Phonological Facilitation Through Translation

in Tip of the Tongue Experiences

of Spanish-English Bilinguals

Micah A. Johnson

Advisor: Dr. Deborah Burke

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Introduction

Many models of bilingual language processing borrow the multilevel system that forms the foundation of monolingual models. Information is represented in four processing levels – semantic, lexical (sometimes included in the semantic level, see Node Structure Theory), and phonological (if spoken) or orthographic (if written). These systems are linked and are activated sequentially in that order during production (Dell, 1986; MacKay, 1987).

Bilingual models test and refine models of monolingual representation and processing in order to account for a bilingual system. A unique requirement, and indeed a challenge, for bilingual models is to explain how a second language is incorporated into the first language system. Most bilingual models assume that the different levels of representation, such as semantic or phonological, for the two languages are integrated. Identifying where and to what degree these representational levels interact across languages is an important step for understanding how a bilingual's production of one language (response language) can be influenced by the presence of another language not being used (nonresponse language).

Bilinguals can perform as efficiently as monolinguals in the response language without interference, or even with facilitation, from the nonresponse language. Conversely, bilinguals can also experience interference from the nonresponse language. Evidence for interfering or facilitatory interactions across the semantic or lexical**,** and phonological or orthographic levels of the bilingual's two languages has spawned an ongoing debate in bilingual research between two different models – language-nonspecific selection and language-specific selection. Both models assume that the lexicons of the two languages are integrated into a single system which, during word retrieval, spreads activation in parallel throughout the representational levels of each language. For example, not only is the target word activated but also other semantically or phonologically related words. Where the two models disagree is how the activation of nontarget words and their features influences the selection of the target word in the target language. Proponents of language-nonspecific selection explain findings of interference as a result of both languages competing for production; that is, words from either language are equal candidates for selection. Proponents of language-specific selection propose that facilitation occurs because only the words in the response language are candidates for selection and production.

The focus of the present paper is to investigate processes that allow a bilingual to select one language and not the other in hopes to shed light on the nature of the representational system in bilinguals. Specifically, I attempt to determine whether bilingual lexical access is better explained by language-nonspecific or language-specific selection at the phonological level.

Monolingual models of language processing can be divided into three main types, those that posit only forward activation, i.e. discrete processing (Levelt, 1989), those that posit cascaded forward activation (Caramazza, 1997; McClelland, 1979), and those that include cascaded forward activation and backward activation, i.e. interactive activation (Dell, 1986; MacKay, 1987). Within a multilevel system comprising semantic, lexical, and phonological or orthographic representations, the flow of activation refers to the transmission of information across the connections between representation levels. In forward activation by itself, an activated semantic level can send activation to the subsequent lexical or phonological level, but those levels cannot propagate activation backwards to the semantic level. Cascaded forward activation also precludes backpropagation but it differs in that it allows the semantic level to cascade activation down to the lexical or phonological level whether or not the semantic level has completed activation. Finally, models of interactive activation add the requirement of backpropagation such that the lexical or phonological level can send activation to the semantic level.

The node structure theory (NST) model is one of the interactive activation models that has proven to be exceptionally powerful in accounting for a variety of language phenomenon, particularly the tip of the tongue state, in monolinguals and bilinguals. For this reason, the NST model is adopted in the present report as a basis for the investigation of the bilingual representation system.

The NST model postulates downward, upward, and horizontal flow of information through the semantic level (which includes the lexical level) and phonological level (see Figure 1). The NST model includes cascaded activation with hierarchical (top-down) connections between the three levels of processing, a necessary reverse connection (top-down and bottom-up spread of priming, described as *feedback*), as well as lateral connections (left-right flow implies simultaneous right-left and vice versa) within the phonological level. These connections link processing units called nodes within the memory system which comprise each independent processing level of language production. For example, within the semantic level for the word *frisbee,* each node represents a component of that word’s meaning, such that there is a node for “are made of plastic” and a node for “are thrown” and so on. These semantic nodes connect to the phonological level, where each node represents a phonological component of *frisbee*, such that there is a node for each syllable (e.g. *fris*), for each phoneme or phoneme group (e.g. *ee* or *fr*), and for each feature of articulation (e.g. *fricative*). All nodes interact within and across processing levels via two proposed mechanisms, *activation* and *priming*. Activation of a given node necessitates the conscious retrieval of its information and is "all-or-none" (p. 543), in other words, a node is either fully activated or not at all. Activation relies on special *sequence nodes* that connect with every node in a level and connect with every sequence node in higher and lower levels. On the other hand, priming prepares a node for activation. When a node becomes activated, it primes all connected nodes (even across levels) for possible activation. The node that receives the most priming reaches threshold and thus activation first.

Figure 1: Node Structure Theory model (copied from Burke et al., 1991)

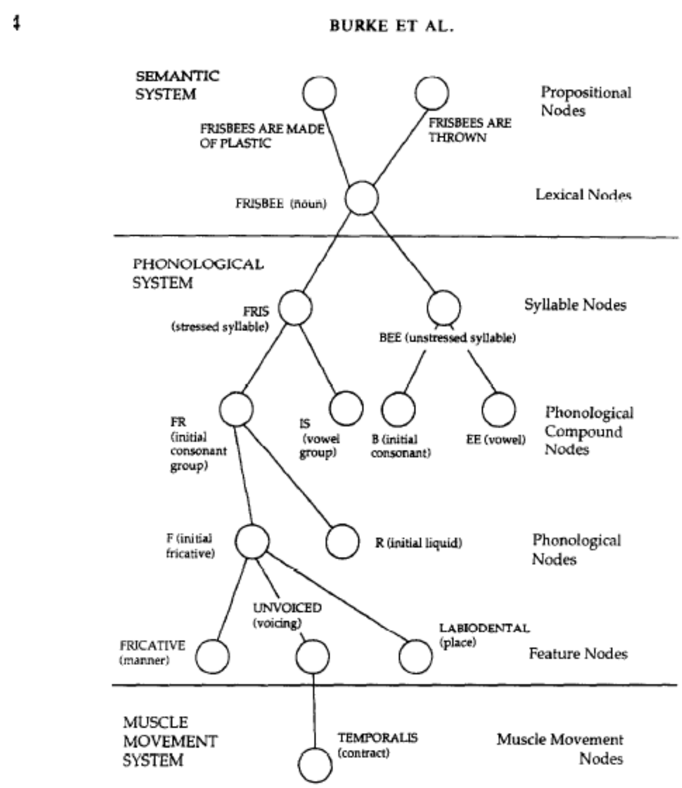


FIG. 1. Nodes representing *frisbee* in the semantic, phonological, and muscle movement systems. Many nodes necessary for producing this word have been left out to simplify the figure.

The NST model's application to word retrieval failures, such as the tip of the tongue (TOT) state, demonstrates the model's power. The TOT state refers to "a dramatic instance of retrieval failure in which one is unable to produce a word although absolutely certain that the word is known" (Rastle & Burke, 1996, p.586). A person suffering a TOT can report the semantic information of the word at large but they struggle to access the word's full phonology necessary for articulation (Burke, MacKay, Worthley, & Wade, 1991). Regardless, the person can typically report partial knowledge of the word's phonology or orthography, such as initial or final phonemes or letters, number of syllables, and stress pattern (Brown, 1991; Brown & McNeill, 1966; Burke et al., 1991; Kohn et al., 1987; Koriat & Lieblich, 1974). Another characteristic of TOTs is that people often report *persistent alternates* (Burke et al., 1991), alternatively called *blockers* (Reason & Lucas, 1984) or *interlopers* (Jones, 1989), which are words semantically, grammatically, or phonologically related to the target word.

Several models have proposed to explain the TOT state (for a review see Gollan & Acenas, 2004), and perhaps the most influential has been the Transmission Deficit (TD) hypothesis, formulated within the NST model. The TD hypothesis explains the evidence of asymmetry of semantic and phonological access in a TOT as a consequence of insufficient transmission of activation from the semantic level to the phonological, in other words a weak connection among semantic and phonological nodes, such that only some of the phonological nodes receive enough priming of activation for retrieval. The phonological level is the proposed locus of TOTs specifically because it contains one-to-one connections that seem most vulnerable to deficits. The TD hypothesis proposes that TOTs can be resolved by additional phonological sources priming the full activation of the target word's phonology; indeed, this has been demonstrated in a variety of priming studies (James & Burke, 2000; Rastle & Burke, 1996; White & Abrams, 2002).

For instance, imagine a person who, while having a TOT for the word *chastity*, reports the persistent alternate word *charity*, thereby also reporting the partial phonological components *ch* and *ity* (see Burke et al., 1991, p.548). Under the NST and TD, the TOT for *chastity* resulted from some of its phonological nodes receiving insufficient top-down priming from the semantic system to be activated (e.g. *as*), whereas others received sufficient priming and thus activated (e.g. *ch* and *ity*). The activated phonological nodes in turn send bottom-up priming to all lexical and semantic nodes which share those phonological nodes. The transmission deficit of *chastity* prevents its full activation and retrieval, whereas the superior priming and activation of *charity* results in its retrieval as a persistent alternate (despite the person knowing that is not the target word).

To assist recovery of *chastity*, the person performs a priming task that includes crucial words like *mastery* or *chasm* which share target phonological components that are underprimed. The additional right-left phonological priming boosts the activation of *as*, thereby removing the transmission deficit for *chastity* and sending feedback to the lexical level, enabling the correct semantic representation to be retrieved and articulated. This example demonstrates priming and activation occurring across forward (cascaded activation) and backward (feedback) connections. It has been noted that only the NST model can account for TOT resolution (Gollan & Acenas, 2004; Muscalu, 2007).

Evidence of TOTs and the ability to prime their resolution clearly supports the mechanisms proposed by the NST model. Further evidence from studies on monolingual language production, cognitive skills, attention, memory, and aging converge in the validation of NST as a reliable and accurate model of monolingual language processing (MacKay, 1987; MacKay & Burke, 1990). Can the NST model accommodate the complexity of bilingual language processing? Important evidence supporting this possibility comes from research on cognates and the facilitatory effect they have on bilingual production (Costa, Caramazza, & Sebastián-Gallés, 2000; Gollan & Acenas, 2004). Cognates are “translation equivalents” (Gollan & Acenas, 2004) that phonologically or orthographically (depending on scripts) resemble each other. Noncognates are simply translation equivalents that have no phonological or orthographic similarity (e.g. the Spanish word for *dog* is *perro*). The middle ground of translation equivalents are “false cognates” (Lalor & Kirsner, 2001), which resemble each other in form but not in meaning (e.g. the Spanish word for *deception* is *engaño* not *decepción*, which means *disappointment*).

Gollan and Acenas (2004) used cognates to test the predictions of the TD hypothesis that insufficient priming of phonological nodes causes TOTs and that additional priming of those nodes from other sources can resolve TOTs. English-Spanish and Tagalog-English bilinguals attempted to name target pictures of objects, some of which were cognates and some of which were noncognates. The crucial result was that for the cognate targets, bilinguals showed just as few TOTs as the monolinguals. This was a completely novel discovery, for bilinguals had always been known to experience more TOTs than monolinguals (Gollan & Silverberg, 2001). Gollan and Acenas (2004) interpreted this result as confirming the TD hypothesis, “the only existing TOT account that predicted cognate facilitation effects” (p.262).

The cognate effect on TOTs bolsters the TD hypothesis, and thus the bilingual applicability of the NST model, by showing that priming of the phonological nodes reduces transmission deficit across the phonological connections, thereby helping to prevent TOTs. Phonological nodes that are shared in cognates should be stronger than the phonological nodes of noncognates because they are activated more frequently when used in either language. Furthermore, because the cognate effect suggests the sharing of phonological nodes, it suggests that these representations are integrated between the two languages of a bilingual.

As demonstrated above, the NST model provides a useful framework for language representation and processes in bilingualism. Building off of interactive activation models like the NST, bilingual models generally assume that each language comprises a hierarchical organization of four representational levels (semantic, lexical, phonological, and orthographic). Most bilingual models also assume, given ample evidence (see review in Kroll & Tokowicz, 2005), that these levels are integrated across languages.

Where bilingual models differ, however, is how they account for lexical selection. Selection is assumed to be required for language production, monolingual or bilingual, because not only the target word but other words, semantically or phonologically related to the target word, are activated (Costa, Miozzo, & Caramazza, 1999). There are two main models that explain how the activation of nontarget words and their features influences the selection of the target word in the target language. The language-nonspecific model postulates that all activated words, target or nontarget, and their activated feature nodes are candidates for selection. Accordingly, activated nodes in the nonresponse language compete with the selection of words in the response language.

Evidence for this model typically comes from studies demonstrating that the nonresponse language interferes with the response language (Duyck, Assche, Drieghe, & Hartsuiker, 2007; Hermans et al., 1998; for review see Kroll, Bobb, Misra, & Guo, 2008). On the other side, the language-specific model proposes that only activated target nodes are candidates for selection, such that activated nontarget nodes do not compete for selection and can only facilitate the selection of target nodes. This model relies on studies showing that production of the response language is facilitated by the nonresponse language (Christoffels, Firk, & Schiller, 2007; Costa & Caramazza, 1999; Gerard & Scarborough, 1989).

Empirical investigation of language-specific or language-nonspecific selection has generated vast evidence for either facilitation or interference at all levels of bilingual representation. To report and critique these findings and their importance for the debate would go well beyond the scope of the present paper. Here instead the debate is discussed with a specific focus at the phonological level of representation.

Bilingual experiments often utilize the picture-word interference task, which requires participants to name pictures in one language while ignoring superimposed distractor words in the second language. Manipulating the relation of the distractor word to the picture name allows investigation of the nonresponse language's influence of the response language at an automatic level (i.e. without the participant's awareness). One phonological variation of the task, which can be called the through translation effect (Knupsky & Amrhein, 2007), involves the phonological relation of the distractor's translation to the picture name. A search through the literature revealed that only three studies have used the through translation effect to determine whether bilingual production involves language-specific or language-nonspecific selection (Costa et al.,1999; Hermans, 2004; Knupsky & Amrhein, 2007). These studies are reported below.

In two experiments, Costa et al. (1999) tried to find a through translation effect on the time it took bilinguals to name pictures (i.e. naming latency). The first experiment required Catalan-Spanish bilinguals (first language (L1) Catalan, second language (L2) Spanish) to name in pictures (e.g. L1: *baldufa*) whose distractors (e.g. L2 *pelea*) were phonologically related to the picture via translation (e.g. L1 *baralla*). In the second experiment, different Catalan-Spanish bilinguals named pictures (e.g. L1: *baldufa*) whose distractors (e.g. L1: *fang*) were phonologically related to the picture via translation (e.g. L2: *barro*). Both experimental conditions were compared to a control condition where the distractor's translation was not phonologically related to the target picture. Costa et al. (1999) did not find a phonological facilitation through translation, in other words, naming latencies of the through translation condition did not decrease relative to the control condition. They concluded that "a distractor's lexical node does not activate its corresponding segmental [phonological] features (or if it does so the activation is too weak to lead to facilitation effects)" (p.383). This study provided evidence that bilingual production is language-nonspecific in selection of words.

Hermans (2004) suspected that Costa et al. (1999) did not find a through translation effect because the distractors needed stronger activation to prime their corresponding translations. Hermans (2004) predicted that choosing distractors that were also the names of other pictures would be sufficient to strengthen the translation activation and thus enable the effect. The results confirmed this prediction: Dutch-English bilinguals could name pictures in their L2 English faster when the L1 Dutch distractors were names of other pictures and whose L2 English translations were phonologically related to the L2 English picture. Thus, this study seemed to provide evidence that bilingual production is language-specific in selection of words.

In one of the experimental set-ups of their study, Knupsky and Amrhein (2007) conducted the most recent replication of the through translation effect found by Hermans (2004). Their methodology was based on some important revisions to the previous studies. First, they suspected that the reason why Costa et al. (1999) did not find the through translation effect but Hermans (2004) did could be due to response language; thus, they included naming in both L1 and L2. Second, they were interested in determining whether TTF could occur even if the distractors of the target names were not also other names. This approach would prevent a practice effect, "given that repetition of stimuli may artificially decrease picture-naming times overall" (Knupsky & Amrhein, 2007). Measuring naming latency, Knupsky and Amrhein (2007) instructed Spanish-English bilinguals to name pictures either in L1 or L2 while trying to ignore superimposed distractors. Some of the distractors were unrelated phonologically to the target names (GUN/*miel*), some were directly related phonologically (CARROT/*carta*), and some were phonologically related *through translation* (LADDER/*risa* [trans: laughter]).

The result was that reaction times were slowest for unrelated, much faster for through translation, and fastest for directly related. This means that participants produced the answer more quickly if facilitated with phonological priming, especially if the priming was direct but even if it was indirect through translation. Another result was that the phonological priming through translation was sensitive to which language used, in that the effect was greater for L2 naming than for L1 naming. Thus, Knupsky and Amrhein (2007) significantly demonstrated that the through translation effect can occur in either language and is not dependent on the practice effect of distractors which Hermans (2004) used. And importantly, their results of a facilitatory effect at the phonological level are also in favor of the language-specific selection model.

To sum, the three studies on the through translation effect provide mixed results that are difficult to interpret with respect to the debate on bilingual language selection. Costa et al. (1999) did not find a facilitatory effect and so argued for support of language-nonspecific selection. The fact that Hermans (2004) found the effect would suggest evidence for language-specific selection; however, the probable presence of a practice effect in the study's design calls the verity of the effect into question. Finally, Knupsky and Amrhein (2007) found the effect and argued for support of language-specific selection. Thus, although it appears that the through translation effect has the potential to identify a phonological contribution towards bilingual language selection, no definite conclusions should yet be reached until further replication.

One of the goals of the present study is to replicate the through translation effect by measuring TOTs instead of reaction times. An interesting statement by Knupsky and Amrhein (2007) provided the motivation for this modification: "A delay of the lexical selection process would provide a window of opportunity for the feedback of activation from translation equivalents. In such cases, the generation of translation-mediated phonological effects would be more likely" (p. 221). Since the TOT state is a massive delay of lexical selection, it would be interesting to observe whether the through translation effect might be more salient in this condition.

With this experimental manipulation, another goal of the present study is to answer an important theoretical question concerning research on bilingualism and the tip of the tongue (TOT) state. Can activation of the nonresponse language facilitate a bilingual's production of the response language by reducing the occurrence of TOTs and thus improving word retrieval? Regarding bilingual research, the question addresses the ongoing debate between language-specific and language-nonspecific selection. Regarding TOT research, the possibility of facilitatory interaction between the nonresponse language and the response language provides an avenue to assay the applicability of the transmission deficit model for bilingual TOTs, and thus for bilingual word retrieval in general. According to the TD model, weakened connections at the phonological level are the cause of TOTs; strengthening these connections, via phonological priming, should therefore facilitate word retrieval and help prevent TOTs.

In the present within-subjects study which uses the through translation version of the picture-word interference task, Spanish-English bilinguals attempted to name pictures in English (e.g. *hopscotch*) while ignoring superimposed Spanish distractor words (e.g. *caliente*) whose English translations were either phonologically related (primed condition; e.g. *hot*) to the picture's name or not related (unprimed condition). Two hypotheses were made, in accordance with language-specific selection and the transmission deficit model. First and foremost, it was predicted that the participants would have fewer TOTs in the primed condition than in the unprimed condition, due to through translation facilitation of phonological priming. Decreased occurrence of TOTs from phonological priming, according to the TD model, implies increased activation of the target word's phonological nodes, which in turn implies increased ability to retrieve the target word. Therefore, contingent on the first hypothesis, the second hypothesis predicted that participants will produce more know responses in the primed condition than in the unprimed condition.

Method

Participants

Participants were 18 Spanish-English bilinguals (M age = 20.5) who received monetary compensation. Originally, 28 participants were tested, but it was necessary to exclude 10 of them from the final analysis (see Results); thus, only the remaining 18 participants are reported here. The 18 participants were native speakers of Spanish (L1) who learned English (L2) as a second language at a young age (M age = 4.3). Self-reported fluency on a 5-point Likert scale showed a mean of 4.61 for Spanish and a mean of 4.9 for English, thus indicating that this group of bilinguals was highly proficient. Self-reported nationalities indicated that 8 were Mexican-American, 5 were Mexican, 1 was Dominican, 1 was Dominican-American, 1 was Guatemalan, 1 was Argentine, and 1 was Mexican-Nicaraguan-American.

Materials

The present experiment used a picture-word interference design, which required three corresponding lists to be created: 1) target names (L2 English); 2) distractor words (L1 Spanish), each one superimposed on its corresponding picture; and 3) translations (L2 English) of distractors. The target list comprised 100 total picture stimuli – 50 drawings of objects, and 50 photos of famous celebrities. These stimuli were selected from Dr. Deborah Burke's (Pomona College) research database of stimuli found to be particularly susceptible to TOTs. The stimuli were visually presented one at a time in random order on a computer screen using Microsoft PowerPoint. Answers were recorded on Microsoft Excel.

The crucial condition for the priming effect in the TTF paradigm was a phonological similarity between the distractor's translation and the name of the picture. Fifty of the stimuli fit this primed condition; the other fifty were phonologically unrelated (unprimed condition). Stimuli in both conditions were counterbalanced across two versions of presentation. In the first version, 50 stimuli were primed and the other 50 were unprimed. In the second version, these stimuli sets reversed condition.

Phonological similarity was defined as the sharing of at least the first two phonemes (e.g. *hot-hopscotch).* The Oxford English Dictionary's IPA pronunciation key was used to ensure exactness in phonological match (Rollin, Carvajal, & Horwood, 2009). To avoid semantic priming effects (see Muscalu, 2007), each distractor and its translation was carefully selected to have no (obvious) semantic relation to the corresponding target picture. Another parameter of the stimuli was that distractors (and their translations) were in different syntactical categories than the corresponding targets, because it is known that syntactical similarity can constrain TOT resolution (Abrams, Trunk, & Merrill, 2007). To avoid interfering effects of word frequency (Rastle & Burke, 1996), Spanish and English word frequencies were matched using databases from Kucera and Francis (1967) and Sebastián-Gallés (2000). An independent samples t-test ($p<.05$) ensured that Spanish distractors in the TTF condition ($M=152$) were no more frequent than the Spanish distractors in the control condition ($M=141$), and another t-test ($p<.05$)

ensured that the English distractor-translations in the primed condition (M=253) were no more frequent than those in the unprimed condition (M=265).

Procedure

After signing the consent form, participants were assigned by coin-toss to one of the two versions of stimuli presentation. Task instructions were then presented on the first slide. Participants were instructed to attempt to name the pictures in English as quickly and accurately as possible while ignoring the superimposed distractors. For each picture, participants were instructed to report one out of three possible responses: know, don't know, or TOT. The description of a TOT was presented as "the agitating state of mind where you know for certain that you know the name, and it is on the verge of coming to mind, but you cannot quite articulate it". All participants reported familiarity with the experience of TOTs. Every time a participant provided a know response that was incorrect, they were instructed to try again or report it as don't know. Every time they responded TOT, they were given the answer and asked if it was what they had in mind – if it was not, the answer was recorded as an incorrect TOT.

After responding to all pictures, each participant was asked if during the experiment they noticed any relation between the target-distractor pairs. If they did not, this indicated that any facilitation effect was automatic and not operating on a conscious level (Knupsky & Amrhein, 2007). After this check, they were asked to translate all the distractors they saw, in order to demonstrate that the possibility of accessing the translation of the TTF distractors was indeed present (Knupsky & Amrhein, 2007). This was followed by a debriefing and monetary compensation.

Results

There are two fundamental criteria of the through translation facilitation effect. The first is that the participant must be able to correctly translate the Spanish distractor word into English in order to ensure that the phonological priming was accessible. If their translation did not match up with the translation predetermined by the experimenter, then that stimulus item was termed a Throw Out and was removed from the individual data set. For the present study, it was determined that eight or more incorrect translations in either the primed or unprimed condition would preclude that participant from the data analysis. Eight participants were excluded for this reason (even though the statistical results were found to be roughly the same with or without their inclusion). The second criterion is that the participant must not notice the phonological similarity between the target word and the distractor's translation in order to ensure that the priming effect occurred automatically. Two participants noticed the phonological manipulation and so were excluded from the data set. In total, ten out of twenty-eight participants were excluded from the present study, resulting in a final data analysis of eighteen participants' responses.

TOT responses were recorded on 7.9% of all trials, producing a total of 142 TOTs. Table 1 shows the mean numbers of TOT, Know, and Don't Know responses, as well as mean number of Incorrect TOT and Throw Outs, for each stimulus condition. Table 2 and Figure 2 show the mean proportions of TOT, Know, and Don't Know responses. Proportions for each response were obtained from dividing the absolute number by the remainder of 50 (number of stimuli in each condition) minus number of Throw Outs.

Table 1
Mean number of TOT, Know, Don't Know, Incorrect TOT, and Throw Out by condition

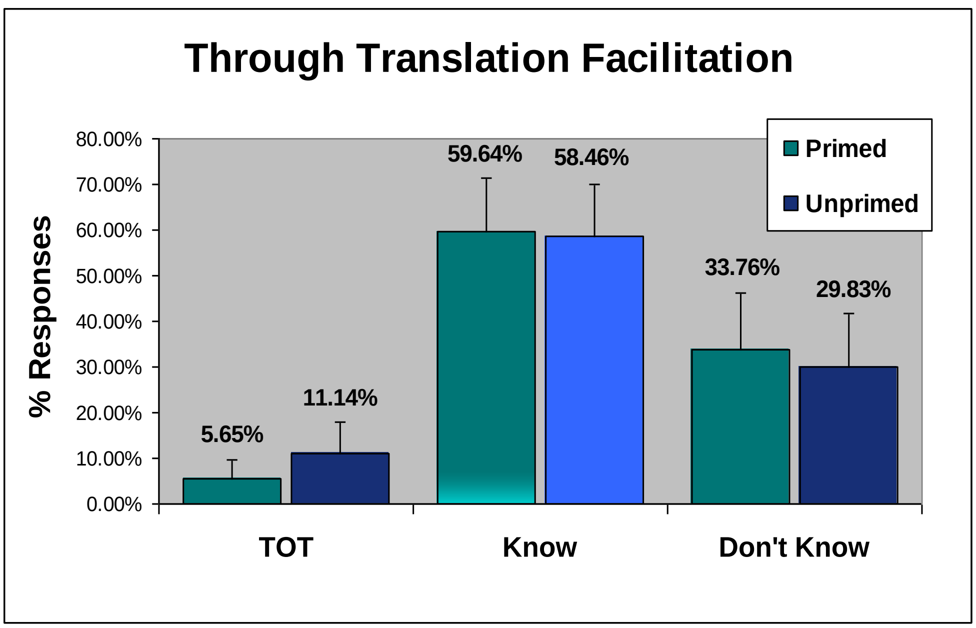
	TOT	KNOW	DON'T KNOW	INCORRECT TOT	THROW OUTS	TOTALS
PRIMED	2.61	27.61	15.67	.44	3.67	50
UNPRIMED	5.28	27.78	14.17	.33	2.50	50

Table 2
Proportion of TOT, Know, and Don't Know responses by condition

	TOT	KNOW	DON'T KNOW
PRIMED	5.65%	59.64%	33.76%
UNPRIMED	11.14%	58.46%	29.83%

A paired-samples t-test was conducted separately for the proportions of TOT, Know, and Don't Know responses. Because three hypotheses were tested on the same data set, the Bonferroni method was used to correct the significance level from $p < .05$ to $p < .017$. The main finding was that participants reported nearly twice as many TOTs for unprimed stimuli (11.14%) than for primed stimuli (5.65%). This result was highly significant ($p = .0005$). A Wilcoxon Signed Ranks Test indicated that 15 out of the 18 participants showed this trend ($Z = -3.027$, $P = .001$). The second finding was a slight trend of increased know responses for primed stimuli (59.64%) compared to unprimed stimuli (58.46%), but this difference was not statistically significant (p = .33). A Wilcoxon Signed Ranks Test indicated that 8 out of the18 participants showed this trend, which was not significant (Z = -.327, P = .372). The final finding was a slight trend of increased don't know responses for primed stimuli (33.76%) compared to unprimed stimuli (29.83%), but this difference was only marginally significant (p = .03). A Wilcoxon Signed Ranks Test also indicated that this trend, observed in 12 out of the 18 participants, was marginally significant (Z = -1.982, P = .024).

Figure 2



Discussion

The primary goal of the present study was to demonstrate that phonological facilitation through translation in a picture-word interference task measuring TOTs can provide evidence for language-specific selection and can be explained by the transmission deficit model of TOTs. The results of the experiment partially satisfy this goal. The primary hypothesis was confirmed: participants reported almost half the percentage of TOTs in the primed condition than in the unprimed condition ($p = .0005$). The fact that this trend was evident in 15 out of 18 participants indicates a robust effect. This finding supports language-specific selection, by showing that activation of the nonresponse language facilitated selection in the response language, as well as the TD model, by showing that the through translation phonological priming strengthened connections in the target word's phonology.

However, the second hypothesis, which was contingent on the first, was not confirmed. Although there was a slight trend for an increased percentage of know responses in the primed condition compared to the unprimed condition, this trend was not significant ($p = .33$). Moreover, there appeared an unexpected, although marginally significant ($p = .03$), trend for an increased percentage of don't know responses in the primed condition compared to the unprimed condition. These findings do not support either language-specific selection or the TD model, since no facilitation of phonological priming from the nonresponse on successful retrieval of the response language was observed.

These mixed results are difficult to interpret with respect to the theoretical motivations. How could it be possible for phonological priming to concomitantly improve word retrieval, by reducing TOTs, and impair word retrieval, by increasing don't know responses? Before discussing potential explanations, it is important to note that, until more participants are tested, only tentative conclusions can be drawn from the data. On the one hand, the small subject group ($n = 18$) was sufficient to show that phonological facilitation through translation had a robust effect on TOTs. Indeed, the fact that this trend was observed in almost all the participants, 15 out of 18, suggests that it would remain resilient with further testing. On the other hand, further testing will be necessary to disambiguate the marginally significant trend of increased don't know responses for the primed condition compared to the unprimed condition.

One potential explanation for the mixed results could be that the phonological priming did not actually strengthen the phonological connections, as the TD model predicts. Rather, it would suggest that the phonological priming prevented TOTs by causing interference between these connections, thereby hindering correct retrieval. This hypothesis would be in line with the account of language-nonspecific selection, which predicts interference from the nonresponse language on naming in the response language (source). However, this explanation seems unlikely. According to the TD model, just as phonological facilitation should decrease TOTs and increase correct retrieval, interference at the phonological level should increase TOTs and decrease correct retrieval.

Another potential explanation could be an inadvertent influence of stimuli differences between the primed and unprimed condition. Previous studies have identified a variety of lexical factors which, if not controlled for, could produce an interference effect of the phonological prime on the target word: examples are grammatical class similarity (Abrams et al., 2007), semantic similarity (Costa, Alario, & Caramazza, 2005; Costa & Caramazza, 1999), orthographic similarity (Muscalu, 2007), and word frequency (Rastle & Burke, 1996). The present study explicitly identified and precluded each of these potential confounds from stimulus preparation by ensuring that the only difference between the primed and unprimed condition was the critical overlap of phonology between the picture names and the distractor's translations. Two other methodological designs, counterbalanced stimuli and random order of presentation, were used to further prevent any possible materials effects.

Despite the methodological precautions, follow-up paired-samples t-tests of response types showed conflicting results for the different versions. Overall, the data from the second version completely supports both hypotheses of the present study. Proportion of TOTs was significantly smaller ($p = .0007$) for primed stimuli (4.93%) than for unprimed stimuli (13.54%). Contingently, proportion of know responses was significantly larger ($p = .01$) for primed stimuli (64.67%) than for unprimed stimuli (56.23%), while there was no statistical difference between don't know proportions ($p = .95$). The data from the first version are much messier and suggest a strong skewing of the combined analysis. Proportion of TOTs was only marginally significantly smaller ($p = .08$) for primed (6.36%) versus unprimed (8.74%) conditions. Proportions of know responses between primed (54.61%) and unprimed (60.69%) conditions showed a significant trend ($p = .04$) opposite the expected direction, and so did the proportions of don't know responses between primed (37.60%) and unprimed (29.65%) conditions ($p = .003$).

Instead of methodological limitations, perhaps the discrepancy between versions could be due to chance differences between the participants who viewed different versions of the stimuli. However, in the present study no statistically significant differences emerged in the participants' self-reported measures of English or Spanish fluency, age of English (L2) acquisition, home language while growing up, or weekly use of either language. Alternatively, it is possible that the participants who viewed the first version happened to have lower vocabulary than those who viewed the second version. This might account for their increased don't know responses in the first version. However, the present study did not assess participants' vocabulary; therefore this possibility remains an open question.

References

Abrams, L. (2008). Tip-of-the-tongue states yield language insights. *American Scientist, 96,* 234-239.

Abrams, L., Trunk, D. L., & Merrill, L.A. (2007). Why a superman cannot help a tsunami: Activation of grammatical class influences resolution of young and older adults' tip-of-the-tongue states. *Psychology and Aging, 22*, 835-845.

Abutalebi, J., Annoni, J., Zimine, I., Pegna, A., Seghier, M., Lee-Jahnke, H., et al. (2008). Language control and lexical competition in bilinguals: An event-related FMRI study. *Cerebral Cortex, 18*(7), 1496-1505. doi:10.1093/cercor/bhm182.

Biedermann, B., Ruh, N., Nickels, L., & Coltheart, M. (2008). Information retrieval in tip of the tongue states: New data and methodological advances. *Journal of Psycholinguistic Research*, *37*(3), 171-198. doi:10.1007/s10936-007-9065-8.

Brown, A. (1991). The tip of the tongue: A review and evaluation. *Psychological Bulletin, 10*, 204-223.

Brown, R., & McNeill, D. (1966). The "tip of the tongue" phenomenon. *Journal of Verbal Learning Behavior, 5,* 325-337.

Burke, D. M., Locantore, J., Austin, A., & Chae, B. (2004). Cherry pit primes Brad Pitt: Homophone priming effects on young and older adults' production of proper names. *Psychological Science, 15,* 164-170.

Burke, D., MacKay, D., Worthley, J., & Wade, E. (1991). On the tip of the tongue: What causes word finding failures in young and older adults? *Journal of Memory and Language, 30*, 542-579.

Burke, D. M., & Yee, P. L. (1984). Semantic priming during sentence processing by young and older adults. *Developmental Psychology, 20*, 903-910.

Caramazza, A. (1997). How many levels of processing are there in lexical access? *Cognitive Neuropsychology*, *14*(1), 177-208.

Chen, H., & Ho, C. (1986). Development of Stroop interference in Chinese-English bilinguals. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *12*(3), 397-401.

Christoffels, I. K., Firk, C., & Schiller, N. O. (2007). Bilingual language control: An event-related brain potential study. *Brain Research*, *1147*, 192-208.

Costa, A., Alario, F., & Caramazza, A. (2005). On the categorical nature of the semantic interference effect in the picture-word interference paradigm. *Psychonomic Bulletin & Review*, *12*(1), 125-131. Retrieved from PsycINFO database.

Costa, A., Albareda, B., & Santesteban, M. (2008). Assessing the presence of lexical competition across languages: Evidence from the Stroop task. *Bilingualism: Language and Cognition*, *11*(1), 121-131. doi:10.1017/S1366728907003252.

Costa, A. & Caramazza, A. (1999). Is lexical selection in bilingual speech production language-specific? Further evidence from Spanish-English and English-Spanish bilinguals. *Bilingualism: Language and Cognition 2, 3,* 231-244.

Costa, A., Caramazza, A., & Sebastian-Galles, N. (2000). The cognate facilitation effect: Implications for models of lexical access. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *26*(5), 1283-1296. doi:10.1037/0278 7393.26.5.1283.

Costa, A., Colomé, A., Gómez, O., & Sebastián-Gallés, N. (2003). Another look at cross language competition in bilingual speech production: Lexical and phonological factors. *Bilingualism: Language and Cognition, 6*(3), 167-179.

Costa, A., Miozzo, M., & Caramazza, A. (1999). Lexical selection in bilinguals: Do words in the bilingual's two lexicons compete for selection? *Journal of Memory and Language, 41*, 365-397.

Costa, A., & Sebastian-Gallés, N. (1998). Abstract phonological structure in language production: Evidence from Spanish. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *24*(4), 886-903. doi:10.1037/0278 7393.24.4.886.

Damian, M., & Bowers, J. (2003). Effects of orthography on speech production in a form-preparation paradigm. *Journal of Memory and Language*, *49*(1), 119-132. doi:10.1016/S0749-596X(03)00008-1.

Dell, G. (1986). A spreading-activation theory of retrieval in sentence production. *Psychological Review*, *93*(3), 283-321. doi:10.1037/0033-295X.93.3.283.

Durgunoglu, A., & Roediger, H. (1987). Test differences in accessing bilingual memory. *Journal of Memory and Language*, *26*(4), 377-391.

Duyck, W., Assche, E., Drieghe, D., & Hartsuiker, R. (2007). Visual word recognition by bilinguals in a sentence context: Evidence for nonselective lexical access. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 33 (4),* 663-679.

Dyer, F. (1971). Color-naming interference in monolinguals and bilinguals. *Journal of Verbal Learning & Verbal Behavior*, *10*(3), 297-302.

Forster, K., & Jiang, N. (2001). The Nature of the Bilingual Lexicon: Experiments with the Masked Priming Paradigm. *One mind, two languages: Bilingual language processing* (pp. 72-83). Malden: Blackwell Publishing.

Gerard, L., & Scarborough, D. (1989). Language-specific lexical access of homographs by bilinguals. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 15*(2), 305-315. doi:10.1037/0278-7393.15.2.305.

Glanzer, M., & Duarte, A. (1971). Repetition between and within languages in free recall. *Journal of Verbal Learning & Verbal Behavior*, *10*(6), 625-630.

Goggin, J., & Wickens, D. (1971). Proactive interference and language change in short-term memory. *Journal of Verbal Learning & Verbal Behavior, 10*(4), 453-458.

Gollan, T. & Acenas, L. (2004). What is a TOT? Cognate and translation effects on tip of-the-tongue states in Spanish-English and Tagalog-English bilinguals. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 30*, 246-269.

Gollan, T., & Kroll, J. (2001). Bilingual lexical access. *The handbook of cognitive neuropsychology: What deficits reveal about the human mind* (pp. 321-345). New York, NY US: Psychology Press. Retrieved from PsycINFO database.

Gollan, T., Montoya, R., & Bonanni, M. (2005). Proper Names Get Stuck on Bilingual and Monolingual Speakers' Tip of the Tongue Equally Often. *Neuropsychology*, *19*(3), 278-287. doi:10.1037/0894-4105.19.3.278.

Gollan, T. & Silverberg, N. (2001). Tip-of-the-tongue states in Hebrew-English bilinguals. *Bilingualism: Language and Cognition, 4*, 63-84.

Guo, T., & Peng, D. (2006). Event-related potential evidence for parallel activation of two languages in bilingual speech production. *Neuroreport: An International Journal for the Rapid Communication of Research in Neuroscience*, *17*(17), 1757-

1760.

Hermans, D. (2004). Between-language identity effects in picture-word interference tasks: A challenge for language-nonspecific or language-specific models of lexical access? *International Journal of Bilingualism*, *8,* 115-125.

Hermans, D., Bongaerts, T., De Bot, K., & Schreuder, R. (1998). Producing words in a foreign language: Can speakers prevent interference from their first language? *Bilingualism: Language and Cognition*, *1*(3), 213-229.

Hernandez, A. E., Dapretto, M., Mazziotta, J., & Bookheimer, S. (2001). Language switching and language representation in Spanish-English bilinguals: An fMRI study. *Neuroimage, 14,* 510-520.

Hernandez, A., Li, P., & MacWhinney, B. (2005). The emergence of competing modules in bilingualism. *Trends in Cognitive Sciences*, *9*(5), 220-225. doi:10.1016/j.tics.2005.03.003.

Hernandez, A. E., Martinez, A., & Kohnert, K. (2000). IN search of the language switch: An fMRI study of picture naming in Spanish-English bilinguals. *Brain and Language, 3,* 421-431.

Hoshino, N., & Kroll, J. (2008). Cognate effects in picture naming: Does cross-language activation survive a change of script?. *Cognition*, *106*(1), 501-511. doi:10.1016/j.cognition.2007.02.001.

Illes, J., Francis, W., Desmond, J., Gabrieli, J., Glover, G., Poldrack, R., et al. (1999). Convergent cortical representation of semantic processing in bilinguals. *Brain and Language*, *70*(3), 347-363.

James, L. E. & Burke, D. M. (2000). Phonological priming effects on word retrieval and tip-of-the-tongue experiences in young and older adults. *Journal of Experimental Psychology, 26,* 1378-1391.

Jones, G. (1989). Back to Woodworth: Role of interlopers in the tip-of-the-tongue phenomenon. *Memory & Cognition*, *17*(1), 69-76. Retrieved from PsycINFO database.

Knupsky, A. C. & Amrhein, P. C. (2007). Phonological facilitation through translation in a bilingual picture-naming task. *Bilingualism: Language and Cognition 10, 3,* 211-223.

Kohn, S., Wingfield, A., Menn, L., Goodglass, H., Berko Gleason, J., & Hyde, M. (1987). Lexical retrieval: The tip-of-the-tongue phenomenon. *Applied Psycholinguistics, 8,* 245-266.

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

Koriat, A., & Lieblich, L. (1974). What does a person in a “TOT” state know that a person in a “don’t know” state doesn’t know? *Memory & Cognition, 2,* 647-655.

Kroll, J., Bobb, S., Misra, M., & Guo, T. (2008). Language selection in bilingual speech: Evidence for inhibitory processes. *Acta Psychologica, 128,* 416-430.

Kroll, J., & De Groot, A. M. B. (Ed.). (2005). *Handbook of Bilingualism.* New-York: Oxford University Press.

Kroll, J., Sumutka, B. M., & Schwartz, A. I. (2005). A cognitive view of the bilingual lexicon: Reading and speaking words in two languages. *International Journal of Bilingualism, 9*(1), 27-48.

Kroll, J. & Tokowicz, N. (2005). Models of Bilingual Representation and Processing. In *Handbook of Bilingualism* (Eds. J. Kroll & A. De Groot). Oxford: Oxford University Press.

Kucera, H. & Francis, W. N. (1967). *Computational analysis of present-day American English.* Providence, RI: Brown University Press.

Lalor, E., & Kirsner, K. (2001). The representation of 'false cognates' in the bilingual lexicon. *Psychonomic Bulletin & Review*, *8*(3), 552-559. Retrieved from PsycINFO database.

Lopez, M., & Young, R. (1974). The linguistic interdependence of bilinguals. *Journal of Experimental Psychology*, *102*(6), 981-983.

MacKay, D. G. (1987). *The organization of perception and action: A theory for language and other cognitive skills.* New York: Springer-Verlag.

MacKay, D., & Burke, D. (1990). Cognition and aging: A theory of new learning and the use of old connections. *Aging and cognition: Knowledge organization and utilization* (pp. 213-263). Oxford England: North-Holland. Retrieved from PsycINFO database.

MacNamara, J., & Kushnir, S. (1972). Linguistic independence of bilinguals: The input switch. *Journal of Verbal Learning & Verbal Behavior*, *10*(5), 480-487.

Marian, V., Spivey, M., & Hirsch, J. (2003). Shared and separate systems in bilingual language processing: Converging evidence from eyetracking and brain imaging. *Brain and Language*, *86*(1), 70-82.

McClelland, J. (1979). On the time relations of mental processes: An examination of systems of processes in cascade. *Psychological Review*, *86*(4), 287-330.

McCormack, P.D. (1977). Bilingual linguistic memory: The independence-interdependence issue revisited. In P. A. Hornby (Ed.), *Bilingualism: Psychological, social and educational implications* (pp.57-66). New York: Academic Press.

Muscalu, L. (2007). The role of phonological activation in bilinguals' orthographic realization of words. Dissertation for Ph.D. in Psychology, Claremont Graduate University.

Nicol, J. L. (2001). *One Mind, Two Languages.* Massachusetts: Blackwell Publishers.

Preston, M., & Lambert, W. (1969). Interlingual interference in a bilingual version of the Stroop color-word task. *Journal of Verbal Learning & Verbal Behavior*, *8*(2), 295-301.

Price, C., Green, D., & von Studnitz, R. (1999). A functional imaging study of translation and language switching. *Brain: A Journal of Neurology*, *122*(12), 2221-2235.

Rastle, K. G. & Burke, D.M. (1996). Priming the tip of the tongue: Effects of prior processing on word retrieval in young and older adults. *Journal of Memory and Language*, *35*, 586-605.

Reason, J. T., & Lucas, D. (1984). Using cognitive diaries to investigate naturally occurring memory blocas. In J. E. Harris & P. E. Morris (Eds.). *Everyday Memory Actions and Absent-Mindedness* (pp.53-70). London: Academic Press.

Rodriguez-Fornells, A., van der Lugt, A., Rotte, M., Britti, B., Heinze, H., & Münte, T. (2005). Second Language Interferes with Word Production in Fluent Bilinguals: Brain Potential and Functional Imaging Evidence. *Journal of Cognitive Neuroscience*, *17*(3), 422-433. doi:10.1162/0898929053279559.

Roediger, H., & McDermott, K. (1995). Creating false memories: Remembering words not presented in lists. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *21*(4), 803-814.

Rollin, N., Carvajal, C. S., & Horwood, J. (Cf. Eds.). (2009). *Pocket Oxford Spanish Dictionary.* Oxford, New York: Oxford University Press.

Rose, R., Rose, P., King, N., & Perez, A. (1975). Bilingual memory for related and unrelated sentences. *Journal of Experimental Psychology: Human Learning and Memory*, *1*(5), 599-606.

Rosenberg, S., & Simon, H. (1977). Modeling semantic memory: Effects of presenting semantic information in different modalities. *Cognitive Psychology*, *9*(3), 293-325.

Schriefers, H., Meyer, A., & Levelt, W. (1990). Exploring the time course of lexical access in language production: Picture-word interference studies. *Journal of Memory and Language*, *29*(1), 86-102. doi:10.1016/0749-596X(90)90011-N.

Sebastian-Galles, N. (2000). LEXESP: *Lexico informatizado del espanol.* Ediciones de la Universitat de Barcelona.

Seidenberg, M., & Tanenhaus, M. (1979). Orthographic effects on rhyme monitoring. *Journal of Experimental Psychology: Human Learning and Memory*, *5*(6), 546-554. doi:10.1037/0278-7393.5.6.546.

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

Van Hell, J., & De Groot, A. (1998). Conceptual representation in bilingual memory: Effects of concreteness and cognate status in word association. *Bilingualism:*

Language and Cognition, *1*(3), 193-211.

Vitevitch, M. (2002). The influence of phonological similarity neighborhoods on speech production. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *28*(4), 735-747. doi:10.1037/0278-7393.28.4.735.

Warriner, A., & Humphreys, K. (2008). Learning to fail: Reoccurring tip-of-the-tongue states. *The Quarterly Journal of Experimental Psychology*, *61*(4), 535-542. Retrieved from PsycINFO database.