Use of Cognates in Bilingual Speakers:

A Picture-Word Interference Paradigm Study

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Table of Contents

List of Tables

Abstract

Cognates share the same semantic and similar phonological/morphological forms across two languages (e.g., *dinosaur* - English; *dinosaurio* - Spanish); therefore, the use of cognates can have an effect across the different languages. Non-cognates include words whose translation equivalents have different spellings and sound patterns (e.g., *king* - English; *rey* - Spanish). Twenty-five highly proficient English-Spanish bilingual speakers named cognates and non-cognates in a picture-word interference paradigm. All stimuli were presented in English, participants responded in English and were unaware of the bilingual nature of the study. English-Spanish speakers who have a high spoken proficiency in both languages demonstrated a definite pattern of facilitatory effects when cognates were named compared to non-cognates. These results suggest that both lexical networks were invoked during naming and provide future directions in the treatment for bilingual individuals with aphasia.

CHAPTER 1

Introduction

According to the 2011 United States Census, 60.6 million people in the U.S. identified that they speak a language other than English at home. Of the 60.6 million, 37.5 million included Spanish speakers (Ryan, 2011). With the increasing numbers in bilingual speakers in the United States, there is a growing need to learn about how their lexical systems are related, and furthermore, how words are stored and retrieved. According to Levelt (1989), speakers have the capacity to produce approximately three words per second (120-300 words per minute) without making more than one error in every 1000 words. Generally, speakers must retrieve and select the desired concept, distribute word length, ascribe sounds, and prepare the articulatory system consisting of over 200 muscles (e.g. tongue, teeth, lips, soft palate) (Caramazza, 1997; Dell, 1986; Levelt, 1989). If you were to ask someone to name a picture of a common object (e.g. *broom*), most monolingual or bilingual speakers would name the picture effortlessly and without hesitation. Although naming a word appears as a simple task, it requires multiple cognitive steps for monolingual speakers and is even more complex for bilinguals. Moreover, when bilinguals are speaking in one language, they are able to suppress interference from the unintended language (Costa, Santesteban, & Caño, 2005).

Picture naming

Picture naming employs many of the same processing steps as speech production. Researchers generally agree that at least four mental operations lead to articulation prior to speech production: conceptual, lexical, phonological, and articulatory (Navarette & Costa, 2005; Strijkers & Costa, 2011). The following steps characterize the general sequence involved in picture naming that researchers have largely agreed upon (Caramazza, 1997; Dell, 1986;

Roelofs, Meyer & Levelt, 1998.) First, a speaker recognizes a picture (e.g., BROOM) and selects semantic representations. However, during this initial phase, BROOM is not the only representation activated; indeed similar semantic representations may also be activated such as *mop, shovel, bristles*, etc. This is referred to as multiple activation of lexical nodes. Next, activation of similar semantic representations spreads (spreading activation) to lexical nodes (words) that activate the representation that matches the picture, BROOM. The speaker must choose the lexical node (word) that best matches the picture among all the other candidates. There is ample evidence to suggest that multiple nodes can be selected (Caramazza, 1997). Although lexical selection typically succeeds, the fact that multiple lexical nodes are activated can often result in semantic errors. For example, if the target phrase is “sweep the floor,” a speaker might instead produce “mop the floor.” Such errors reflect the failure of a selection mechanism whose function is to select the lexical node with the highest amount of activation (Caramazza & Hillis, 1990). Researchers have tended to agree that the selection mechanism chooses the lexical node that corresponds with the greatest overlap with the intended target word. In the case of bilingual individuals, activation spreads from the semantic system to both language lexicons even if the individual has only selected a word in the intended language. For example, when a bilingual individual intends to name *broom*, its Spanish translation *escoba* will also be activated. Next, in the phonological encoding state, the lexical node is selected and the phonological components are retrieved (e.g. /b/ /r/ /ʊ/ /m/). Finally, the individual naming the picture establishes articulator placement to prepare for speech. There has been little disagreement amongst researchers about the general architecture of this process; however, an issue within current speech production models is *what type of information* is active at each of the levels and if the process occurs in a serial or free flowing nature (Navarrete & Costa, 2005). Currently, two speech production models that attempt to explain the underlying process of language production include discrete and cascade models. Recently, studies support cascade models' explanation for how monolingual and bilingual speakers access language (Morsella & Miozzo, 2004; Navarrete & Costa, 2005; Peterson & Savoy, 1998). These studies have concluded that activation from unselected lexical nodes cascades to the phonological encoding stage (Peterson & Savoy, 1998).

Discrete and Cascade Models

Researchers have agreed on two general conclusions in bilingual research: 1) both languages share a common conceptual store, and 2) some segregation exists between the lexical representations of the two languages (Kroll & Stewart, 1994; Van Hell & DeGroot, 1998). However, beyond this, there has been considerable controversy over how bilingual speakers' systems should be represented. One main theory of how speech production occurs is through the discrete model (Levelt, 1989). Within this model, activation from the lexical level is only sent to the phonological level and that speech production is a strictly serial process. Moreover, only phonological representations of the possible lexical selections are activated. In contrast, the cascade model proposes that activation can occur more freely between the processing levels (Peterson & Savoy, 1998). Evidence from Peterson and Savoy (1998) suggested that one picture can result in phonological activation of multiple sources. Within this view, phonological forms can be activated before lexical selection and unselected lexical nodes can activate phonological encoding. Morsella and Miozzo (2002) addressed the contention between serial and cascaded processing in a picture–picture interference naming study. Participants included 39 monolingual English speakers and 32 monolingual Italian speakers. Stimuli consisted of a distractor line drawing (in red) superimposed on a target line drawing (in green). The group of English monolinguals and Italian monolinguals named the same picture composites, however the picture composites were only phonologically-related in English. In essence, the pictures that the Italian speakers named showed no phonological similarity to the target picture (e.g. MANO – *cappello.*). Using the same list for both participant groups controlled for any unintended differences in stimuli. Nineteen of the distractor drawings were phonologically-related to the target picture, in English, (e.g. CAN - *cat*) and 19 were not related semantically or phonologically (e.g. CHAIR - *bat*). Participants were instructed to name the green picture and ignore the red picture while their reaction times (RTs) were recorded. English-speaking participants named pictures with phonologically-related distractors significantly faster than unrelated, whereas no significance was found in the Italian-speaking participants' RTs. Results revealed that participants responded faster when a phonologically-related distractor was present. Researchers concluded that the cascade model of speech production best explained these results since some of the participants' responses were influenced by activation of phonological processes, which, ultimately, influenced speech production. For example, if the target picture BOAT appeared with the phonological distractor *bone*, the distractor would activate the phonemes /b/ /o/. Thus, *bone* influenced production of BOAT, which would result in a facilitation of naming processes. This example illustrates the notion of feed-forward activation. In feed-forward activation, activation from the distractor lexical nodes facilitates the phonological encoding stage. The cascade model can also account for these facilitatory effects through feedback activation, which posits that phonologically-related distractors facilitate both the phonological and lexical nodes selection. For example, the phonological distractor (*bone*) activates some phonemes required for production of BOAT, then, phonemes from the phonological level send activation back to the lexical level. This additional activation can account for why phonologically-related distractors resulted in faster RTs. Although both feed-forward and feedback classes of cascade models differ in their course of activation, they both offer explanations for why the phonologically-related facilitatory effects occur.

According to cascade models (Costa & Santesteban, 2004) a selection mechanism is needed in order for bilinguals to choose the correct word in the correct language amidst the activation of several lexical candidates. It is accepted that the lexical node with the greatest amount of activation receives selection for speech production. This principle can be applied to bilingual speakers and the use of cognates. Cognates share the same semantic and similar phonological/morphological forms across two languages (e.g., *dinosaur* - English; *dinosaurio* - Spanish). Costa, Caramazza, and Sebastian-Galles (2000) found evidence for parallel activation of phonology in highly proficient speakers whose first-language was Catalan (L1) and second-language was Spanish (L2). Spanish monolingual speakers were asked to name pictures on a computer screen that corresponded to Spanish-Catalan cognates and non-cognates (e.g., *gato* - Spanish; *gat* – Catalan) in Spanish. Participants were asked to name the pictures as quickly and accurately as possible, and their RT for each picture was recorded. Derived from the cascade model, researchers predicted that only the bilingual group would name cognates faster. Participants named all pictures in Spanish and results revealed that cognates were named more rapidly than non-cognates. Within the cascade model, cognates were named faster than non-cognates because the non-selected lexical items in the language not programmed for production also activated their phonological properties. In conclusion, evidence from this study provided support for cascade model of lexical processing in bilinguals because phonological representations of both English and Spanish translations of the possible lexical selections were activated.

Lexical Non-Selectivity

Lexical access is a process that both monolingual and bilingual speakers experience. As previously stated, studies have demonstrated that when a speaker recognizes a word in their native language, they activate the target word and additional words that share similar lexical forms. Lexical selectivity refers to the process of 'selecting' the intended word in a given context (French & Jacquet, 2004), and for bilingual speakers it refers to selecting the right word in the correct language within a given context. Researchers have used RTs, or picture naming latencies, and word distractions during naming to help provide information about lexical selection (Hall, 2011).

Results from recent studies have demonstrated that language access in bilinguals is non-selective (Colomé, 2001; Costa, Miozzo, & Caramazza, 1999; Hermans, Bongaerts, DeBot, & Schreduer, 1998; Kroll, Bobb, & Wodniecka, 2006; Schwarz, Kroll, & Diaz, 2007). Non-selective access consists of activating lexical candidates in the *unintended* language; these candidates can either be selected or inhibited. How do bilinguals select the correct target word when there is competition from other lexical candidates? Presently, two models account for possible answers to this question. According to the language-specific selection model (Costa, et al., 1999), conceptual and lexical candidates in the unintended language are activated. In contrast, the language non-selective model argues that while the lexical candidates of the unintended language are indeed generated, they are inhibited in order for the speaker to carry on fluently. For example, according to the language-specific model, if a picture of a *dog* appeared during an English-Spanish picture naming task, the picture would activate the semantic nodes (e.g. *animal, tail, fur, bark*) and the lexical node, *dog* (but not *perro*). During the same task, the lexical non-selective model posits that a picture of a dog would first activate semantic nodes, then the lexical nodes *dog* and *perro* would both be activated.

To determine the status of lexical selectivity during cognate naming, Schwarz and colleagues (2007) investigated bilingual speakers' reaction times to cognates with varying degrees of orthographic and phonological overlap. Research questions included: Do similar phonological dynamics occur *across languages*? Does processing of cognates with a high degree of cross-language orthographic overlap influence the corresponding cross-language map in phonology? Participants included 18 moderately proficient English-Spanish speakers that were recruited from upper level Spanish courses at Pennsylvania State University. The authors asked L1 English-L2 Spanish bilingual participants to name cognates and non-cognates in two random trial blocks; one block consisted of naming in English and the other in Spanish. To serve as a control group, 16 monolingual English speakers also named cognate and non-cognate pictures. To obtain objective measures of orthographic similarity between English-Spanish cognates, the researchers used an algorithm that has been used extensively by researchers in previous studies (Van Orden, 1987). Based on the algorithm, the authors created four sets of cognate conditions: +Orthography +Phonology (*actor* - English; *actor* - Spanish), +Orthography -Phonology (*acre* - English; *acre* - Spanish), -Orthography +Phonology (*fruit* - English; *fruta* - Spanish), - Orthography -Phonology (*bank* - English; *banco* - Spanish). English-Spanish bilinguals named pictures of cognates and non-cognates in two randomized blocks. Participants named pictures once in English and once in Spanish, however the authors created two versions of stimuli so that participants only named items once. Results indicated that the bilingual participants named cognates more slowly than non-cognates in English where there was a high degree of phonological overlap and low degree of orthographic overlap (e.g., *train* - English; *tren* -

Spanish). The authors stated that increased RTs resulted from inhibition from competing distinct orthographic codes in the non-target language. Moreover, the more distinct the orthography and phonology in a given stimulus, the slower the RT. Naming accuracy was facilitated when there was a consistent mapping from orthography to phonology, suggesting evidence for automatic co-activations of the bilinguals' languages (lexical non-selectivity). These results demonstrated that naming facilitation could be altered according to the orthographic or phonological properties of a word; in other words, cross-activation of the two languages and language non-selectivity occurred because participant RTs were facilitated or inhibited due to the presence of increased/decreased phonological activation. Taken together, these studies provided evidence for the presence of lexical non-selectivity in bilingual speakers. When bilinguals are exposed to one language, it appears that they cannot avoid activating information from both languages (Colomé, 2001; Costa, et al., 1999; Hermans, et al., 1998; Kroll et al., 2006; Schwarz et al., 2007).

Cognates

One way to examine possible interactions between a bilingual's lexical networks is to use cognates. There is a growing body of research suggesting that bilingual speakers recognize and produce cognates more rapidly and accurately than non-cognates during visual picture naming tasks (Costa et al., 2000; Dijkstra, Van Jaarsveld & Ten Brinke, 1998; Kohnert, 2004; Kroll & Stewart, 2004; Rosselli, Ardila, Jurado, & Salvatierra (2014); Schwartz, et al., 2006). Since cognates share the same semantic and similar phonological/morphological forms across two languages (e.g., *dinosaur* - English; *dinosaurio* - Spanish) the use of cognates can have an effect across the different languages. Some cognates even have identical overlap (e.g., *radio* - English; *radio* - Spanish; *animal* - English; *animal* - Spanish) and others have similar overlap (e.g., *plant* -

English; *planta* - Spanish). Non-cognates include words whose translation equivalents have different spellings and sound patterns (e.g., *king* - English; *rey* - Spanish).

One explanation for this effect is that the shared features result in activation of lexical candidates in the unintended language. As a result, naming is facilitated when using cognates because of multiple sources of activation (semantic and phonological) from both languages. Since cognates exist across languages, they can provide unique insight into the assembly of a bilingual's lexicon. This rapid recognition and production of cognates is known as the *cognate facilitation effect* (CFE). Empirical evidence has shown that the CFE occurs as a result of an overlap of a given word pair in a bilingual's lexicon, resulting in a stronger mapping of the pair and greater likelihood of selection. This effect is robust and has been noted from several researchers in a range of languages, including: Dutch-English, English-French, and Catalan-Spanish, English-Spanish (Costa, et al., 2000; Dijkstra et al., 1998; Kroll & Diaz, 2006; Kroll, Dijkstra, Janssen, & Schriefers, 1999; Kroll & Stewart, 2004). The CFE has been found across word production, naming, and reading tasks (Gollan, Fennema-Notestine, Montoya, & Jernigan, 2007; VanAssche, Duyck, Hartsuiker, & Diependaele, 2009). The robustness of the CFE has provided support for the notion of shared bilingual lexicons and furthermore, that cognates are more resistant to production errors in normal speakers and speakers with aphasia (Costa et al., 1995).

Costa et al. (2000) conducted two experiments to determine which linguistic conditions resulted in a CFE. In Experiment 1, 21 highly proficient Catalan (L1)-Spanish (L2), and 21 Spanish monolingual speakers were asked to name pictures on a computer screen that corresponded to Spanish-Catalan cognates and non-cognates (e.g., *gato* - Spanish; *gat* - Catalan) in Spanish. Participants were asked to name the pictures as quickly and accurately as possible and their RT for each picture was recorded. Based on the cascade model, researchers predicted that only the bilingual group would name cognates faster. Participants named all pictures in Spanish and results revealed that cognates were named more rapidly than non-cognates. In Experiment 2, 46 participants named pictures that had cognate and non-cognate translations. All of the participants had strong proficiencies in Spanish and Catalan, however, 23 participants spoke Spanish as their dominant language and the remaining 23 participants spoke Catalan as their dominant language. Each participant named pictures in two sets; one set in their dominant language and one set in their non-dominant language. Results of Experiment 2 mimicked the results of Experiment 1. An interaction effect was found between language dominance and cognate type. Results also revealed the CFE occurred with greater magnitude for individuals naming in their non-dominant language (L2). Kroll and Schwarz (2004) proposed that the amount of activation received by lexical items in dominant and non-dominant languages differs. Costa et al. (2000) rationalized these results by stating that when a bilingual speaker named pictures in his/her weaker language, "the large activation received by its translation in the dominant language spreads to its phonological segments helping the retrieval of the target phonological units in the non-dominant language" (p.1293). The researchers suggested that an explanation for the CFE could be found within the cascade model. Within this model, the CFE occurred because the non-selected lexical items in the language that were not programmed for production also activated their phonological properties. The authors concluded that non-selected lexical items were sufficiently activated and affected processing at the segmental phonological level. In brief, the degree of the CFE is expected to be proportional to the level of activation of the non-selected lexical node. In the bilingual version of the cascade model, bilinguals hold a common conceptual store and independent lexicons (Kroll & Stewart, 1994). Within this model, a given concept is activated in both languages and the intended language is selected; however, the non-selected form also spreads some activation to its phonemes. In the case of cognates, the same phonemes are activated from two sources, resulting in reduced naming RTs.

Kohnert (2004) conducted a case study that investigated the effects of two types of clinical cognitive-linguistic intervention on a 62-year old Spanish (L1)-English (L2) bilingual male with severe non-fluent aphasia. The participant was reportedly very proficient in both languages prior to a cerebral vascular accident (CVA) that resulted in limited spontaneous productions and relatively preserved repetition. The study was conducted one-year post-onset. Treatment 1 focused on non-linguistic cognitive processing skills such as visual scanning, arithmetic, and categorization. Treatment 2 focused on lexical semantic training of cognates and non-cognate word pairs. In Treatment 1, the participant received retraining of non-verbal logical reasoning tasks (e.g. categorization, single digit addition/subtraction, visual scanning number and letter searches). Treatment took place for two months. Verbal feedback from a bilingual clinical researcher was provided in Spanish for the first month and English for the following month. Lexical-semantic skills were the primary intervention of Treatment 2 (cognate intervention). Treatment 2 was completed to investigate if treatment gains in one language could transfer to the other. If it is possible, then under what conditions is treatment most effective? Training tasks included matching written words to pictures, generating semantic descriptors of target words, and confrontation naming of target words. Target stimuli included 20 high-frequency concrete nouns. Half of the words were Spanish-English cognates (e.g., *zebra*- English; *cebra* - Spanish) and the remaining half were non-cognates (e.g., *apple*- English; *manzana* - Spanish). Pre-test results indicated that the participant named cognate stimuli with greater accuracy (40%) than non-cognates (20%). Training occurred in Spanish, however, the post-testing required the participant to complete confrontation naming tasks in both English and Spanish. As to be expected, the participant's naming in Spanish improved substantially for cognates (80%) and non-cognates (70%). One week post-treatment, the participant named stimuli in English. Interestingly, cognates were named in English with 70% accuracy and non-cognates were named with 10% accuracy. These results indicated a generalization of gains across languages only for cognate stimuli. The fact that the cognates were named with greater accuracy was thought to be due to cross-linguistic lexical-semantic links (Dijkstra, Grainger, & Van Heuven, 1999; Kohnert, 2004).

Rosselli and colleagues (2014) uncovered the CFE in a confrontation-naming task with Spanish-English bilingual speakers. The researchers investigated whether naming accuracy and naming RTs were influenced by the use of L1 or L2 of the bilingual participant. Participants included 108 neurologically-intact Spanish-English speakers and the speakers were split into two groups: balanced and non-balanced bilinguals. Balanced bilinguals demonstrated approximately equal proficiency in both languages, whereas non-balanced participants demonstrated stronger proficiency in one language. Participants were asked to name pictures in the Boston Naming Test-Second Edition (BNT) (Kaplan, Goodglass, & Weintraub, 2000) first in Spanish, then in English. The BNT was used as stimuli because approximately half of the items in the BNT are cognates. Results revealed that all participants named cognates significantly faster than non-cognates in both Spanish and English responses. The CFE was stronger in the L2 of the non-balanced participants. Authors concluded that the RTs of non-balanced bilinguals were faster because the dominant language produced stronger activation at the phoneme level, which in turn, facilitated naming in both languages. Based on these studies, the following conclusions can be made:, 1) cognates hold a unique lexical status, 2) cognates can be used to understand bilingual language access, and 3) studies that have found a robust CFE support the idea of an overlap of lexical items in a bilingual's lexicon, resulting in a stronger mapping of cognates and greater likelihood of selection.

Picture Word Interference Paradigm

Since the early 1990s, many bilingual studies have employed the picture word interference (PWI) paradigm to gather information about the time it takes a bilingual speaker to name pictures or words. PWI paradigms are one way to track the facilitation and inhibition of cognate naming. In a PWI task, a target picture and word are presented at varying times and the bilingual participant is asked to name the picture while ignoring the word (Kroll & De Groot, 2005). Distractor words are presented at different intervals (also known as stimulus onset asynchronies or SOAs) in relation to the target picture, and naming RTs can be compared to learn about activation patterns during the course of naming. A growing body of bilingual research supporting cross-language competition has been cultivated through the use of PWI paradigms (Kroll, Bobb, Misra, & Guo, 2008). These studies have shown that semantically-related distractors result in interference, whereas phonologically-related distractors lead to facilitation (La Heij, Van der Heijden, & Schreuder, 1985). Facilitation of naming results in faster RTs and inhibition of naming results in slower or more latent RTs. For example, if the semantic distractor word *lion* appeared over a picture of a TIGER, RTs would be slower compared to a phonological or unrelated distractor. This is known as the semantic interference effect. Studies have shown that if a semantic distractor appeared just before or in sync with the target picture, naming latencies increased. In contrast, if a phonological distractor *time* appeared over a picture of *TIGER,* naming facilitation occurred. Maximal facilitation occurs when the phonologically-related distractor word appears *after* the target picture rather than before it (La

Heij, Van der Heijden, & Schreuder, 1985). These results have been documented in both monolingual and bilingual word production studies (Costa et al., 1999; Hermans et al., 1998). Costa et al. (1999) used a PWI paradigm to determine that naming is facilitated when the distractor word is the direct translation of the picture. Kroll et al. (2008) raised an interesting issue regarding how bilingual participants process the distractor in PWI experiments: "If bottom-up activation of the distractor word intrudes into processing that would not otherwise occur during the planning of the picture's name, it becomes difficult to tell whether the observed effects reveal the locus of cross-language activation and language selection during speech planning or a complex interaction between the processing of the word and picture" (p.5). This observation alludes to the complex nature of PWI paradigms. Although PWI paradigms have been widely used in previous bilingual studies, their results have been difficult to interpret because both languages are involved and consequently, both lexical networks are likely activated. In those cases, participants are asked to name the picture in L1 while words are presented in their L2 Given the complexity of these variables, results are often challenging to interpret and authors have provided several alternative interpretations for results (Hermans, et al., 1998; Rosselli et al., 2014). Nonetheless, when used appropriately, PWI paradigms are a useful tool providing a great deal of information because the timing of semantic, phonological, and orthographic variables can be manipulated.

CHAPTER 2

Purpose

Numerous bilingual studies have used PWI paradigms, but because both languages were involved (e.g., participants are asked to name the picture in their first, L1, language but words are presented in their second, L2, language), results were difficult to interpret because both lexical networks would have likely been activated. While useful in tracking lexical access and retrieval processes over time, the use of multiple languages makes it difficult to interpret the findings. Because results are based on a number of different variables, the interpretation of findings produce conflicting conclusions or findings that are difficult to interpret.

The current study avoids that issue by having L1 English-L2 Spanish bilingual participants name pictures in English while ignoring distractor words that are presented in English. This study represents a departure from previous studies because participants are only responsive to English stimuli, and therefore should not consciously invoke their L2 lexical network. Thus, if evidence is found for activation of both lexicons, support for the lexical non-selective theory would be supported. Three different conditions were used in a group of 25 English-Spanish speaking adults: a strong cognate condition (STRONG), in which the pairs had a high degree of phonological-orthographic overlap (e.g. *piano* - English; *piano* - Spanish); a weak cognate condition (WEAK), in which pairs had a low degree of phonological-orthographic overlap (e.g. *flute* - English; *flauta* - Spanish), and a non-cognate condition (CONTROL) in which words had no phonological-orthographic overlap (e.g. *bear* - English; *oso* - Spanish). These pairs were presented at three different SOAs: an early SOA of -200ms (word presented 200ms before the picture was presented), a mid SOA of 0ms (word was presented simultaneously with the picture), and a late SOA of +200ms (word was presented 200ms after the picture was presented). Naming RTs were measured. Research questions included: 1) Do highly proficient L1 English- L2 Spanish bilingual speakers name cognates faster than non-cognates?; 2) Are both lexical networks (English and Spanish) active during a cognate naming task?

It was predicted that English-Spanish speakers who had a high spoken proficiency in both languages would demonstrate a definite pattern of facilitation effects when strong cognates were used relative to weak cognates. This prediction assumes that lexical activation and selection is language non-specific, and if that is the case, the presentation of a strong English cognate word should automatically and implicitly access the counterpart Spanish word. Activation of both sources will help the speaker name the picture more quickly than if weak cognate or non-cognates were to be used. It was also predicted that strong cognates would yield more robust facilitation effects than weak cognates. Again, this assumes a language non-specific selection mechanism. If this is the case, strong cognates will have stronger inter-lexical connections that have been developed and reinforced over time through use of both languages. Finally, it was predicted that words presented before the picture (SOA = -200 ms) or after the picture (SOA = +200 ms) would yield facilitation effects because the time-frame of both SOAs allow for activation of both lexical networks to occur by the time that the picture is named.

CHAPTER 3

Method

Participants

Participants included 25 (age range 18 – 41 years) neurologically-intact, highly proficient English-Spanish bilingual speakers. Participants were recruited from the University of Wisconsin-River Falls (UWRF) and Minneapolis-Saint Paul communities. Several bilingual participants consisted of students enrolled in advanced Spanish courses at the university and were paid for their participation. Inclusionary and exclusionary criteria included: 1) completion of high school or GED; 2) normal or corrected-to-normal vision; 3) adequate hearing acuity for 1:1 conversational exchanges; 4) use of English as primary language; 5) high proficiency of Spanish as a second language, as determined by self-rating questionnaire (see below); 6) no previous history of neurological- or psychiatric-based illnesses or disease, language or learning disabilities, or alcohol/substance abuse. Exclusionary criteria included no previous history of neurological or vision impairment, alcohol or drug abuse, learning disability, or attention disorder.

Since high language proficiency was crucial for this study, a standardized rating scale called the Interagency Language Roundtable (ILR) was selected as the tool to evaluate a participant's language proficiency. Participants self-rated their Spanish proficiency on the ILR in all four linguistic categories (e.g. Production, Comprehension, Reading, Writing). Individuals who rated themselves between three (Professional Working Proficiency) and five (Native or Bilingual Proficiency) in speaking, listening, reading, and writing were considered eligible to participate (see Table 1). The number of individuals who rated themselves as a 3, 4 or 5, as well as a descriptive summary of levels 3-5 is provided in Table 2.

Language history

	Spanish (L2)	
	M	*SD*
Age (in years)*	12.9	5.08
Learning L2 (in years)	10.87	6.61

*Age that participant began speaking Spanish (L2)

Second language skills*

	Spanish	
	M	*SD*
Production	3.6	0.71
Comprehension	3.76	0.67
Writing	3.68	0.63
Reading	3.52	0.65

*The second language skills scores were obtained by a questionnaire administered after the experiment. A 5-point scale called the Interagency Roundtable Scale was used.

Table 1: Participants' language background.

Language proficiency (Spanish L2)

	Production	Comprehension	Reading	Writing
Level 3 Minimum Professional Proficiency (Able to use language with sufficient structural accuracy and vocabulary to participate effectively in most formal and informal conversations on practical, social, and professional topics)	n=13	n=9	n=10	n=14
Level 4 Full Professional Proficiency (Able to use the language fluently and accurately on all levels normally pertinent to professional needs, Able to understand fully all speech with extensive and precise vocabulary, subtleties and nuances in all standard dialects on any subject relevant to professional needs within the range of his/her experience)	n=9	n=13	n=13	n=9
Level 5 Native/Bilingual Proficiency (Equivalent to that of an educated native speaker)	n=3	n=3	n=2	n=2

Table 2. Participant self-ratings of Spanish (L2) language proficiency.

To ensure that participants were not aware that this study examined bilingual lexical access patterns, participants were recruited through the following methods: researchers asked friends, family, and colleagues if they could refer anyone who meets the inclusionary and exclusionary criteria. After contact information was obtained, researchers contacted the potential participants and provided a case history questionnaire to determine eligibility. Throughout this process, there was no mention to the participants that the study required knowledge of Spanish language. After a participant was deemed eligible and participated in the study, researchers provided information about inclusionary and exclusionary criteria and the participant was asked if they were able to recruit additional participants.

Stimuli Development

A total of 72 stimuli were created for use in the PWI paradigm. The following measures were used to create the conditions. Twenty-four individuals rated cognate stimuli on a Likert Scale to ensure that no significant differences were found in familiarity or visual complexity. Orthographic similarity of the cognates was computed using the algorithm developed by Van Orden (1987) and described in Schwartz et al. study (2007). The algorithm examined graphemic similarity between cognate pairs and has been used in prior research to provide an objective measure of orthography (Van Orden, 1987). Through use of the algorithm, the cognate pairs received a score; if the score was >.70 in graphemic similarity, it was designated as having either STRONG or WEAK cognate status. Final cognate status (STRONG or WEAK) was determined by combining graphemic and phonological similarity. To obtain an objective measure of phonology, one Spanish-English bilingual female (Appendix B) recorded word pairs in a randomized list. An independent group of fifteen monolingual English speakers listened to the recording and ranked the phonological properties of the cognate and non-cognate (control) pairs on a Likert Scale from 1 to 10 (1= two words sound completely different; 10= two words sound identical). Stimuli that received a rating of 7.5-10 were assigned to the STRONG condition, 2.5-5 to the WEAK condition, and 0-1, CONTROL. On the basis of these ratings, the final list included STRONG, WEAK, and CONTROL conditions. Unrelated distractor pairs (e.g., *box – tire*) were also included in order to prevent participants from using a strategy of reading the distractor word instead of naming the picture.

Procedure

Prior to participation in the actual experiment, participants viewed a PowerPoint slideshow that provided all target pictures that were used in the PWI paradigm. The target pictures were previewed to ensure that all participants had equal familiarity with the stimuli and to allow naming to be as rapid and automatic as possible. At the start of the experiment, all participants were provided verbal and written instructions that explicitly stated, “For this section of the study, the goal is to say the name of each photo as quickly as possible while ignoring the word.” During the experiment, picture-word pairs were randomly presented on the center of a computer screen and the participant was asked to name pictures in English as quickly and accurately as possible while ignoring the words. Lists were randomized so that picture-word pairs were presented at varying SOAs. The PWI paradigm used an SOA of -200 ms, SOA of 0ms, and SOA of +200 ms. The application program, SuperLab 5 (Cedrus Corporation, 2015), presented the picture at varying SOAs and the SV-I Voice-Key (Cedrus Corporation, 2015) collected response times in milliseconds at the onset of articulation. Sessions lasted 20-30 minutes. All testing took place at the UWRF Speech, Language, and Hearing Clinic, a public library, the participant’s home or workplace. Following participation in the study, participants were asked about their perceptions regarding the purpose of the study in order to informally assess if they understood the nature of the tasks. Most participants reported that they thought the study was focused on the unrelated distractor items (e.g. *box* – *tire*). Although anecdotal, these reports confirm that participants were unaware of the nature of the study.

CHAPTER 4

Results

Naming and technical errors were eliminated from the data set. This constituted 6% of the total trials (219 errors/3600 total opportunities). Data were also trimmed by replacing outliers with the mean item RTs plus two standard deviations above the mean for each condition. Naming RTs were submitted to a 3 Cognate Type (STRONG, WEAK, CONTROL) x 3 SOA (-200 ms, 0ms, +200 ms) repeated-measures ANOVA. A significant main effect of Cognate type was obtained, $F(2,30) = 1912.015$, $p < .05$. No other significant effects were found. These results indicated that there were significant differences between cognate types. Contrasts revealed significant differences when comparing strong cognates and non-cognates as well as weak cognates and non-cognates (Table 3). Follow-up contrasts revealed that differences between early and late SOA were trending toward significance, which indicated that providing the word before the picture resulted in faster naming times.

Cognate status	**-200ms**		**0ms**		**200ms**	
	M	*SD*	*M*	*SD*	*M*	*SD*
STRONG	643.8*	30.9	730.8	25.8	798.8	66.7
WEAK	652.5*	52.8	753.3	54.3	796.3	53.6
CONTROL	671.1	41.0	751.8	29.5	780.7	33.1

Table 3. Mean and standard deviations of reaction times.
*Statistically significant values

CHAPTER 5

Discussion

The aim of the study was to examine the effects of cognates on naming RTs in a group of 25 highly proficient bilingual English-Spanish speakers and to investigate if both lexical networks were invoked during a monolingual task. Participants named picture-word pairs in a PWI paradigm and RTs were collected and analyzed. English-Spanish speakers who had a high spoken proficiency in both languages demonstrated a definite pattern of effects when cognates were named compared to non-cognates. Results indicated that English- Spanish cognates, with a strong phonological-orthographical overlap, allow for quicker naming and reactions times in English. These results are consistent with the finding of Costa et al. (2000) and Costa et al. (2005); results from both studies were consistent with the non-selective theory of lexical access. With the similarities of the stimulus in both the participants' L1 and L2, it is possible that they were activating both lexical networks to access the word. If this is the case, it could explain why follow up contrasts revealed a weaker significant effect between the WEAK and CONTROL condition compared to the effect found between the STRONG and CONTROL conditions.

During the initial stages of naming (SOA = -200ms), exposure to English words allowed picture naming to occur more quickly relative to when non-cognates were used because the time frame allowed activation of both lexical networks to occur by the time the picture was named. However, during the later stages of naming (SOA = +200ms), exposure to English words slowed picture naming relative to when non-cognates were used. There are two possible explanations for why RTs were greater for the SOA +200 ms condition. First, it is possible that participants required time to suppress one of their lexical networks. Although the presentation of the trials was randomized, in the SOA +200 ms condition, participants saw the picture, semantic activation occurred, and then the distractor word appeared. It is possible that latency occurred because the participants needed to suppress one of the two lexical networks that had been activated. Secondly, participants could have been strategic by waiting to see what word would appear after picture presentation. Since the PWI paradigm used SOAs at -200 ms, 0 ms, and +200 ms, participants saw the word before the picture or simultaneously in two-thirds of the trials (SOAs of -200 ms, 0 ms) but saw the picture before the word in only one-third of the trials (SOA +200 ms). In the SOA -200 ms and SOA 0 ms conditions, the participants' naming is "confirmed" by the distractor word since the word appears prior to picture presentation, whereas in the SOA +200 ms condition, they are presented with the picture first and might hesitate to provide a response until they can confirm their response (by waiting for the appearance of the word).

Although anecdotal, participants who reported the highest L2 language proficiency (4-5 in all linguistic areas) appeared to have activated both lexicons during the naming process. When presented with the picture of a shark, and distractor word, *bread*, two participants erroneously named "tiburon," the Spanish translation for *shark*. When presented with the same stimuli (e.g. SHARK - *bread*), another participant named "tiger." Following the experiment, the participant explained that her initial reaction to the picture was "tiburon," and knowing that response would have been in the inappropriate language, and under pressure of time, she produced "tiger" in English. The participant clearly accessed and retrieved the word in the non-response language (Spanish), suggesting that both languages were invoked even though there was no mention of use of Spanish during the experiment. Additionally, two participants produced /jɑmə/ for llama (the Spanish pronunciation). Finally, some participants produced a Spanish vowel in an English word. For example, one participant produced the initial vowel of ambulance as /a/, even though the English pronunciation is /æ/. Within the framework of cascade models, lexical non-selective access could explain these anecdotal findings. Non-selective lexical access consists of activating lexical candidates in the *unintended* language; these candidates can either be selected or inhibited. Participant responses that overtly demonstrated involvement of English and Spanish lexicons suggested that unselected lexical nodes activated phonological encoding before a single response was produced (Costa et al., 2000; Savoy & Peterson, 1998). Lastly, evidence from Peterson and Savoy (1998) suggests that one picture can result in phonological activation of multiple sources and researchers observed this process during the experiment (e.g. *tiger* for *shark*).

Some limitations need to be considered. One weakness centers on the inclusionary criteria used in the current study. More robust findings may have emerged had a more homogeneous group of individuals been chosen. As previously mentioned, speakers who self-rated 3s across linguistic areas demonstrated different response behaviors than individuals who self-rated their Spanish language proficiency as 4s-5s. Individuals who self-rated their Spanish proficiency with 4s and 5s also reported that they spoke Spanish regularly in the home or workplace and moreover, six of these participants' spouses speak Spanish as a first language. These six participants all reported that both English and Spanish are spoken in the home, but Spanish with a greater occurrence. It is hypothesized that if the language proficiency of participants were more stringent, participants with a language proficiency of 3 in all linguistic categories would have likely yielded more robust findings in cognate effect. Moreover, it is predicted that participants with greater language proficiency (4-5) and associated daily use of both English and Spanish would have yielded a smaller cognate effect, than individuals who self-rated their L2 proficiency as 3s. This is hypothesized because participants with greater L2 proficiency could have demonstrated increased patterns of inhibition from their L2.

Erroneous responses that clearly required inhibition of the speaker's L2 could be partially explained by Ivanova and Costa's (2008), findings, which concluded that bilinguals demonstrate decreased naming of cognates and non-cognates when compared to monolinguals. Specifically, this disadvantage for bilinguals was more pronounced for low-frequency words (e.g. *shark*). Researchers determined that the CFE was found more often when a bilingual was naming high-frequency cognates (e.g., *banana* - English; *banana* - Spanish) in their L2 (Costa et al., 2000; Ivanova, & Costa, 2008). Although volunteers in the present study ranked the stimuli for familiarity, they were not ranked in terms of word frequency. An interaction between low-frequency word status and cognate status could have influenced participant RTs. In future studies that examine cognate status, word frequency effects should be considered.

Results from the current study have implications for use of cognates in treatment with bilingual individuals with aphasia. Kohnert (2004) concluded that a bilingual's two languages are functionally interconnected and that knowledge of interconnected bilingual lexicons can be used to inform future studies and treatment with bilinguals with aphasia. The results of this study, in conjunction with previous studies that illustrate the CFE, lay the groundwork for trialing use of cognates as stimuli in treatment for bilingual individuals with aphasia.

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Appendix A.

Stimulus set

Condition	Picture name (English)	Distractor Word	Spanish translation
STRONG			
	ambulance	ambulance	ambulancia
	banana	banana	banana
	band	band	banda
	bomb	bomb	bomba
	bus	bus	bus
	camel	camel	camello
	cereal	cereal	cereal
	doctor	doctor	doctor
	llama	llama	llama
	piano	piano	piano
	plant	plant	planta
	radio	radio	radio
	telescope	telescope	telescopio
	television	television	television
	tomato	tomato	tomate
	unicorn	unicorn	unicornio
WEAK			
	boat	boat	bote
	circle	circle	círculo
	desert	desert	desierto
	elephant	elephant	elefante
	flute	flute	flauta
	fountain	fountain	fuente
	garden	garden	jardín
	hammock	hammock	hamaca
	hippopotamus	hippopotamus	hipopótamo
	hurricane	hurricane	huracán
	lamp	lamp	lámpara
	motorcycle	motorcycle	motocicleta
	pear	pear	pera
	penguin	penguin	pingüino
	pyramid	pyramid	pirámide
	triangle	triangle	triángulo

Appendix A (cont'd).

Stimulus set

Condition	Picture name (English)	Distractor Word	Spanish translation
CONTROL			
	ant	ant	hormiga
	bear	bear	oso
	butterfly	butterfly	mariposa
	cake	cake	pastel
	feather	feather	pluma
	ghost	ghost	fantasma
	goat	goat	cabra
	helmet	helmet	casco
	hummingbird	hummingbird	colibrí
	jellyfish	jellyfish	medusas
	king	king	rey
	pig	pig	cerdo
	skunk	skunk	mufeta
	sunflower	sunflower	girasol
	tree	tree	árbol
	wolf	wolf	lobo

Appendix B.

Phonological Reader: Language history

Bilingual English-Spanish (simultaneous acquisition)

Female, Age 20

Lived in Mexico for 4 years total (throughout childhood)

Spanish spoken in home since birth

Attended English and Spanish-speaking schools

Self-rating on ILR

Production	4	*Full Professional Proficiency*
Comprehension	4	*Full Professional Proficiency*
Writing	5	*Native-Bilingual Proficiency*
Reading	5	*Native-Bilingual Proficiency*