2013-01-01

Between-Language Repetition Priming In Antonym Generation: Examining Conceptual Encoding And Representation Of Adjectives

Randy Steven Taylor
University of Texas at El Paso, rstaylor@miners.utep.edu

BETWEEN-LANGUAGE REPETITION PRIMING IN ANTONYM GENERATION: EXAMINING CONCEPTUAL ENCODING AND REPRESENTATION OF ADJECTIVES

RANDOLPH STEVEN TAYLOR
Department of Psychology

APPROVED:

Wendy Francis, Ph.D., Chair

Ana Schwartz, Ph.D.

Ashley Bangert, Ph.D.

Ellen Courtney, Ph.D.

Benjamin C. Flores, Ph.D.
Dean of the Graduate School

Dedication

To my Mother and Father for inspiring me and supporting me in my journey through graduate school. To my brother and his ongoing quest in the pursuit of higher education.

BETWEEN-LANGUAGE REPTETION PRIMING IN ANTONYM GENERATION: EXAMINING CONCEPTUAL ENCODING AND REPRESENTATION OF ADJECTIVES

by

RANDOLPH STEVEN TAYLOR, B.A.

THESIS

Presented to the Faculty of the Graduate School of

The University of Texas at El Paso

in Partial Fulfillment

of the Requirements

for the Degree of

MASTER OF ARTS

Department of Psychology

THE UNIVERSITY OF TEXAS AT EL PASO

December 2013

Acknowledgements

I would like to thank my mentor, Wendy Francis, for her support and encouragement throughout my academic career without which I would have never gotten to this point. I would also like to thank Natalia Strobach for her help and advice not only on this project but throughout my time in graduate school. I would also like to thank Daniel Cruz for his hard work in data collection.

Table of Contents

List of Tables

List of Figures

Chapter 1: Introduction

Research involving bilingual participants can provide insight not only into language processing but also into other areas of cognitive psychology, one of the most applicable being memory (for an extensive review see Francis, 1999). One of the critical characteristics unique to bilingual participants is that they have access to two words that refer to the same item or idea. These translation equivalents are phonologically and orthographically different yet represent the same concept. For example, the English word “dog” and the Spanish word “perro” both name the companion animal that likes to bury things in the yard. This leads to some intriguing questions in regards bilingual cognition. One question of interest is, do a bilingual’s two languages share conceptual representation across languages or do they have separate concept representations? Or put another way, how interconnected are the two languages? Does encoding in one language facilitate retrieval in the other language? These questions can be posed not only in relation to language but also in regard to human memory for example, questions related to differences in representation of concrete and abstract items would be intriguing in a general sense.

1.1 Prior Research

One common approach used to examine the nature of memory representation in bilingual participants has been to examine repetition priming between languages. Repetition priming is the decrease in response time to a stimulus given prior exposure to that stimulus. Repetition priming can be conceptual or perceptual with conceptual priming benefiting from prior processing of stimulus meaning and perceptual processing benefiting from prior processing of stimulus form (Gabrieli, 1998). It is important to note that in many cases the literature refers to perceptual priming or perceptual processes however a more precise description would be phonological or orthographic priming or processes. Thus, in the current work the use of the word perceptual is meant in the phonological/orthographic sense. The theory behind repetition priming in bilingual participants is that priming between-languages would indicate shared conceptual representation (Francis, 1999).

Early research found no between-language repetition priming effects using lexical decision tasks (Kirsner, Brown, Abrol, Chadha & Sharma, 1980; Kirsner, Smith, Lockhart, King & Jain, 1984; Scarborough, Gerard & Cortese, 1984) or word fragment completion tasks (Durgunoglu & Roediger, 1987; Watkins & Peynircioglu, 1983). This lack of repetition priming would seemingly indicate the absence of a shared representation across a bilingual's two languages. However, both the lexical decision task and the word fragment completion task are considered to be perceptual in nature (Roediger, Weldon & Challis, 1989). That is, the priming effects depend on non-conceptual characteristics of the stimulus form, such as phonology and orthography. These results may not indicate a lack of shared representation between languages; rather they seem to indicate that task selection is very important when attempting to examine between-language repetition priming.

Although early research failed to find repetition priming between languages, more recent research has been more selective in utilizing conceptually based tasks and has provided clear evidence for shared representation such that there is very little, if any, debate about the existence of the effect. Between-language priming was found using a word fragment completion task when participants were required to process sentences conceptually at encoding suggesting that conceptual processing at study led to recruitment of conceptual information at test (Smith, 1991). That is, participants had to process the meanings of the words at both encoding and test. The importance of conceptual processing is supported considering that long term between-language priming was found for conceptually based tasks but not for perceptually based tasks; the failure to find priming in perceptually based tasks remained even when the encoding task was conceptually based (Zeelenberg & Pecher, 2003). Similarly, deep (conceptual) encoding led to between-language priming while shallow encoding only facilitated within-language priming (Francis, Fernandez & Bjork, 2010). Further evidence of between-language transfer in conceptual repetition priming has been reported utilizing picture naming tasks (Francis, Augustini & Saenz, 2003), semantic classification tasks (Zeelenberg & Pecher, 2003), and concrete/abstract noun decision tasks (Francis & Goldmann, 2011). Finally, evidence of between-language priming has been reported utilizing verb generation tasks (de la Riva Lopez, Francis & Garcia, 2012; Seger, Rabin, Desmond & Gabrieli, 1999). The latter results are of greatest interest to the current study considering that the current task also utilizes a generation task where a change in generation response time is the measure of priming.

Taken together the between-language priming results mentioned above provide evidence for shared conceptual representations. The evidence also suggests that conceptually mediated tasks are required to tap into between-language priming. Also of interest is that the majority of the evidence shows that the between-language priming effect is smaller than the within-language effect (only Seger et al, 1999 found equivalent levels of priming), which suggests that both perceptual and conceptual processing contribute to within-language priming (Francis, Fernandez & Bjork, 2010). Another possible explanation of this pattern is that there may be incomplete sharing of concepts between-languages, one idea being that conceptual representations are made up of many features and all of these features may not be shared between-languages leading to an attenuation of the effect (Van Hell & de Groot, 1998).

1.2 Transfer Appropriate Processing

As explained above, there is evidence for conceptual transfer between languages on a variety of tasks. Furthermore this transfer appears to occur regardless of direction, whether it be L1 to L2 or L2 to L1 (de la Riva Lopez, Francis & Garcia, 2012; Francis, Augustini & Saenz, 2003; Francis, Fernandez & Bjork, 2010; Francis & Goldmann, 2011). These results are consistent with the logic of the *transfer appropriate processing* framework developed by Morris, Bransford and Franks (1977) which was a refinement of the *levels of processing framework* (Craik & Lockhart, 1972).

Whereas the levels of processing framework was mainly concerned with depth of processing at encoding the transfer appropriate processing framework (hereafter referred to as TAP) supposes that memory performance depends on the degree of matching between cognitive operations required at encoding and retrieval. The more the operations match, the greater the transfer from encoding to retrieval (Roediger, Gallo & Geraci, 2002). Therefore, according to the TAP framework, when priming exists between a conceptual encoding task and a conceptual retrieval task it is due to the matching conceptual nature of the tasks.

Thus, if priming between languages is observed it cannot be the perceptual operations that match, because the perceptual aspects of the languages are different, so it must be conceptual operations. The TAP framework can also shed light on the nature of the tasks themselves. For example, if a retrieval task is known to be conceptually based and priming is observed from an encoding task whose basis is unknown it may be taken as evidence that the encoding task is also conceptually based.

1.3 Models of Bilingualism

Within the literature on bilingual processing much attention has been paid to trying to understand and model how languages interact and connect with each other. Models of bilingualism have focused on the links between the languages themselves and conceptual stores and have different assumptions of what processes are at work (see Table 1). Two contrasting models are the word association model and the concept mediation model (Potter, So, Von Eckardt & Feldman, 1984). The word association model (see Figure 1) assumes a direct link between the two languages at the lexical level. However, only the first language (L1) is linked to the concept store. According to this model the only access the second language (L2) has to the concept store is through L1. Thus in this model L2 productions should have limited access to the concept making them more difficult in conceptually mediated tasks. Under this model, translation in both directions would be lexically based because L2 has no direct conceptual connection.

Table 1: Language models and assumptions

Model	*Assumptions*
Word association	Translation in both directions would be mediated lexically. Thus, translation would not serve as a deep encoding mechanism.
Concept mediation	Both languages are connected to the concept. Thus translation is mediated conceptually and translation serves as a deep encoding mechanism.
Revised hierarchical	Both languages are connected to each other and concept. Strength of connection varies thus translation would serve as deep encoding mechanism depending on direction, L1 to L2 translation is conceptual and L2 to L1 translation is lexical.

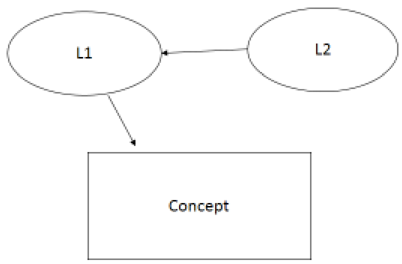

Figure 1: Word association model

The concept mediation model (see Figure 2) assumes no direct link between L1 and L2. However, the lexicon of each language has its own link to the concept store and both languages are connected to each other through it. Thus in this model the language of production should have little or no effect in conceptually mediated tasks because both languages are connected to the concept store. Because both L1 and L2 are directly connected to the concept translation in either direction would be conceptually based.

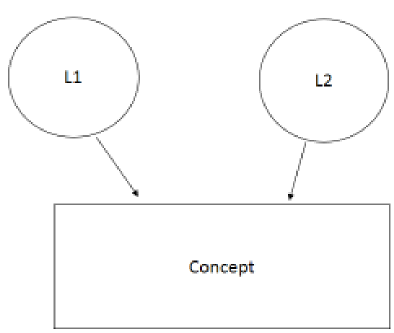

Figure 2: Concept mediation model

A more sophisticated model is the revised hierarchical model (Kroll & Stewart, 1994). This model (see Figure 3) proposes that both languages have links to each other as well as to the conceptual store; what varies is the strength of these connections. For example, although both L1 and L2 have connections to the concept, the connection from L2 is weaker than the connection from L1. The connections between the languages also vary; going from L2 to L1 the link is lexically mediated and going from L1 to L2 the link is conceptually mediated. In this model, strength of connection would determine performance on a conceptually mediated task. This model also opens the possibility that these connections may strengthen with language proficiency and experience. Under this model, conceptually-based translation from L1 to L2 would be more similar to the concept mediation model, whereas lexically-based translation from L2 to L1 would be more similar to the word association model. However, considering the possibility of increased connection strength with increased proficiency it would also seem possible that L2 to L1 translation could become conceptually based with increased experience. There is evidence that translation in both directions is conceptually mediated in highly proficient bilinguals (Francis et al., 2003; Francis & Gallard, 2005; Francis et al., 2011).

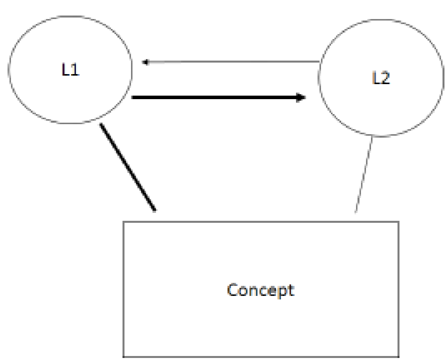

Figure 3: Revised hierarchical model

1.4 The Current Experiment

The goals of the current experiment are to build on the between-language priming literature, using the TAP framework to examine conceptual representation as well as to examine the role of translation as an encoding mechanism. The experiment will utilize translation as the encoding task and antonym generation at test. The antonym generation task (Jacoby, 1983) provides participants with a word and requires them to generate the antonym (e.g. Hot-???). The task relies primarily on conceptual processing and facilitates conceptual transfer, both on explicit and implicit tests (Mulligan & Dew, 2009). Tests showing positive generation effects (increased priming) are considered to be conceptually driven (Roediger & McDermott, 1993). Conceptual priming is maximal when encoding focuses on conceptual analysis of stimulus meaning. There is evidence that conceptual priming is mediated by amodal language areas of the brain (Gabrieli, 1998), indicating that language plays a role not only in the perceptual aspects of processing but in conceptual aspects as well.

Understanding the structure of the TAP framework can also shed light on the role of translation as an encoding mechanism. If priming occurs from translation to antonym generation it can be inferred through the TAP framework that translation is activating conceptual processes. If priming is found between languages we can assume that translation is working as a deep encoding mechanism considering that between-language priming has been observed with deep but not shallow encoding (Francis, Fernandez & Bjork, 2010). Between-language priming will also serve as evidence for shared conceptual representation of adjectives. Thirdly, prior research has shown that the between-language priming effect is smaller than the within-language priming effect, which indicates either that more than just conceptual processing contributes to the within language effect or that shared representation between languages is incomplete (see above). By using translation at encoding, we can examine whether activation of both languages reduces or even eliminates this difference.

The current study will add to the literature by utilizing adjectives as stimuli. The majority of past experiments have used concrete nouns, which are known to be linked to shared conceptual representations (Francis & Goldmann, 2011). As mentioned above, although it is pretty well understood that there is a between-language priming effect much less attention has been paid to the distinction between concrete and abstract representation and there is some assumption that abstract representation would differ in the sense that the sharing of concepts may be incomplete, shared or non-existent (Paivio & Desrochers, 1980; de Groot, 1992; Van Hell & de Groot, 1998). Evidence of between-language priming with adjectives will expand the knowledge of shared conceptual representations beyond nouns and a few studies that have found effects with verbs (Seger et al, 1999; de la Riva Lopez, Francis & Garcia, 2012). This is important not simply because it is research using a different part of speech but because adjectives serve as abstract stimuli. A second contribution will be adding to the past evidence of between-language repetition priming obtained utilizing a task in which RT to generate is used as the measure of priming (see above).

Thus the current experiment has two main goals. The first area of interest is to examine between-language conceptual transfer. It is hypothesized that between-language priming will be observed, indicating that adjectives share conceptual representations across languages. The second area of interest is to examine the role of translation as an encoding mechanism in highly proficient bilinguals. It is hypothesized that translation will facilitate priming, indicating that it serves as a deep encoding mechanism.

Chapter 2: Methods

2.1 Participants

Participants were 64 English-Spanish bilinguals (49 women, 15 men) who were recruited from the introduction to psychology research pool at the University of Texas at El Paso. The mean age of the participants was 19 years old. Participants self-reported as early acquisition bilinguals with the mean age of acquisition of English being 5 years old and the mean age of acquisition of Spanish being 1 year old. Language dominance was balanced, with 33 reporting as Spanish dominant and 31 reporting as English dominant. The average time spent speaking each language was reported as English 47% of the time, Spanish as 42% of the time, and a mixture of English and Spanish 9% of the time.

An additional 21 individuals completed the experimental protocol but had to be replaced due to either excessive voice-relay error (5 participants) or excessive incorrect response/don't know trials (16 participants). Participants were replaced if at least half of the trials in two or more conditions were incorrect/don't know and/or voice-relay error. In other words, only participants for whom at least half of the data were usable were included.

2.2 Design

The experiment utilized a 4 (encoding condition) × 2 (antonym generation language) within-subjects design. The encoding conditions were not presented, shallow encoding, translation to the test language, and translation from the test language. The antonym generation languages were English and Spanish. The dependent variable was RT of antonym generation.

The not-presented encoding condition served as a baseline against which priming in the other conditions was measured. The shallow encoding condition consisted of a read only task in which participants were required to read words in the same language that they would later see at test. The deep encoding conditions consisted of two translation tasks, one in which participants translated words to the test language and one in which they translated from the test language.

Between and within-language deep-encoding conditions were determined by the language of production (See Table 2). For example if at encoding the participant translated a Spanish word into English and then at test produced that word as an English antonym, the language of production matched from encoding to test and was thus considered a within-language trial. On the other hand, if at encoding the participant translated an English word into Spanish and then at test produced that word as an English antonym, the language of production mismatched from encoding to test and was thus considered a between-language trial.

Table 2: Sample Stimuli for the Experimental Conditions

Within Language Condition	
Translate:	Antonym:
E: See “caliente” produce “hot”	See “cold” produce “hot”
S: See “hot” produce “caliente”	See “frio” produce “caliente”
Between Language Condition	
Translate:	Antonym:
E: See “caliente” produce “hot”	See “frio” produce “caliente”
S: See “hot” produce “caliente”	See “cold” produce “hot”
Shallow Encoding Condition (within language)	
E: See “hot” produce “hot”	See “cold” produce “hot”
S: See “caliente” produce “caliente”	See “frio” produce “caliente”

2.3 MATERIALS

The initial list of stimuli was selected from the MRC Psycholinguistic Database. To qualify for initial selection the list was filtered to adjectives with a minimum Kucera-Francis written frequency of 20. Antonyms to these adjectives were then produced using an online thesaurus. The selected stimuli were then translated into Spanish by two highly proficient bilinguals with special consideration given to the equivalence of frequency and meaning. Adjective-antonym pairs were filtered out based on translation issues (ensuring no identical cognate target words), antonyms that were simply modified versions of the adjective (for example secure and insecure), and pairs that represented the same concept.

After this filtering process the remaining pairs were pilot tested in English and Spanish with bilingual participants to ensure that they produced the intended antonyms. Pairs in which pilot data indicated that the intended antonym was produced less than 50% of the time were removed leaving a stimuli set of 64 adjective-antonym pairs. Of these 64 pairs, 5 were identified as having a significantly higher rate of co-occurrence compared to the others (Justeson & Katz, 1991) and were distributed to separate lists. All Spanish adjectives were in the masculine gender. The 64 pairs (see appendix) were randomly assigned to 8 sets. These sets were rotated through the 8 cells of the design across participants using a Latin square to control for specific-item effects.

A short (1 page) language background questionnaire was used to collect demographic as well as language acquisition and usage information.

2.4 Apparatus

The experiment was programmed using PsyScope software. Response times were recorded using an ioLab Systems button box with a microphone attachment. Stimuli were presented on an Apple Macintosh computer.

2.5 Procedure

Participants were tested individually in sessions lasting approximately 30 minutes. Upon entering the lab participants were seated and completed an informed consent form as well as a language background and usage questionnaire. After completing both forms an experimenter led the participant to the testing room and the participant was seated in front of a microphone and computer screen to begin the experiment.

The experimenter began by explaining that the experiment utilized a microphone and advised participants to speak loudly and clearly as well as to avoid making noises other than the intended response that might trigger the microphone. The experiment was divided into an encoding phase and a test phase. To begin the encoding phase the experimenter told participants they would see words appear one at a time and that they would have to either read or translate the words, depending on the block of trials. Participants read 8 words in English and 8 words in Spanish; they also translated 16 words from English to Spanish and 16 words from Spanish to English. The order of tasks and languages was counterbalanced across participants.

After completion of the encoding phase the experimenter led participants through the test phase explaining that participants would see words one at a time and would be required to produce the antonym to each word. The test phase consisted of two blocks of antonym generation trials, one in English and one in Spanish (in counterbalanced order). The first three words in each test block were practice items, which were followed by 32 experimental items.

The antonym word participants were required to produce on each trial was either a word not previously seen or a word that had been read or translated at encoding. Throughout the experiment, the experimenter utilized a correct response sheet to mark incorrect responses and timing error trials. After debriefing participants were assigned course credit.

Chapter 3: Results

Data were analyzed in terms of response time in which priming was measured as the difference in RT between words that had been seen at encoding and words that had not previously been seen. Any reporting of significant priming indicates that the priming effect was different from zero. Priming was calculated by subtracting the RT of the repeated conditions from the RT of the control condition. Baseline RT (control items) averaged 1668 ms in English, 1712 ms in Spanish, 1623 ms in L1 and 1757 ms in L2. Data were analyzed using paired samples T-Test as well as repeated measures ANOVA. For RT analyses, incorrect/pass responses (22%) in which incorrect responses were classified as any response that was not the intended target word even if the response could technically be considered a correct antonym, voice-relay error trials (3%) and responses under 200 ms and over 5000 ms (1.4%) were removed. After data cleaning 73.6% of trials were retained for analysis.

Data were also analyzed in terms of the probability of giving the expected response in which priming was measured as bias to generate the expected response. Again, any report of significant priming indicates the effect was different from zero. Priming was calculated as the difference between the number of errors in the repeated condition and the number of errors in the control condition. This number was then converted into a proportion by dividing the average priming score by the number of items per condition. In other words, bias to generate breaks responses down into two categories, either the anticipated response is produced or an alternative response is produced (incorrect response or pass). A positive bias indicates that participants were more likely to produce the expected response (or less likely to provide an incorrect response or pass) when they had seen the word at encoding compared to when the word was novel. Baseline error proportion (or the proportion of errors made in the control condition) averaged .29 in English, .29 in Spanish, .27 in L1 and .30 in L2.

Analyses of overall RT priming effects (see Figure 4) revealed significant priming in the read condition $t(63) = 2.98$, $MSE = 30.8$, $p > .01$, the between-language condition $t(63) = 3.32$, $MSE = 31.84$, $p > .01$, and the within-language condition $t(63) = 4.16$, $MSE = 30.3$, $p > .01$. Analyses of overall bias priming effects (see Figure 5) also revealed significant priming in all three conditions, read $t(63) = 4.19$, $MSE = .019$, $p < .01$, between $t(63) = 8.21$, $MSE = .013$, $p > .01$ and within $t(63) = 4.84$, $MSE = .017$, $p > .01$. These results indicate shared conceptual representation of adjectives as well as provide evidence for translation acting as a deep encoding mechanism. Interestingly, the read only condition also facilitated conceptual priming, which was not predicted. Data were also analyzed as a function of the nominal language of the test trial (English/Spanish) and as a function of the language dominance of the test trial (L1/L2). Priming scores are listed in Tables 3 and 4 as a function of nominal test language and language dominance.

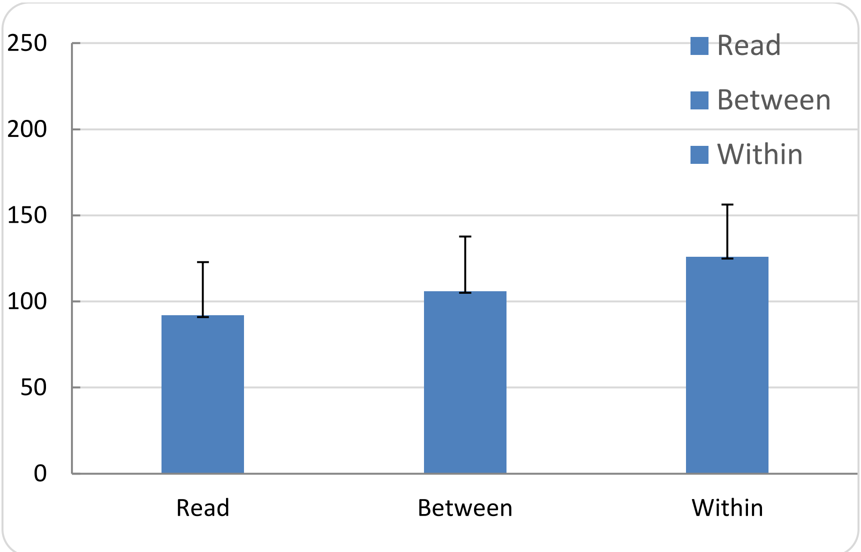

Figure 4: Overall priming effects as a function of response time

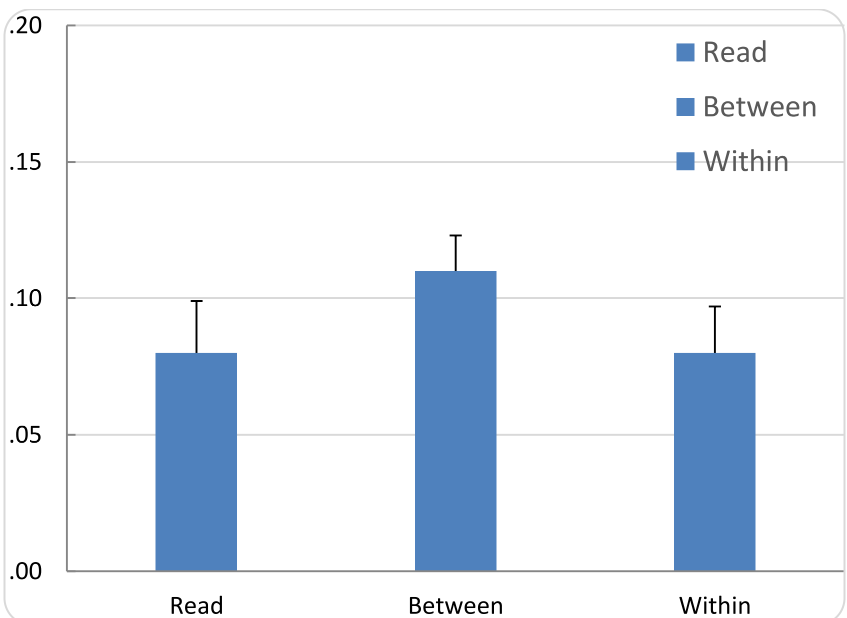

Figure 5: Overall priming effects as a function of bias to generate

Table 3: Mean RT Priming

Encoding	*Test*									
	English		*Spanish*		*L1*		*L2*		*Overall*	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Read	120	388.3	63.9	296.9	75.7	348.7	108	344.1	91.9	246.4
Between	175	377.6	36.9	356.5	114	328.1	97.9	414.2	106	254.7
Within	191	292	61.2	388.4	87.2	334.3	165	360.3	126	242.5

Table 4: Mean Bias Priming

Encoding	*Test*									
	English		*Spanish*		*L1*		*L2*		*Overall*	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Read	0.1	0.23	0.06	0.29	0.07	0.28	0.09	0.24	0.08	0.15
Between	0.14	0.19	0.07	0.23	0.12	0.21	0.1	0.22	0.11	0.10
Within	0.13	0.2	0.04	0.26	0.09	0.21	0.07	0.25	0.08	0.13

3.1 ANALYSES AS A FUNCTION OF NOMINAL TEST LANGUAGE

Paired samples t-tests revealed no significant differences in new item (control item) performance as a function of test language for RT $t(63) = .755$, $p = .453$ or for bias $t(63) = .000$, $p = 1.00$. Analyses of RT as a function of the nominal test language (see Figure 6) revealed significant priming effects when testing in English for the read condition $t(63) = 2.47$, $MSE = 48.54$, $p = .02$, the between-language condition (translation from English to Spanish) $t(63) = 3.69$, $MSE = 47.2$, $p > .01$, and the within-language condition (translation from Spanish to English) $t(63) = 5.23$, $MSE = 36.5$, $p > .01$. Analysis of RT for Spanish test language revealed no significant priming effects. A 2 (encoding condition) x 2 (test language) repeated measures ANOVA was conducted on the priming scores. This analysis revealed a main effect of test language on priming, with English trials exhibiting more priming than Spanish trials $F(1,63) = 4.407$, $MSE = 253014.96$, $p = .04$. The main effect of encoding condition $F(2,62) = .656$, $MSE = 57356.26$, $p = .521$ and the interaction of test language and encoding condition $F(2, 62) = 1.053$, $MSE = 61473..87$, $p = .352$ were not significant. Interestingly significant priming was revealed in all three conditions for English and in no conditions for Spanish, these results suggest that there may be differences in the effectiveness of the task based on test language.

A similar pattern of results was also found in the analysis of bias (see Figure 7) with significant priming in English for the read condition $t(63) = 3.31$, $MSE = .029$, $p > .01$, the between- condition $t(63) = 4.99$, $MSE = .025$, $p > .01$ and significant priming in Spanish found only in the between language condition $t(63) = 5.77$, $MSE = .025$, $p > .01$, and for the within-language condition $t(63) = 2.432$, $MSE = .029$, $p = .018$. A repeated measures ANOVA on bias produced no main effects of language $F(1,63) = 2.177$, $MSE = 11.96$, $p = .145$, or condition $F(2,62) = 1.971$, $MSE = 1.00$, $p = .144$, and the interaction was also not significant $F(2,62) =$

1.721, *MSE* = 1.64, *p* = .354. These results support the notion of differential task performance based on test language.

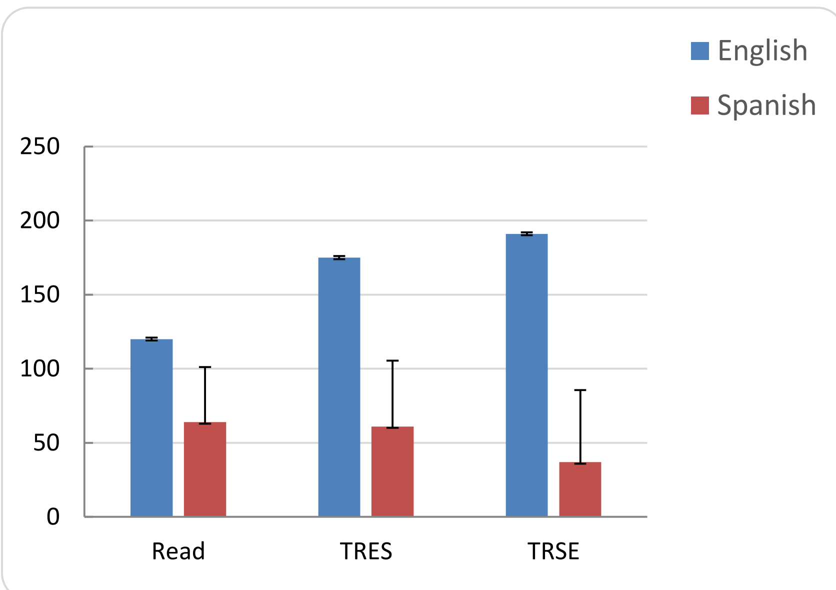

Figure 6: RT Priming as a Function of Test Language

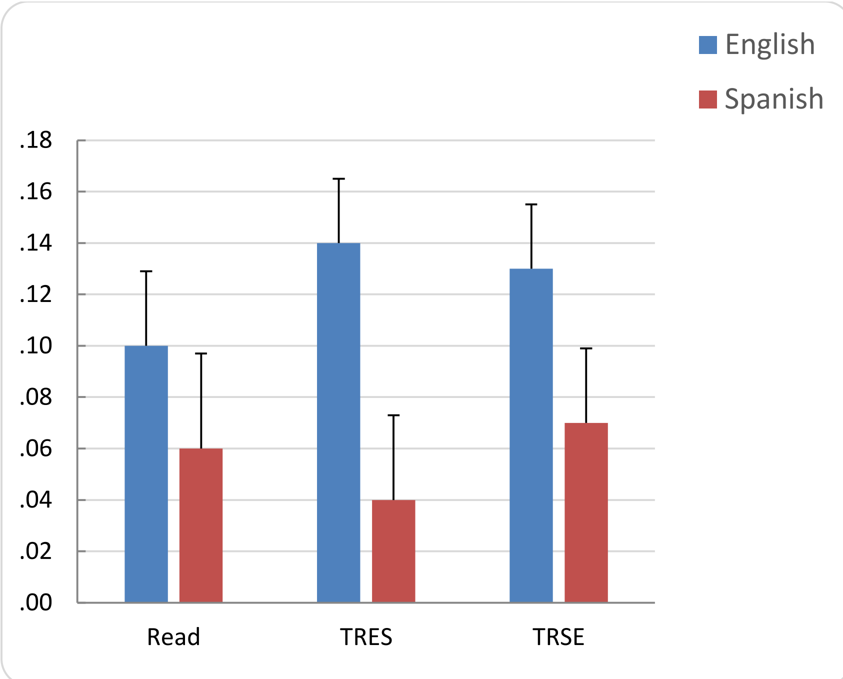

Figure 7: Bias Priming as a Function of Test Language

3.2 Analyses as a function of language dominance

Paired samples t-tests on control items revealed that L1 was processed significantly faster than L2 $t(63) = -2.39$, $p = .021$. However no significant difference was observed in terms of the propensity to give the expected response, $t(63) = -.925$, $p = .359$. An analysis of RT in terms of language dominance (see Figure 8) indicated significant L1 priming for the between-language condition $t(63) = 2.77$, $MSE = 41$, $p = .01$, and for the within-language condition $t(63) = 2.09$, $MSE = 41.8$, $p = .04$. Priming in the read condition was not significant $t(63) = 1.763$, $MSE = 43.6$, $p = .087$. In L2, significant priming was revealed in the RT analysis for the read condition $t(63) = 2.52$, $MSE = 43$, $p = .01$ and for the within-language condition $t(63) = 3.66$, $MSE = 45$, $p > .01$. However, priming in the between-language condition was not significant, $t(63) = 1.89$, $MSE = 51.8$, $p = .06$. A repeated measures ANOVA on the RT data revealed no main effect of language dominance $F(1,63) = .354$, $MSE = 269200.23$, $p = .554$, encoding condition $F(2,62) = .656$, $MSE = 57356$, $p = .521$, or a language by condition interaction $F(2,62) = 1.135$, $MSE = 61395$, $p = .325$. Interestingly the above findings of differential task performance based on test language do not seem to carry over to language dominance.

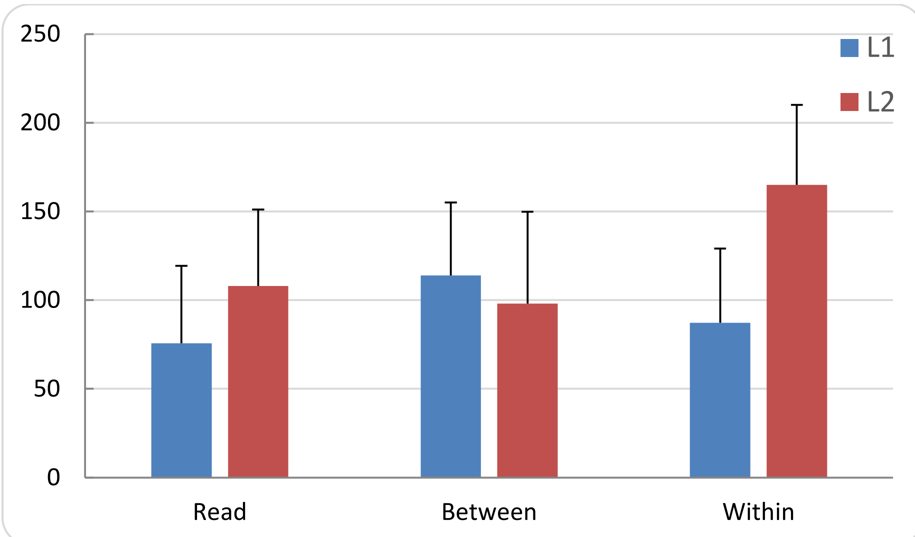

Figure 8: RT Priming as a Function of Language Dominance

Analysis of language dominance as a function of bias (see Figure 9) indicated significant priming in L1 for the read condition $t(63) = 2.05$, $MSE = .035$, $p = .04$, the between condition $t(63) = 4.46$, $MSE = .026$, $p > .01$, and the within condition $t(63) = 3.21$, $MSE = .027$, $p > .01$. L2 also revealed significant priming for the read condition $t(63) = 2.79$, $MSE = .031$, $p = .01$, the between condition $t(63) = 3.39$, $MSE = .028$, $p > .01$, and the within condition $t(63) = 2.29$, *MSE* 2.287, $p = .03$. A repeated measures ANOVA on bias data revealed no main effects for dominance $F(1,63) = .030$, $MSE = 12.37$, $p = .862$, or condition $F(2,62) = 1.971$, $MSE = 1.003$, $p = .144$, and the interaction was also not significant $F(2,62) = .727$, $MSE = 1.65$, $p = .646$. These findings match the overall findings of significant priming in all conditions in both L1 and L2.

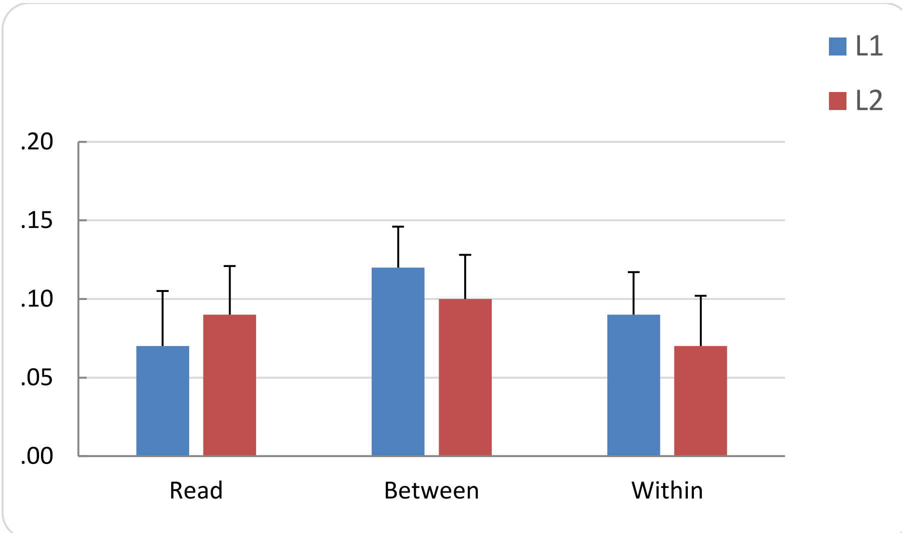

Figure 9: Bias Priming as a Function of Language Dominance

Chapter 4: Discussion

The main findings of the current study were significant overall priming effects for both RT and bias to generate the expected antonym, whether the word was read in the target language, translated from the target language, or translated to the target language at encoding. The finding that priming transferred across languages is consistent with past evidence for shared concept representation between languages. The current study is the first to use adjectives as stimuli in a between-language repetition-priming paradigm, providing evidence that shared representation extends beyond nouns and verbs to adjectives, which are more abstract. This finding is intriguing not only in a bilingual aspect but also in consideration of abstract concept representation. The current results are interesting in a broad cognitive sense considering that the current study suggests that abstract words exhibit transfer between languages, which may indicate that between-language sharing of abstract word concepts is stronger or more complete than previously thought.

The current results also suggest that translation acted as a deep encoding mechanism as predicted by the concept mediation model and the revised hierarchical model (see above). Translation facilitated conceptual priming regardless of whether the direction was to the dominant language or to the non-dominant language. This finding supports the concept mediation model and opposes the word association model, which assumes that translation in either direction is lexically based, and the revised hierarchical model, which assumes that only translation from L1 to L2 is conceptually based. However, as mentioned in the introduction, the revised hierarchical model leaves open the possibility that the strength of the connection from the word to the concept may strengthen with increased proficiency, and the bilinguals in this study were highly proficient, which may have contributed to the effect. Thus, it is difficult to draw a clear distinction between the concept-mediation model and the revised hierarchical model based on these results.

Interestingly, analysis of response times and bias revealed significant priming effects for all three conditions in English; however only one condition yielded significant priming in Spanish, an effect in bias for the between-language translation condition. At first glance this appears to suggest a problem with the antonym generation task in Spanish. It is possible that these findings are an indication of differential antonym association strength in English and Spanish, it may be the case that adjective-antonym pairs are simply not as strongly associated in Spanish as they are in English. It is also important to note that in Spanish some adjectives can also be nouns and it is difficult to say exactly what impact this may have had. However when the data were analyzed in terms of language dominance the language differences were not as clear. The only systematic difference was not between L1 and L2 but from RT to bias. Bias data indicated significant priming effects for all conditions in both L1 and L2 while the response time data showed that only the L1 read and L2 between conditions failed to produce significant priming. Thus it appears that bias to generate viewed in terms of L1 and L2 produced the strongest results, as all conditions in both the dominant and non-dominant languages showed significant priming.

The current study was the first to utilize response times for antonym generation as a test measure and the variability of those response times was rather large (see Tables 2 & 3). In future studies employing a similar design, researchers may want to consider using bias to generate as the main priming measure. That being said, despite the high variability, response time data still provided useful information most notably the significant overall priming effects in all conditions.

Also of interest was the finding that the read condition facilitated significant priming effects for both response time and bias to generate when looking at overall, English, L1 and L2 priming effects. It was hypothesized that the read task would act as a shallow encoding mechanism and thus not lead to significant priming in the antonym generation task, which was thought to rely primarily on conceptual processes. Examining results in a TAP sense it may be that because there was no between-language retrieval of the read items the perceptual match from encoding to test facilitated priming in a conceptual task. Previous work suggests that even conceptually based tasks are not completely conceptual in nature meaning that other processes may play a role in observed priming effects for conceptual tasks (Francis, Fernandez & Bjork, 2010). It may also be the case that although participants were only instructed to read they may have translated the items (intentionally or not) leading to the read condition to act more like the translate conditions.

Finally, the results indicated a lack of significant differences in priming effects across conditions, languages and language dominance. The only difference was a significant main effect of nominal language RT with English showing significantly more priming than Spanish. This finding is most intriguing considering that past research has found an attenuation of the between-language priming effect compared to the within-language effect. It has been suggested that this difference in priming effects indicated that more than just conceptual processes were involved in the within-language effect (see introduction). With this in mind it may be the case that utilizing translation as an encoding mechanism activated additional processes, namely perceptual, which may have led to an elimination of this difference. Alternatively, with the high level of variability in scores, there may not have been enough power to detect a difference between within- and between-language priming effects.

The current study attempted to add to the literature of between-language conceptual priming by examining generation of antonyms to adjectives. Overall the results of the current study supported the hypotheses. Between-language priming was observed, indicating that shared representation of adjectives and translation served as a deep encoding mechanism by facilitating priming both within and between-languages. These results suggest that translation in both directions utilizes conceptual processes. The main strengths of the current study are that it adds to a growing body of research which indicates shared conceptual representation in a bilingual's two languages and specifically that it is the first evidence of such effects coming from adjectives. This indicates not only that adjectives are tied to at least moderately strong conceptual representations in the cognitive framework but more importantly that these representations are shared across languages.

The findings of this study are intriguing not only in the sense that shared representation appears to extend across many parts of speech, but more importantly that adjectives would be considered more abstract while nouns and verbs may seem more concrete. Some theories of bilingual representation have incorporated the idea that abstract words do not have shared representations across languages or that the representations have fewer shared features across languages (Paivio & Desrochers, 1980; de Groot, 1992; Van Hell & de Groot, 1998). Nevertheless, abstract words did exhibit substantial between-language conceptual priming in a study of semantic classification priming (Francis & Goldman, 2011). The current results oppose the idea of weak abstract representation. However the current study does not provide much additional insight into the idea of shared features and thus it is difficult to say whether the current results support or oppose that idea, it may be the case that abstract items simply share more features than had previously been thought.

Also of interest is that the current study is the first to utilize antonym generation as a test task in a priming paradigm. Although the variability in response time was high the task may still prove useful in a similar function for other experiments especially if bias to generate is considered as the measure of priming. Also, more stimuli would be available and the response times would likely be less variable in a monolingual study of repetition priming in antonym generation. Future research on the mechanisms contributing to the within and between-language effects as well as further examination of abstract representation will be useful.

In conclusion the current study had two major goals, to examine between-language repetition priming effects of adjectives as well as the role of translation as a deep encoding mechanism. The results of the current work provide evidence that translation acted as a deep encoding mechanism and that adjectives share representation between-languages. Perhaps most importantly, the current study expands the literature on the extent of bilingual concept representation and provides evidence for shared abstract representation in a bilingual framework.

References

Craik, F. M., & Lockhart, R. (1972). Levels of processing: A framework for memory research. *Journal of Verbal Learning and Verbal Behavior,* 11(6), 671-684.

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

de la Riva Lopez. E. M., Francis, W. S., & Garcia, J. (2012). Repetition priming within and between languages in verb generation: Evidence for shared verb concepts. *Memory,* 20(4), 358-373.

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

Francis, W. S. (1999). Cognitive integration of language and memory in bilinguals: semantic representation. *Psychological Bulletin,* 125(2), 193-222.

Francis, W. S., & Gallard, S. L. K. (2005). Concept mediation in trilingual translation: Evidence from response time and repetition priming patterns. *Psychonomic Bulletin & Review,* 12(6), 1082-1088.

Francis, W. S., & Goldmann, L. L. (2011). Repetition priming within and between languages in semantic classification of concrete and abstract words. *Memory,* 19(6), 653-663.

Francis, W. S., Augustini, B. K., & Saenz, S.P. (2003). Repetition priming in picture naming and translation depends on shared processes and their difficulty: Evidence from Spanish-English bilinguals. *Journal of Experimental Psychology: Learning, Memory and Cognition,* 29(6), 1283-1297.

Francis, W. S., Fernandez, N. P., & Bjork, R. A. (2010). Conceptual and non-conceptual repetition priming in category exemplar generation: Evidence from bilinguals. *Memory,* 18(7), 787-798.

Gabrieli. J. D. E. (1998). Cognitive neuroscience of human memory. *Annual Review of Psychology,* 49, 87-115.

Jacoby, L. (1983). Remembering the data: Analyzing interactive processes in reading. *Journal of Verbal Learning and Verbal Behavior,* 22, 485-508.

Justeson, J. S., & Katz, S. M. (1991). Co-occurrences of antonymous adjectives and their contexts. *Association for Computational Linguistics,* 17, 1-19.

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

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

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.

Morris D. C., Bransford J. D., & Franks J. J. (1977). Levels of processing versus transfer appropriate processing. *Journal of Verbal Learning and Verbal Behavior,* 16(5), 519-533.

Mulligan N. W., & Dew L. T. Z. (2009). Generation and perceptual implicit memory: different generation tasks produce different effects on perceptual priming. *Journal of Experimental Psychology: Learning, Memory, and Cognition,* 35(16), 1522-1538.

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

Potter, M. C., So, K. F., Von Eckardt, B., & Feldman, L. B. (1984). Lexical and conceptual representations in beginning and proficient bilinguals. *Journal of Verbal Learning and Verbal Behavior,* 23(1), 23-38.

Roediger H. L., & McDermott K. B. (1993). Implicit memory in normal human subjects. *Handbook of Neuropsychology,* 8, 63-131.

Roediger H. L., Gallo D. A., & Geraci L. (2002). Processing approaches to cognition: The impetus from the levels-of-processing framework. *Memory,* 10(5/6), 319-332.

Roediger, H. L., Weldon, M. S., & Challis, H. B. (1989). Varieties of memory and consciousness: Essays in honour of Endel Tulving. New Jersey: Lawerence Erlbaum Associates.

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.

Seger, C. A., Rabin, L. A., Desmond, J. E, & Gabrieli, J. D. E. (1999). Verb generation priming involves conceptual implicit memory. Brain and Cognition, 41, 150-177.

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(2), 234-244.

Van Hell, J. G., & de Groot, A. M. B. (1998). Conceptual representation in bilingual memory: Effects of concreteness and cognate status in word association. *Bilingualism: Language and Cognition,* 1, 193-211.

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, 385-394.

Zeelenberg, R., & Pecher, D. (2003). Evidence for long-term cross-language repetition priming in conceptual implicit memory tasks. *Journal of Memory and Language,* 49, 80-94.

Appendix

List of stimuli

Cue word: English	Cue word: Spanish	Target word: English	Target word: Spanish
together	juntos	separate	separado
under	debajo	over	encima
bad	malo	good	bueno
drunk	borracho	sober	sobrio
cold	frío	hot	caliente
dumb	tonto	smart	inteligente
skinny	flaco	fat	gordo
all	todos	none	ninguno
safe	seguro	dangerous	peligroso
poor	pobre	rich	rico
short	corto	tall	alto
general	general	specific	específico
new	nuevo	old	viejo
better	mejor	worse	peor
future	futuro	past	pasado
easy	facil	hard	difícil
beautiful	bonito	ugly	feo
guilty	culpable	innocent	inocente
lost	perdido	found	encontrado
white	blanco	black	negro
liquid	liquido	solid	solido
ahead	adelante	behind	atrás
inside	dentro	outside	afuera
near	cerca	far	lejos
liberal	liberal	conservative	conservador
sour	agrio	sweet	dulce
married	casado	single	soltero
dry	seco	wet	mojado
empty	vacio	full	lleno
adult	adulto	child	niño
open	abierto	closed	cerrado
healthy	sano	sick	enfermo

Cue word		Target word	
English	Spanish	English	Spanish
tight	apretado	loose	suelto
calm	calmado	nervous	nervioso
strong	fuerte	weak	débil
early	temprano	late	tarde
negative	negativo	positive	positivo
alive	vivo	dead	muerto
greedy	avaricioso	generous	generoso
happy	feliz	sad	triste
religious	religioso	atheist	ateo
down	abajo	up	arriba
asleep	dormido	awake	despierto
loud	ruidoso	quiet	callado
curved	curveado	straight	recto
alike	similar	different	diferente
maximum	máximo	minimum	mínimo
cheap	barato	expensive	caro
false	falso	true	verdadero
small	pequeño	big	grande
first	primero	last	último
light	Illuminado	dark	oscuro
private	privado	public	publico
north	norte	south	sur
left	izquierdo	right	derecho
few	pocos	many	muchos
tense	tenso	relaxed	relajado
clean	limpio	dirty	sucio
more	más	less	menos
front	enfrente	back	atras
feminine	feminino	masculine	masculino
cowardly	cobarde	brave	valiente
absent	ausente	present	presente
fast	rapido	slow	lento

Vita

Randy Taylor earned a B.A. in Psychology from the University of Texas at El Paso in 2011 where he completed an honors thesis working in the Bilingual Cognition Lab. Randy began graduate work at UTEP in the fall of 2011 and he is currently a PhD student in the SCN program. While continuing research in the Bilingual Cognition Lab Randy has also worked as teaching assistant, three semesters of which he taught a lab section of General Experimental Psychology.

Permanent address: 300 Skyview Apt E-6

El Paso, TX 79912

This thesis/dissertation was typed by Randy Taylor.