the recognition rate of test items and the proficiency of the participant.

Procedure

Participants were told the experiment was exploring memory. Participants were instructed that they would see a number of lists, each followed by a math question, and then would be asked to decide if words had been presented in one of the lists. The experimenter gave verbal instructions to supplement the on-screen instructions, and did not remain present during the experiment. There was a brief practice session to familiarize participants to the presentation of the lists and math questions. The study items appeared on the screen one at a time for two seconds each. After each study list participants were required to answer a difficult math question. The purpose of these math questions was to remove any memory of list words from short-term memory. Participants had fifteen seconds to answer the math questions. However, the experiment did not proceed until the end of the fifteen seconds, even if the participant answered the math question before the end of the allotted time. The experimenter informed the participant that the math questions were designed to be difficult and so instructed participants to "do their best," but to not become anxious or worry if they could not answer the question in the allotted time.

During the recognition test, a single word appeared on the screen and participants used a response box to indicate whether or not the word had been presented in one of the study lists. The participant's response, the correct response, and the accuracy of the participant's response were recorded. Feedback about the accuracy of the participant's response was not available to participants during the recognition task.

Additionally, if the participant recognized the test item, a follow up question asked the participant to indicate whether they remembered or knew that the item had appeared. Participants received verbal and written instructions for how to make the remember/know judgment. These instructions defined a *remember* experience as "one in which you can mentally relive the experience (perhaps by recalling its neighbors, what it made you think of, what you were doing when you saw the word, or physical characteristics associated with its presentation)." In contrast, a *know* judgment "is made when you are confident that the item occurred on the list but are unable to reexperience (i.e. 'remember') its occurrence" (taken from Roediger & McDermott, 1995, p. 807).

Results

Language Proficiency

There were two tests of L2 language proficiency: an objective CBM measure and a subjective self report score on a scale out of 10. As a measure of convergent validity, the scores from these two tests were compared. Figure 6 illustrates the positive correlation between CBM scores and self-reported L2 proficiency.

Insert Figure 6 about here

This correlation was significant at a .05 alpha level, r = .467, p = .028, with an r^2 of .218. Thus, CBM scores agreed with participants' subjective opinion of their own proficiency.

Recognition

      During the recognition test, participants indicated whether or not a word had been presented during the study session. Test items fell into three categories: words that had been presented in the study session (studied), words that were new and had not been presented in the study session (unstudied), and CNWs that were new but were the semantically related targets of the study words (critical). Recognition rates were calculated[1] for each category, such that the recognition rate for the studied category represents correct recognition, and the recognition rates for unstudied and critical words represents false recognition. Studied items were correctly recognized 57% of the time, unstudied items falsely recognized 13% of the time, and critical items falsely recognized 47% of the time. Before computing inferential statistics, the proportional data was normalized using an arc sin transformation.

      A one-way repeated measures analysis of variance (ANOVA) revealed that there was a significant difference in recognition rate between studied, unstudied, and critical test items, F (2,42) = 85.51, p < .001 (see Figure 7). An LSD pairwise comparison indicated that both studied words and critical lures were recognized more frequently than unstudied words (p<.001). Studied words were recognized more

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[1] Due to a recurring mechanical error, there were instances in which responding to one test word resulted in skipping over items in the recognition test. Thus, any individual word that had a response time at or below 100 ms was removed from the data set. There were 19 total instances of skipping.

often than CNWs (p=.007); however, the effect size, as measured by Cohen's *d,* of

this comparison was relatively small (.64) when compared with the difference

between critical or studied words and unstudied words (2.16 and 3.01 respectively).

This suggests that false recognition rates for CNWs and correct recognition rates for

studied words were roughly similar. Overall, effect sizes and the estimated observed

power (1.00) were large, suggesting that there was a good chance of correctly

rejecting the null hypothesis.

Insert Figure 7 about here

Study lists fell into one of three conditions: English only, Spanish only, and

mixed English and Spanish. Grosjean (1998) suggests that it is necessary for

bilingual research to consider the language mode of the participants, such that one

might expect different results if the participants were in a bilingual mode as opposed

to a monolingual mode. Thus, the present study predicted that the mixed language

condition should result in higher false recognition of the critical lures. This

prediction was not supported by the results. For both studied and critical lists Spanish

only lists had the highest rate of recognition (.64 and .489 respectively), followed by

mixed lists (.596 and .474) and then English only lists (.443 and .436; see Table 1). A

2 (studied vs. critical word type) X 3 (English only vs. mixed vs. Spanish only study

lists) repeated measures ANOVA confirmed a main effect for word type, $F_{(1, 21)}$ =

6.582, p=.016. In addition, there was a main effect for study language, $F_{(2, 42)}$ =

6.058, p = .005. There was also a significant interaction between word type and study

language, F (2, 42) = 4.370, p = .019. Thus, the main effect of study language appears to be different for studied and critical words. Two planned post-hoc comparisons revealed that there was a language effect for studied words, F (2, 42) = 19.218, p < .001, but was not significant for critical words, F (2, 42) < 1. Specifically, for studied items Spanish only and mixed conditions resulted in higher recognition rates than English only conditions (p<.001). Contrary to predictions, there were no significant language mode effects on false recognition of critical lures.

Insert Table 1 and Figure 8 about here

A 2 (studied vs. critical word type) X 2 (same language vs. different language) repeated measures ANOVA again confirmed the predicted word type effect, F (1, 21) = 5.975, p = .023. There was a moderately significant congruency effect, F (1, 21) = 2.975, p = .099. However, there was a significant interaction between word type and congruency effect, F (1, 21) = 11.198, p = .003. To examine this interaction, two planned post-hoc tests were conducted. Consistent with Kawasaki-Miyaji et al.'s (2003) findings, studied words were correctly recognized more frequently if the word was tested in the same language as at the time of study. When the study and test languages were the same, the mean recognition rate was .65; when they were different the mean recognition rate was .49. This effect was significant at a .05 level, t (21) = 5.520, p<.001. However, this result does not suggest that the two languages are not conceptually interdependent, as will be discussed later. Additionally, there was no significant study-test language congruency effect for critical words, t (21) <1.

There was no difference in false recognition rate between critical lures that were tested in the same language as their target study list (e.g., the list for *foot* was presented entirely in English, and the CNW *foot* was tested in English) and those that were tested in a different language.

The developmental hypothesis predicts that as L2 proficiency increases so too should false recognition of critical lures. However, this was not supported by the data as false recognition of the critical lure was slightly negatively correlated with L2 proficiency, $r = -.048$, $p = .833$. Contrary to the developmental hypothesis, an increase in L2 proficiency did not correspond with an increase in conceptual mediation and false recognition of CNWs.

Finally, the Revised Hierarchical Model (Kroll & Stewart, 1994) incorporates L1 and L2 asymmetries that would predict a difference in false recognition of CNWs between lists that were presented in the participants' L1 and lists that were presented in the L2. The results do not support this prediction, as there was no significant difference between these two conditions, $t(21) < 1$.

Discussion

Implications for theories of bilingual language representation

The primary goal of the present study was to test theories of conceptual-level episodic representation of two languages in memory. The interdependence hypothesis maintains that there is a single integrated memory store (Gerard & Scarborough, 1989), and as such would predict parallel activation of both languages. If, in the DRM false memory paradigm, participants were more likely to falsely recognize the critical lure than non-studied, non-target words, then this would provide

evidence for the interdependence hypothesis. Indeed, false recognition rate of the critical lures was significantly higher than unstudied words. Moreover, the false recognition rate for CNWs approached the correct recognition, or hit, rate for studied words. These high rates of false recognition occurred between languages, suggesting that the lists of associates were activating the target word in both languages. This pattern was found regardless of the study and test languages. Because of this parallel activation of languages, these results provide support for the interdependence hypothesis.

The developmental hypothesis states that as L2 proficiency increases, so too should conceptual mediation (Kroll & De Groot, 1997). If conceptual mediation increases, false recognition of the CNW should increase. Contrary to this prediction, the present study found no correlation between L2 proficiency and false recognition of the CNW. This seems to provide evidence against the developmental hypothesis. It is possible, though, that the CBM used in the present study may not have been an appropriate measure of proficiency for the DRM false memory task. The CBM was originally used to assess reading ability, and so when it is adapted to measure language proficiency, it is measuring reading proficiency in that language. For instance, one participant reported that she did not know many of the words used in the study, yet she did relatively well on the CBM. As mentioned earlier, there are many different aspects to language proficiency. A person might be good at reading in a language and at the very same time not have a large vocabulary. The CBM was assessing reading proficiency, not vocabulary size, and so may not have been an

appropriate measure of proficiency. Thus, further research is needed to examine the effect of language proficiency on false recognition of critical lures in the DRM.

Grosjean (1998) argues that bilingual research needs to take into account the language mode of the participant. To examine language mode effects, the present experiment divided study lists into English only, mixed, and Spanish only. I predicted that the mixed language condition would result in a higher false recognition rate for CNWs because it would establish the participant in a bilingual mode as opposed to a monolingual mode. The results did not support this prediction, as there were no significant differences between the three conditions.

An alternative explanation of these results is that language mode effects may not have been observed since it is not clear that the participant was actually in one mode or the other. It is perhaps unreasonable to assume that viewing a fifteen word mixed-language list of associates might effectively establish a bilingual mode. Additionally, the lists were presented in a random order such that the participant would not have known what type of list it was, suggesting that a bilingual mode might have been maintained throughout the experiment, regardless of study-list condition. Again, further research is needed to explore language mode effects.

Kawasaki-Miyaji, et al. (2003) found that rates of correct recognition of studied items were higher when the language at the time of study and at the time of testing was congruent. They interpreted such language congruency effects as conflicting with the interdependence hypothesis. The present study found similar language congruency effects, as the hit rate for studied items was significantly higher when the test and study languages were the same. However, as mentioned earlier,

this is not necessarily inconsistent with the interdependence hypothesis. Both the RHM (Kroll and Stewart, 1994) and distributed models of language representation predict that recognition is not merely a result of conceptual overlap, but also of lexical overlap. According to these models, the greater the lexical overlap between study and test, the higher the hit rate for studied items should be. Furthermore, the present study found no language congruency effects for critical words. That is, CNWs were not more likely to be falsely recognized if the test language was the same as the language of the study list. There would be no lexical overlap for same language CNWs because the word was never presented in a study list. Because there is no lexical overlap, there should be no increased recognition rate. Thus, the results of the present experiment are consistent with the RHM (Kroll & Stewart, 1994) and distributed models of language representation.

Finally, the RHM (Kroll & Stewart, 1994) predicts that there should be language asymmetries in false recognition rates for CNWs. No such asymmetry was found in the present experiment. However, this might be explained by the participants' high L2 proficiency. Language asymmetries should decrease as the L2 proficiency increases and the participant gets closer to the mythical "balanced bilingual" state. I recruited participants from upper level Spanish classes and who were often Spanish majors. The seven native Spanish speakers were all very proficient in English as they had been living in the United States for several years and had been taking classes in English. Because all of the participants in the study were highly proficient in the L2, the RHM (Kroll & Stewart, 1994) would not have predicted large L1-L2 asymmetries in false recognition of CNWs.

Limitations of the present study

     The first limitations of the present study are the translation difficulties that arose while putting together the Spanish only and mixed word lists. The word lists consist of associates, and so many times this resulted in a number of synonyms in each list. For example, the list for *anger* includes *ire, wrath, rage,* and *enrage.* When translating the lists into Spanish, it was difficult to find a separate and distinct Spanish word for each of the English words. There was not always a direct translation equivalent, and this was problematic when attempting to create lists of associates. Because there might not be a separate word for *wrath* and *anger,* participants might incorrectly translate the word for *wrath* as *anger.* If, due to translation errors, participants are studying the CNWs, then false recognition of the critical lure would be spuriously high. This situation occurred frequently for abstract words, as the distinctions between abstract words are less definite than between concrete words. Because of this translation difficulty, I removed two study lists that were particularly difficult to translate from each condition (the two lists from the English only condition were chosen at random).

     Another translation difficulty occurred as a result of dialect differences in Spanish. There are many dialect differences between the Spanish spoken in Spain and Latin America. There is even considerable difference between dialects of Spanish within Latin America. There were several words that would be translated one way in a particular country but differently in another country (e.g., the words for *cake* and *jam* vary across dialects). When dialectical discrepancies occurred, the fourth coder was asked to determine which translation was the most common and

most appropriate. However, it is quite possible that there were words that the participant did not know due to dialectical differences.

The second limitation of the present study is its use of outdated and culturally specific norming data to create the associate lists. The associate lists were taken from Russell and Jenkin's norming study from 1954. Fifty-one years later, some of the associates are out of date. For instance, one of the items for *mountain* is *molehill*, coming from the idiomatic phrase, *you are making a mountain out of a molehill*. This phrase is not nearly as popular as it once was, and unless one knows the phrase, *molehill* is not going to activate *mountain*. It is also likely that in the past half-century the fifteen most common associates of a word have changed. In addition to being outdated, Russell and Jenkin's norming data from 1954 is culturally specific. A large number of the associates were taken from language-specific idioms (e.g., *molehill (mountain), molasses (slow),* and *haystack (needle)*). If a participant is not familiar with the idiom, then it is less likely to activate the CNW and create false memories.

While there was strong false recognition of critical lures, the norms were problematic when attempting to create the study lists. Not only were some lists dropped from the study, but also when creating the mixed-language lists, I was occasionally forced to abandon the random assignment of study-list words to one language or another. That is, words like *molehill* were left in English because it was impossible to translate them into Spanish. Thus, there may have been some bias when compiling the study lists, and so it is important to correct this by creating new lists from more current norming studies.

Future Directions

In future studies, it is necessary to establish a new, updated set of associate lists that will resolve many of the limitations of the present study. Rather than attempting to translate 50 year old lists of associative norms into another language, it is important to create the lists through norming studies in both English and Spanish. This avoids many of the pitfalls of attempting to translate a long list of very similar synonyms into another language, and also ensures that the list will be culturally relevant. The present study used lists filled with culturally specific idioms and several lists were removed because of translation difficulties. Simply creating new lists from English and Spanish associative norms will alleviate much of these difficulties and should result in greater false recognition of CNWs.

In addition to new lists, a more appropriate and valid measure of proficiency should be explored. While the CBM was a valid measure of proficiency, it was assessing reading proficiency, and so was not appropriate for the DRM false memory task, which was heavily influenced by vocabulary size. In other words, a high score on the CBM did not necessarily translate into better performance on the DRM because the two tasks required different types of knowledge. Thus, in order to accurately examine the effect of language proficiency on conceptual mediation and the creation of false memories, it is important to develop a more appropriate measure of proficiency.

Finally, the paradigm should be amended in some way such that language mode effects can be examined. The present study attempted to explore such effects by having mixed and single language study lists. However, this may not an effective

way to put participants in either a bilingual or monolingual language mode. Perhaps each participant could receive only one study-list condition and read several mixed or single language passages before the beginning of the experiment. This might be a more effective way to artificially create a language mode and so allow for the exploration of language mode effects on false recognition rates.

Overall, the findings of the present experiment provide evidence for the interdependence hypothesis. False recognition of CNWs was much higher than the false recognition of unstudied, non-target words across two languages, suggesting that there was parallel activation of both languages during encoding. These results support models of language representation such as the RHM (Kroll & Stewart, 1994) and distributed models. However, before drawing any further conclusions, it is important to establish new lists of associates as well as a new proficiency measure.

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Figure Captions

Figure 1. The Word Association model (adapted from Potter et al., 1984).

Figure 2. The Concept Mediation model (adapted from Potter et al., 1984).

Figure 3. The Revised Hierarchical Model (adapted from Kroll & Stewart, 1994).

Figure 4. The distributed conceptual feature model (adapted from De Groot, 1992).

Figure 5. The distributed conceptual/lexical feature model (adapted from Kroll & De

Groot, 1997).

Figure 6. CBM scores by self-reported proficiency.

Figure 7. Mean recognition rates for unstudied words, studied words, and critical

lures.

Figure 8. Mean recognition rate by word type and study list condition.

Figure 9. Language congruency effects for studied words.

Word Type
- ■ studied
- ▨ critical
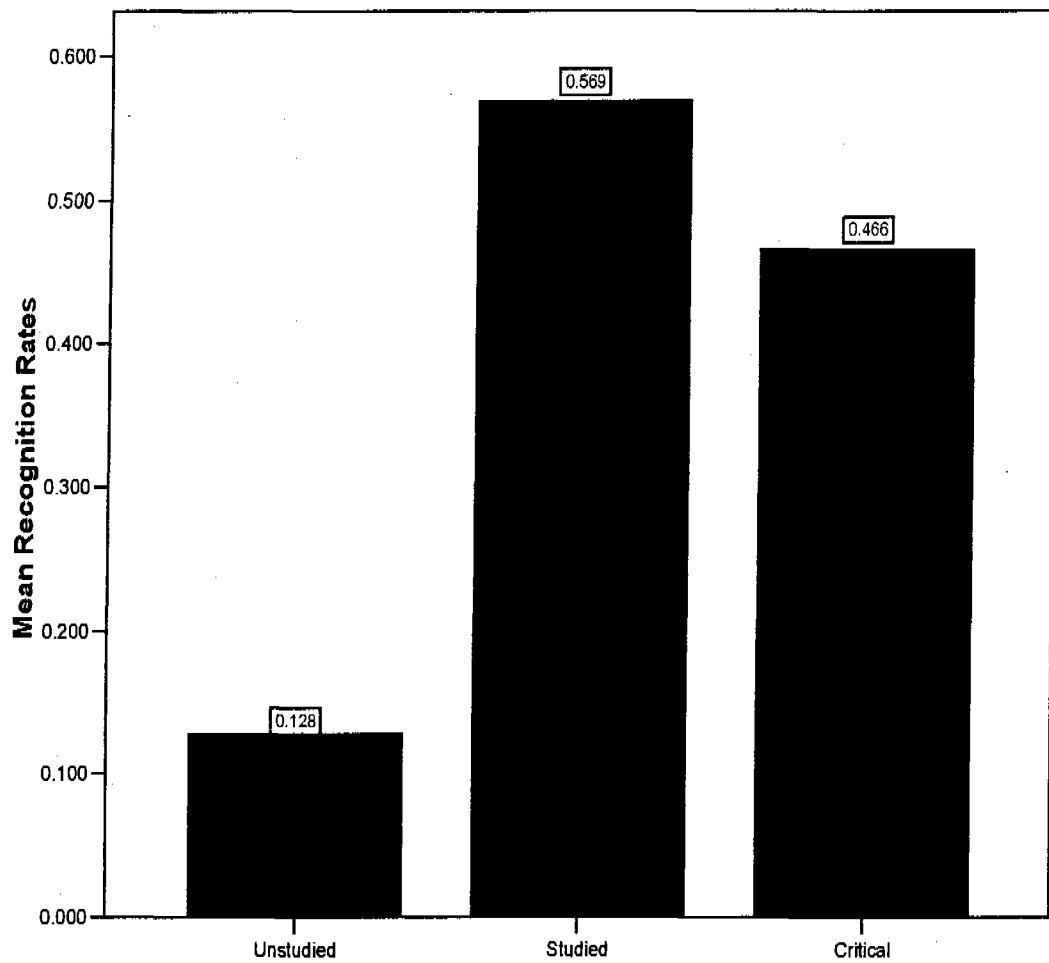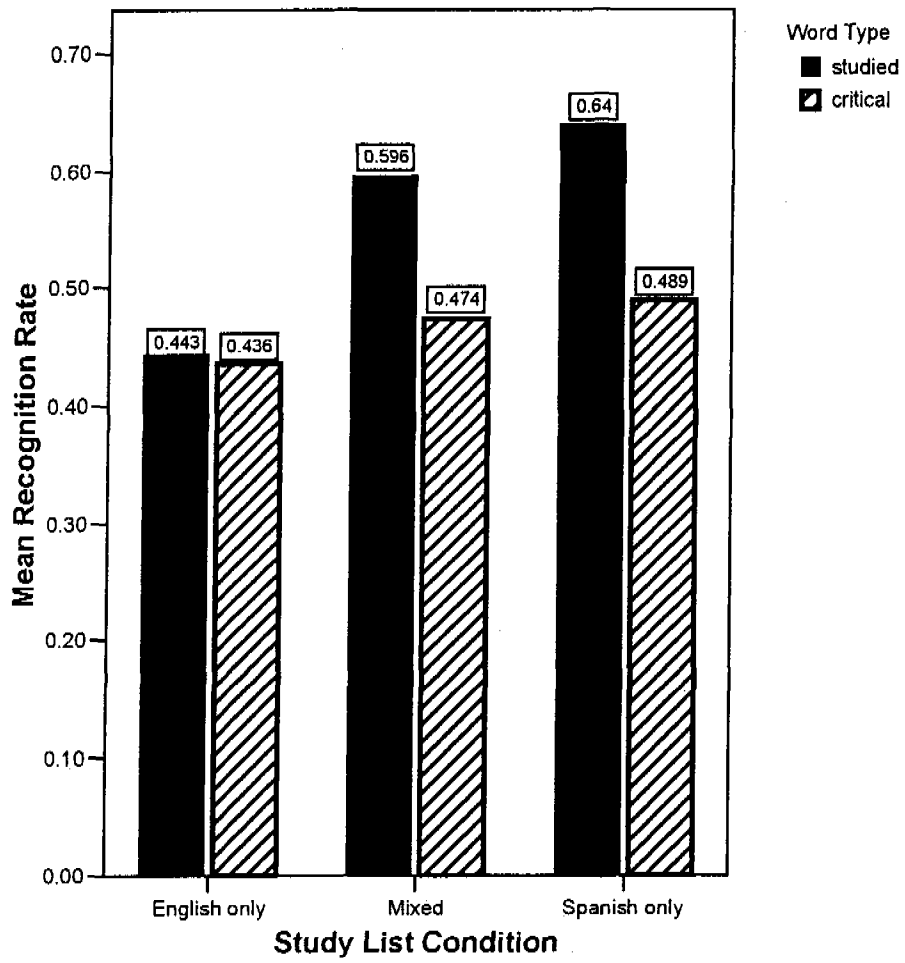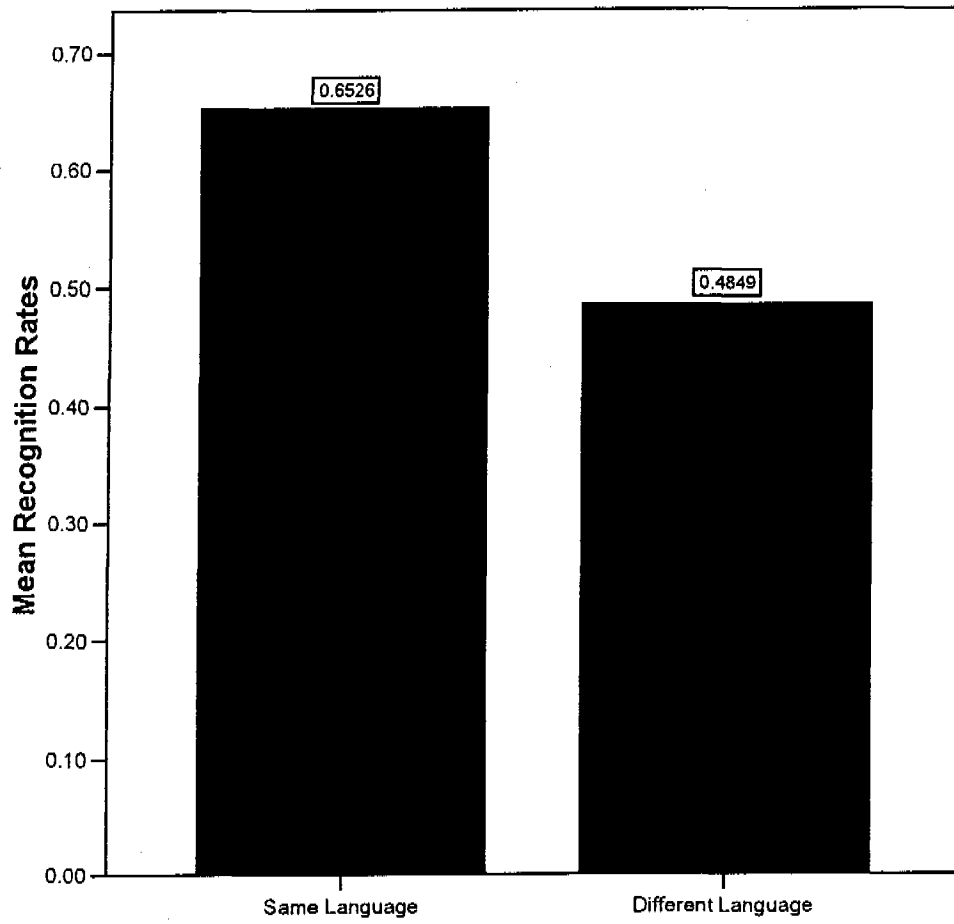
Appendix A.

English Only

Target word	King	Black	Foot	Needle	River	Soft
	queen	white	shoe	thread	water	hard
	England	dark	hand	pin	stream	light
	crown	cat	toe	eye	lake	pillow
	prince	charred	kick	sewing	Mississippi	plush
	George	night	sandals	sharp	boat	loud
	dictator	funeral	soccer	point	tide	cotton
	palace	color	yard	prick	swim	fur
Studied	throne	grief	walk	thimble	flow	touch
words	chess	blue	ankle	haystack	run	fluffy
	rule	death	arm	thorn	barge	feather
	subjects	ink	boot	hurt	creek	furry
	monarch	bottom	inch	injection	brook	downy
	royal	coal	sock	syringe	fish	kitten
	leader	brown	smell	cloth	bridge	skin
	reign	gray	mouth	knitting	winding	tender

Appendix A (continued)

Spanish Only (*translation*)

Target word	Cold		Sweet		Spider	
	caliente	*hot*	ácido	*sour*	telaraña	*web*
	nieve	*snow*	caramelo	*candy*	insecto	*insect*
	tibio	*warm*	azúcar	*sugar*	bicho	*bug*
	invierno	*winter*	amargo	*bitter*	susto	*fright*
	hielo	*ice*	bueno	*good*	mosco	*fly*
	mojado	*wet*	sabor	*taste*	arácnido	*arachnid*
Studied	frígido	*frigid*	diente	*tooth*	arrastrarse	*crawl*
words	fresco	*chilly*	agradable	*nice*	tarantula	*tarantula*
	calor	*heat*	miel	*honey*	veneno	*poison*
	clima	*weather*	soda	*soda*	morder	*bite*
	congelar	*freeze*	chocolate	*chocolate*	escalofriante	*creepy*
	aire	*air*	corazón	*heart*	animal	*animal*
	temblor	*shiver*	pastel	*cake*	feo	*ugly*
	ártico	*Arctic*	agrio	*tart*	pequeño	*small*
	escarcha	*frost*	tarta	*pie*	**"feelers" removed	

Spanish Only (*translation*)

Target word	Music		Fruit		Doctor	
	nota	*note*	manzana	*apple*	enfermera	*nurse*
	sonido	*sound*	vegetal	*vegetable*	enfermo	*sick*
	piano	*piano*	naranja	*orange*	abogado	*lawyer*
	cantar	*sing*	kiwi	*kiwi*	medicina	*medicine*
	radio	*radio*	cítrico	*citrus*	salud	*health*
	banda	*band*	maduro	*ripe*	hospital	*hospital*
	melodía	*melody*	pera	*pear*	dentista	*dentist*
Studied	trompeta	*horn*	platano	*banana*	remedio	*remedy*
words	concierto	*concert*	baya	*berry*	indispuesto	*ill*
	instrumento	*instrument*	cereza	*cherry*	paciente	*patient*
	sinfonía	*symphony*	cesta	*basket*	officina	*office*
	jazz	*jazz*	jugo	*juice*	estetoscopio	*stethoscope*
	orquesta	*orchestra*	ensalada	*salad*	cirujano	*surgeon*
	arte	*art*	bol	*bowl*	clinica	*clinic*
	ritmo	*rhythm*	cóctel	*cocktail*	curación	*cure*