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The Cognate Facilitation Effect: Implications for Models of Lexical Access

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Do nonselected lexical nodes activate their phonological information? Catalan–Spanish bilinguals were asked to name (a) pictures whose names are cognates in the 2 languages (words that are phonologically similar in the 2 languages) and (b) pictures whose names are noncognates in the 2 languages. If nonselected lexical nodes are phonologically encoded, naming latencies should be shorter for cognate words, and because the cognate status of words is only meaningful for bilingual speakers, this difference should disappear when testing monolingual speakers. The results of Experiment 1 fully supported these predictions. In Experiment 2, the difference between cognate and noncognate words was larger when naming in the nondominant language than when naming in the dominant language. The results of the 2 experiments are interpreted as providing support to cascaded activation models of lexical access.

Following a seminal proposal by Garrett (1975, 1976), current models of speech production assume that lexical access occurs in two main "stages" (e.g., Bock, 1995; Caramazza, 1997; Dell, Schwartz, Martin, Saffran, & Gagnon, 1997; Levelt, Roelofs, & Meyer, 1999; Starreveld & La Heij, 1996). In the first stage, the lexical item corresponding to an intended meaning is activated and selected from the set of activated lexical nodes. In the second stage, the phonological properties of the selected lexical node are retrieved and the word is finally articulated. There is also general agreement on the assumption that semantic representations activate multiple lexical nodes during the first stage of lexical access. That is, it is assumed that the semantic system activates not only the intended lexical item but also other semantically related words. For example, when a speaker wants to name a picture of a table, the semantic system activates not only the lexical node *table* but also semantically related nodes such as *stool, chair, cupboard,* and so on. The lexical node with the highest level of activation, usually corresponding to the intended meaning (e.g., *table*), is selected. However, there are also major differences among models of lexical access. One area of disagreement concerns whether stages operate in discrete, serial order or in cascaded fashion.

The discrete serial models of lexical access (e.g., Levelt, 1989; Levelt et al., 1999; Roelofs, 1992; Schriefers, Meyer, & Levelt, 1990) posit that only the lexical node selected in the first stage sends activation to the phonological layer. According to this view, the activation of semantic competitors at the lexical node layer does not lead to the activation of their phonological properties. Furthermore, the phonological content of the target word receives activation only *after* the target lexical node has been selected. Thus, phonological activation is restricted to the selected lexical node. By contrast, the cascaded activation models of lexical access (e.g., Caramazza, 1997; Dell, 1986; Dell et al., 1997; Dell & O'Seaghdha, 1991, 1992; Harley, 1993; Humphreys, Riddoch, & Quinlan, 1988; Peterson & Savoy, 1998) assume that activation flows continuously from the lexical layer to the phonological layer. According to these models, all lexical nodes activated through the semantic system (e.g., *table, stool, chair*) spread some proportional activation to their corresponding phonological segments, regardless of whether they are selected. Therefore, phonological activation is not restricted to the lexical node selected at the lexical layer.

The issue of whether there is phonological activation of nonselected lexical nodes has been a topic of intense research over the past several years (e.g., Cutting & Ferreira, 1999; Dell & O'Seaghdha, 1991, 1992; Jescheniak & Schriefers, 1998; Levelt et al., 1991a, 1991b; Schriefers et al., 1990; Starreveld & La Heij, 1996). Although recent studies seem to support the cascaded activation assumption of lexical access, the results are not conclusive. Consider a study by Peterson and Savoy (1998), which reports one of the more compelling experimental findings in favor of cascaded processing. In their study, participants were required to name a set of pictures (e.g., *couch*). On some critical trials, participants were asked to name a word instead of naming the picture presented just before. The relationship between the word and the preceding picture's name was systematically manipulated in the following way. The target word was either phonologically related to the picture's name (e.g., *count*), phonologically related to a near-synonym of the picture's name (e.g., *soda,* which is related to *sofa*), or phonologically related to a semantically related word (e.g., *bet,* which is related to *bed*) or unrelated to it (e.g., *harp*). Moreover, the delay between the prime and the target was varied. Peterson and Savoy replicated the previous results observed by Levelt et al. (1991b), in which no difference between

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words phonologically related to a semantically related word (*bet*) and the unrelated condition (*harp*) was observed. More interesting is the result related to the synonyms. Participants named both the words phonologically related to the target's name (*count*) and those related to the near-synonym's name (*soda*) faster than the unrelated words (*harp;* for a similar result using the picture–word interference paradigm, see Jescheniak & Schriefers, 1998). This priming effect was found at several delays (150, 200, 300, and 400 ms) in which the magnitude of the priming effect for words related to the target's name (e.g., *count*) and for words related to the near-synonym's name (e.g., *soda*) was similar. This result suggests that during the retrieval of the target's name, the phonological properties of both potential target words (e.g., *couch* and *sofa*) are activated to similar degrees. However, at longer delays (600 ms), priming was only observed for the word related to the target's name (e.g., *count*), indicating that at that point in the lexical access process the activation of the phonological properties of the non-selected lexical node (e.g., *sofa*) had already decayed.

According to Peterson and Savoy (1998), the shorter naming latencies obtained for words that are phonologically related to the near-synonym's name (*soda*) suggest that nonselected lexical nodes (e.g., *sofa*) also activate their phonological properties. This facilitation effect arises because the word *sofa* activates to some extent its phonological segments (/s/, /o/, /f/, /a/), which overlap with phonological information required to name the target word (*soda*). However, Peterson and Savoy also reported a result that seems to contradict this interpretation. According to the general principle of multiple lexical activation, when intending to produce the word *couch,* the semantic system also activates the semantically related word *bed,* which in turn should activate, to some extent, its phonological features (/b/, /E/, /d/). In such a scenario, one should expect shorter naming latencies for words that share some of those activated phonemes (e.g., *bet*). However, no difference was obtained between such words (*bet*) and unrelated words (*harp*). The authors argued that this lack of difference reflects that the phonological activation of a nonselected lexical node is only detectable when this node reaches a very high level of activation. Because the level of activation of the nontarget lexical nodes is presumably proportional to their semantic overlap with the target lexical node, one may expect larger effects for near-synonym words than for semantically related words.

At first glance the phonological activation of near-synonyms would seem to pose a major problem for the assumption that only the selected lexical nodes activate their phonological properties. However, in a recent article Levelt et al. (1999) argued that their discrete serial stage model of lexical access could also explain this facilitation effect. They proposed that the effect observed by Peterson and Savoy (1998) for near-synonyms might reflect the unusual situation in which two lexical nodes are selected for one semantic representation. According to these authors, when two lexical nodes are highly activated and both fulfill the requirements for being selected, as in the case of near-synonyms (e.g., they belong to the same semantic and syntactic categories), the lexical selection mechanism might select both.[1] Given that the two lexical nodes are selected, both send activation to their respective phonological segments (see Roelofs, 1992, for a similar proposal to explain speech errors in which two words are blended). According to this view, the priming effects obtained for words that are phonologically related to near-synonyms of the target response would not be problematic for the strict serial activation theory of lexical access. This is because the phonological activation produced by the lexical node corresponding to the near-synonym would be coming from a selected lexical node and not from an unselected lexical node.

Other features of the experiments conducted by Peterson and Savoy (1998) could limit the conclusions that one can draw from the results. First, it could be argued that the facilitation effect observed for words that are phonologically related to the nonselected synonym may reflect the effects of backward priming. As discussed by the authors, it could be the case that, in some conditions (especially those in which the target word was presented just after the presentation of the picture), both forward priming and backward priming contributed to the observed effects. Finally, both in the Peterson and Savoy and the Jescheniak and Schriefers (1998) studies, phonological facilitation was observed only for a particular type of words: near-synonyms. This is a rather small set within the language, which may have peculiar properties. Therefore, the extent to which the phonological facilitation effect of nonselected lexical nodes may generalize to other types of words is unclear. For these reasons, it is important to provide converging evidence on the issue of cascaded versus noncascaded processing with tasks that are not subject to the same reservations that have been voiced against the Peterson and Savoy study.

The principal goal of the study reported here was to further test the extent to which nonselected lexical nodes activate their phonological segments. For this purpose, we followed the same rationale developed by Peterson and Savoy (1998). They argued (see also Dell & O'Seaghdha, 1991) that the possibility of experimentally detecting phonological activation of a nonselected lexical item is restricted to those situations where both the target and the nonselected item are highly activated at the lexical node layer. The case of near-synonym pairs satisfies this condition because the semantic representations of the two words are very similar and, therefore, activate both lexical nodes to roughly comparable extents.

There is another situation in which the overlap between the semantic representations of two lexical nodes may be even larger—the case of translation words in the languages of bilinguals. *Translations* are lexical items that have the same meaning in the two languages of a bilingual, and therefore, it might be supposed that they both reach high levels of activation in the course of producing one of them. If lexical access involves cascaded activation, we would expect some activation of the phonological properties of the translation words in the nonspoken language. For example, when a Catalan–Spanish bilingual is required to name the picture of a table in Spanish (*mesa*), we may expect strong activation of the phonological properties of the intended word (/m/, /e/, /s/, /a/) but also some activation of its Catalan translation (*taula;* /t/, /a/, /u/, /l/, /ə/). By contrast, the discrete serial activation

[1] The basis for this assumption is not clear. In the WEAVER++ model (Roelofs, 1992) adopted by Levelt et al. (1999), word meanings are represented by lexical concepts. This means that the lexical concepts of "couch" and "sofa" are as independent as the lexical concepts of "couch" and "furniture." Therefore it is not obvious how it comes about that the activation levels of the lemmas of couch and sofa supposedly end up being very similar.

models would predict that only the selected node (e.g., *mesa*) would be phonologically activated and encoded. A promising way to experimentally test these two predictions is by investigating the performance of bilingual speakers when naming cognate and noncognate words. *Cognates* are those translation words that have similar orthographic–phonological forms in the two languages of a bilingual (e.g., *gat*—Catalan, *gato*—Spanish [*cat* in English]; *guitarra*—Spanish, *guitar*—English); noncognates are those translations that only share their meaning in the two languages (*taula*—Catalan, *mesa*—Spanish [*table* in English]). Obviously, the cognate–noncognate contrast is only meaningful in the context of bilingualism. For a monolingual Spanish speaker, the fact that *gato* and *mesa* happen to be, respectively, *gat* and *taula* in Catalan is absolutely irrelevant. It is only for the Spanish–Catalan bilingual that the orthographic–phonological properties of translations might be of significance in how words are processed in the two languages. Cascaded activation and discrete serial activation models make different predictions about the effects of the cognate status of a word in the picture naming performance of bilingual speakers.

If nonselected words spread some activation to their phonological segments, as proposed by the cascaded activation models, pictures whose names are cognates should be named faster than pictures whose names are noncognates. Continuing with our example, the activation of the nonselected Catalan word *gat* would spread some activation to its segments (/g/, /a/, /t/). Because this word is a cognate, some of its activated segments are the same as the segments of the Spanish target word *gato* (/g/, /a/, /t/). On the assumption that the ease with which the phonemes are retrieved depends on their levels of activation (see also Meyer & Schriefers, 1991, for similar proposal), the selection of the phonemes corresponding to the Spanish word *gato* (/g/, /a/, /t/, /o/) is achieved very quickly; their level of activation is quite high because they receive activation from two lexical nodes (the selected Spanish word *gato* and its nonselected Catalan translation *gat;* see Figure 1). The situation is very different for noncognates such as *table* (Spanish: *mesa;* Catalan: *taula*). In this case, the nonselected Catalan word *taula* also activates some of its phonological segments (/t/, /a/, /u/, /l/, /ə/). However, they do not overlap with those required to produce the selected Spanish word *mesa* (/m/, /e/, /s/, /a/; see Figure 2), and therefore no facilitation is expected in this case.

The discrete serial activation models predict that cognate and noncognate words should behave similarly, because only the selected Spanish lexical node is phonologically encoded, and therefore the phonological characteristics of its translation do not play any role in naming performance.

The predictions we derived for cascaded activation and discrete serial activation models in processing cognate and noncognate words depend on two important assumptions about the architecture of bilingual lexical systems. First, we assumed that the two languages of a bilingual share a common semantic system. Second, we assumed that the semantic system activates the two languages of a bilingual in parallel. These two assumptions are widely adopted by current models of bilingual language processing (Costa, Miozzo, & Caramazza, 1999; de Bot, 1992; D. W. Green, 1998; Hermans, Bongaerts, de Bot, & Schreuder, 1998; Kroll & Stewart, 1994; Potter, So, von Eckhardt, & Feldman, 1984; Poulisse, 1997). Furthermore, recent results support the notion of parallel activation of the two languages of a bilingual (Hermans et al., 1998; Kroll & Peck, 1998). In addition to these two assumptions, we also assumed that the mechanisms involved in bilingual lexical selection are governed by the same principles postulated by theories of language production for monolingual speakers. Nevertheless, it is important to note that despite widespread agreement on the above-mentioned principles (parallel activation and common semantic store), models of bilingual language production also differ on other aspects of the process. For instance, some models posit that the lexical items in the bilingual's two lexicons may compete during lexical selection (e.g., D. W. Green, 1998). According to these models, the lexical selection mechanism takes into consideration not only the activation of the lexical items in the response language, but also the activation levels of lexical nodes in the nonresponse language. More recently, this view has been challenged and some researchers (Costa et al., 1999; Costa & Caramazza, 1999; Roelofs, 1998) have proposed that lexical selection may be language specific. For instance, according to Roelofs (1998), the lexical selection mechanism only considers the activation of lexical nodes in the response language, thereby precluding competition from the lexical nodes of the language not programmed for response. However, whether or not there is competition across lexicons has no consequences for the predictions derived from cascaded and strict serial models regarding the cognate effect. According to the discrete serial models, any competition between lexicons should affect both cognate and noncognate words equally.

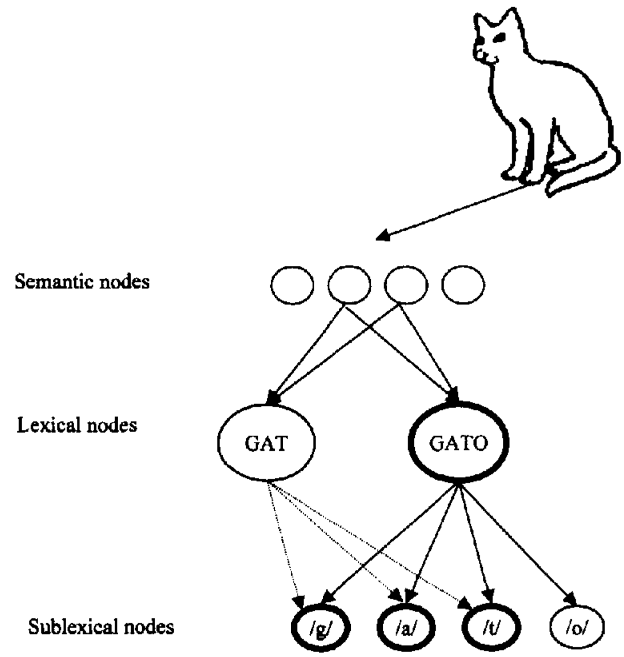

Figure 1. Schematic representation of lexical and sublexical access for cognate words. The Catalan–Spanish pair *gat–gato* [cat] is illustrated. Activation is indicated by arrows. Thickness indicates the level of activation of lexical nodes and sublexical nodes.

In the experiments reported below, we contrasted the predictions derived from the cascaded activation and discrete serial activation view by investigating the performance of Catalan–Spanish bilinguals and Spanish monolinguals when naming pictures whose names were either cognates or noncognates. As stated above, the

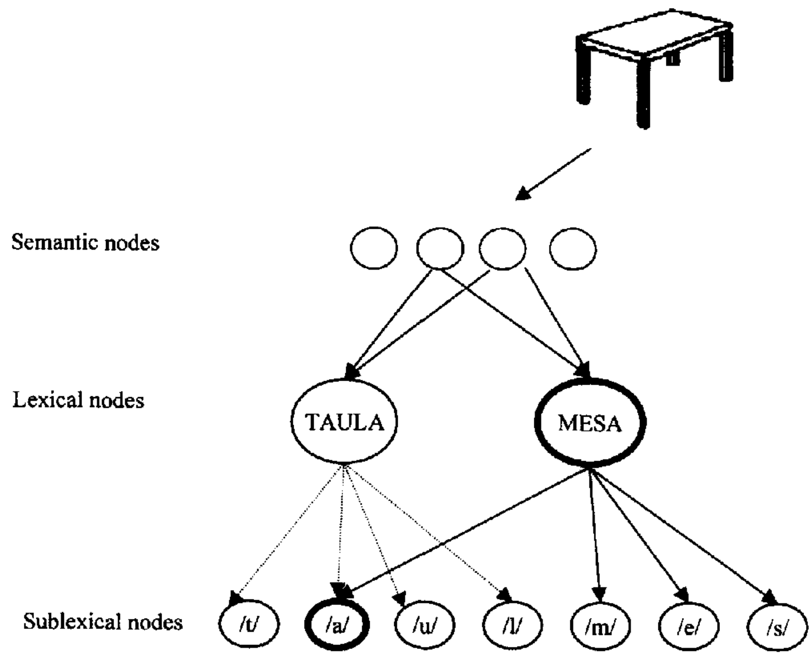

Figure 2. Schematic representation of lexical and sublexical access for noncognate words. The Catalan–Spanish pair *taula–mesa* [table] is illustrated. Activation is indicated by arrows.

cognate status of words is only meaningful in the context of bilingualism. Therefore, if the cascaded activation assumption is correct, we expected to find a difference between cognate and noncognate words only for bilingual speakers, whereas monolingual speakers should behave in the same way with the two types of words. By contrast, the discrete serial activation models predict no difference between the two populations of speakers.

The analysis of the performance of bilingual speakers in naming cognate and noncognate words as a way to test cascaded and noncascaded activation models of lexical access allowed us to elude some of the criticisms directed to Peterson and Savoy's (1998) study. First, because Spanish and Catalan have many cognate words (65–70%; J. N. Green, 1988), we were not restricted to having to select stimuli from a small set of words that may have peculiar properties, as might be the case for near-synonyms. That cognates are very common in Spanish and Catalan allowed us, at the very least, to assess the generalizability of the results obtained by Peterson and Savoy. Second, in our experiments participants were required to perform a very simple picture naming task that did not involve the complexities of the priming paradigm and its possible interpretive difficulties (such as the problem of backward priming discussed above).

Third, and most important, our experimental paradigm makes implausible an explanation of any facilitation effect that might be obtained in our experiments in terms of multiple lexical selection. There are at least two reasons why an explanation of the potential cognate effect in terms of multiple lexical selection would be highly implausible. These have to do with the fact that if multiple selection were a common event in bilingual lexical access it would have extremely deleterious consequences that are not in fact observed in the performance of fluent bilinguals. First, because the multiple selection principle has been used by Levelt and collaborators to explain the existence of blend errors in slips of the tongue, one should predict a large number of cross-language blend errors in bilingual speech production. Second, if bilingual speakers select two lexical items each time they produce a word, it would result in copious cross-language intrusion errors. These two expectations are at variance with the reality of fluent bilingual production where it is clear that bilinguals do not unintentionally produce many blends or cross-language intrusion errors (see the General Discussion for a more detailed consideration of these issues).

In the following experiments we test the different predictions derived from the cascaded and the discrete activation models of lexical access for the effect of the cognate status of a word in picture naming.

Experiment 1: Catalan–Spanish Bilinguals and Spanish Monolinguals

Experiment 1 was designed to explore the extent to which picture naming is affected by the cognate status of the picture names. Two groups of participants were tested: highly proficient Catalan–Spanish bilingual speakers (bilingual group) and monolingual Spanish speakers (monolingual group). These two groups were asked to name a set of pictures in Spanish. Two types of pictures were included in the experiment: pictures whose names are cognate words in Catalan and Spanish (e.g., *gato–gat* [cat]) and pictures whose names are not cognates in these languages (e.g., *mesa–taula* [table]). If the two sets of pictures are comparable with respect to variables that affect naming latencies (e.g., frequency), monolingual Spanish speakers should show identical naming latencies for the two sets. Furthermore, if the cognate status of a word affects picture naming latencies for the reasons derived from the cascaded activation assumption, we would expect to observe a difference between the two sets of pictures (cognates vs. noncognates) only for the bilingual group.

Method

Participants. Forty-two participants took part in the experiment. The 21 participants included in the bilingual group were highly proficient Catalan–Spanish bilinguals (a description of both languages and relative use is presented in Appendix A). These participants were students at the University of Barcelona (ages 18–25) and received course credit for their participation. They reported being highly proficient in the two languages, and they used both regularly in their daily life. However, they also reported to have a preference (or dominance) for one of the languages (Catalan). Furthermore, they were all native speakers of Catalan; they were exposed almost exclusively to Catalan during their first 3 to 4 years of life (see Appendix B). Because participants were asked to name pictures in Spanish, we considered the task as requiring the use of their second language. The 21 participants included in the monolingual group were native speakers of Spanish recruited from the Universidad Autonoma de Madrid. They reported having no knowledge of Catalan.

Materials. A total of 40 pictures were selected from a wide range of semantic categories (e.g., body parts, buildings, animals, furniture). Two variables were manipulated orthogonally: the cognate status of the picture and its frequency. This resulted in four experimental conditions: (a) 10 low-frequency pictures with cognate names, (b) 10 high-frequency pictures with cognate names, (c) 10 low-frequency pictures with noncognate names, and (d) 10 high-frequency pictures with noncognate names. (The stimuli are listed in Appendix C.) We manipulated the frequency of the picture names to assess the power of the experiment and the comparability of the two groups of participants. It is well established (e.g., Jescheniak & Levelt, 1994; Oldfield & Wingfield, 1965) that pictures with high-frequency names are named faster than pictures with low-frequency names. Therefore, regardless of whether we obtain a difference between cognate and noncognate words, we should replicate the frequency effect. Furthermore, although we expected a cognate effect only for the bilingual group, we predicted a similar frequency effect for the monolingual and bilingual groups. The onsets of words in the different conditions were controlled by considering their phonological features (plosive, nasal, etc.). The distribution of onsets following these criteria was similar across conditions (see Appendix C). The syllable length of cognate and noncognate words was also controlled (mean number of syllables: cognates = 2.5, noncognates = 2.5, range = 1–4; $F < 1$). The mean frequency of the picture names in the low- and high-frequency conditions was 52 and 818, respectively (Sebastian-Galles, Marti, Cuetos, & Carreiras, 1996). The mean frequencies of the picture names in the cognate and noncognate conditions were statistically indistinguishable (cognates = 460, noncognates = 408, $F < 1$). The cognate words shared on the average five phonological segments (range = 3–7) in the two languages. Almost all the cognate words (17 out of 20) shared at least the whole first syllable, and all of them shared at least the first phoneme. There was no obvious phonological or orthographic overlap between noncognate translation words. None shared their first phoneme and only 3 out of 20 shared the first vowel. The grammatical gender of the pictures' names in the two languages was also controlled: Only 3 of the 40 words had a different gender in the two languages.

The pictures were presented four times in four separate blocks. Each block included each picture only once. Block trials were randomized so that pictures of the same experimental condition appeared in no more than two consecutive trials. The order of block presentation varied across participants. In the first three blocks, a standard picture naming task was used, whereas in the fourth block, participants were asked to perform a delayed naming task.

Procedure. Participants were tested individually in a soundproof booth. Instructions were administered in Spanish. Participants were instructed to name the pictures as fast and as accurately as possible in Spanish. They were explicitly told that the aim of the experiment was to obtain normative data on picture naming latencies for the pictures administered in the experiment. Before the experiment started, participants were presented with the entire set of pictures along with their expected Spanish names. The trial structure of the standard picture naming part of the experiment was the following. First, a fixation point (an asterisk) was shown in the center of the screen for 1 s. This was followed by a blank interval of 500 ms. Then, the picture was presented for 400 ms. If a response was not provided within 1.9 s from the offset of the picture, the next trial started automatically. The experiment was self-paced and self-administered. Response latencies were measured from the onset of the stimulus to the beginning of the naming response. After the experimental session, all the pictures were presented again, and participants were required to name the pictures when presented with a visual cue. This delayed naming task was included in order to control for possible differences among words in the different experimental conditions in triggering the voice key. Because different words are used in the different conditions, differences between conditions could be due to the ease with which speakers have access to the words' articulatory routines in different conditions. If that were the case, the differences that are observed in the standard naming task should also be obtained in the delayed naming task, because the articulatory component is shared by the two tasks. Alternatively, if differences that are observed in the standard naming task are not found in the delayed naming task, we may be confident that neither access to the articulatory routines nor any systematic difference between the words in triggering the voice key is responsible for those differences.

The trial structure of the delayed naming block was very similar to that of experimental trials, except that a cue appeared 1 s after the picture's presentation. Participants were required to prepare the name of the picture when it appeared on the screen and to start its articulation when the cue appeared. Naming latencies were recorded from the onset of the cue's presentation.

Stimulus presentation was controlled by an adaptation of the EXPE Program (Pallier, Dupoux, & Jeannin, 1997). Response latencies were measured by means of a voice key calibrated for each participant before starting the experiment. The entire experimental session lasted approximately 40 min. At the end of the experimental session, participants were asked to fill in a questionnaire about how often they use the two languages and how proficient they were in the two languages.

Analyses. Three types of responses were scored as errors: (a) production of names that differed from those designated by the experimenter; (b) verbal disfluencies (stuttering, utterance repairs, production of nonverbal sounds that triggered the voice key); (c) recording failures; and (d) errors in which the bilingual participants named the picture in Catalan. This type of error was extremely rare—4 errors in Experiment 1 (.14%) and 11 (.09%) in Experiment 2. Erroneous responses and outliers (i.e., responses exceeding 2 s or three standard deviations from the participant's mean) were excluded from the analyses of response latencies; this resulted in 5.1% of data points being discarded. Separate analyses were carried out with participants and items as dependent variables, yielding F_1 and F_2 statistics, respectively.

Results and Discussion

Table 1 shows the distribution of mean response latencies and error rates for the four experimental conditions in the two tasks (regular and delayed naming) separately for the two groups of participants. Four variables were examined: cognate status of the pictures (cognate vs. noncognate), frequency of the target (high vs. low frequency), block repetition (three repetitions), and group of participants (bilingual vs. monolingual). Because there was no interaction between block repetition and the other three variables, we report the analyses for the frequency, cognate status, and group variables without considering the variable block repetition.

Table 1
Bilinguals' and Monolinguals' Mean Reaction Time (RT; in Milliseconds) and Error Rates (ERs; in Percentages) for the Four Experimental Conditions in the Two Tasks: Experiment 1

Block and word type	Bilingual group			Monolingual group		
	RT	*SD*	ER	RT	*SD*	ER
	Standard naming					
Block 1						
Cognate	718	66	5.4	690	76	7.1
Noncognate	739	61	6.4	677	73	7.3
Difference	−21			13		
Block 2						
Cognate	669	60	4.2	651	47	5.9
Noncognate	698	56	4.0	653	47	5.4
Difference	−28			−2		
Block 3						
Cognate	667	49	3.3	642	55	4.2
Noncognate	685	51	3.8	645	49	4.7
Difference	−18			−3		
Total blocks						
Cognate	685		4.4	661		5.7
Noncognate	707		4.9	658		5.8
Difference	−22			3		
	Delayed naming					
Cognate						
High frequency	414	98	5.7	385	65	5
Low frequency	419	103	7.1	380	72	6
Difference	5			−5		
Noncognate						
High frequency	412	93	5.2	387	71	4
Low frequency	427	98	5.2	379	67	4
Difference	−15			8		
Overall Cognate-Noncognate						
High frequency	2			−2		
Low frequency	−7			1		

For the regular naming session, the following results were obtained. The analyses of errors show a main effect of block repetition, $F_1(2, 80) = 16.2$, $p < .001$, $MSE = .49$; $F_2(2, 72) = 11.8$, $p < .001$, $MSE = 1.4$. There were no differences between the monolingual and bilingual groups (both $Fs < 1$). The main effect of the variable frequency was significant only in the subject analysis, $F_1(1, 40) = 11.2$, $p < .003$, $MSE = .6$; $F_2(1, 36) = 2.4$, $p < .12$, $MSE = 6.1$. All other comparisons were nonsignificant (all $ps > .3$).

The analyses of the naming latencies show the following effects. The main effect of block repetition was significant, $F_1(2, 80) = 48.7$, $p < .001$, $MSE = 2{,}002$; $F_2(2, 72) = 34.0$, $p < .001$, $MSE = 1{,}290.5$. The main effect of the cognate status was significant only in the subjects analysis, $F_1(1, 40) = 14.0$, $p < .001$, $MSE = 868$; $F_2(1, 36) < 1$. Naming latencies were also shorter with high-frequency words than with low-frequency words, $F_1(1, 40) = 17.8$, $p < .001$, $MSE = 1{,}843$; $F_2(1, 36) = 1.3$, $p < .25$, $MSE = 20{,}315$. The interaction between the frequency of the target and the other two variables was not significant (all $Fs < 1$). Of crucial interest in this experiment is the interaction between the variables group of participants and cognate status. This interaction was significant, $F_1(1, 40) = 22.3$, $p < .001$, $MSE = 868$; $F_2(1, 36) = 7.8$, $p < .009$, $MSE = 1{,}290.5$, suggesting that the difference between the cognate and noncognate words depends on the group of participants tested. Finally, no significant effects were observed for the three-way interactions. The analyses of the naming latencies and error rates in the delayed naming task showed no main effects of the variables cognate status or frequency. Furthermore, the interaction between the latter variables and the variable group were not significant (all $ps > .2$). The results of the delayed naming task suggest that the difference observed between the different experimental conditions in the standard naming task is due neither to a systematic difference in the accessibility of articulatory routines nor to differences in the ease with which the words in the different conditions trigger the voice key.

Post hoc analyses considering the monolingual and bilingual groups separately were carried out in order to evaluate the effect of cognate status in the two populations under study. For the monolingual group the main effect of cognate status was not significant (both $Fs < 1$), reflecting the similar naming latencies for the cognate and noncognate pictures. By contrast, the main effect of cognate status was significant for the bilingual group in the analysis by participants, $F_1(1, 20) = 29.3$, $p < .001$, $MSE = 1{,}064.3$, but not by items, $F_2(1, 36) = 1.3$, $p < .27$, $MSE = 12{,}491.0$.

This experiment was designed to determine whether the cognate status of words affects picture naming latencies. Bilingual and monolingual participants showed very different patterns regarding this variable. Bilingual speakers named the pictures with cognate names faster (23 ms) than the pictures with noncognate names; monolingual speakers named the two sets of pictures equally fast. However, the two populations behaved similarly in other respects of lexical access, as indicated by the comparable effects of frequency obtained in the naming task. Thus, it may reasonably be concluded that the difference observed between the two sets of words can be attributed to their cognate status.

In the introduction we argued that the cascaded activation models of lexical access predict the cognate facilitation effect obtained in Experiment 1. According to these models, the cognate effect arises because the nonselected lexical items in the language not programmed for production (Catalan in our experiment) also activate their phonological properties. Critical to this argument is the assumption that the nonselected lexical items are sufficiently activated so that they can spread enough activation to affect processing at the segmental phonological level (and, hence, detectable in our experiments). In other words, the magnitude of the cognate facilitation effect is expected to be proportional to the level of activation of the nonselected lexical node. This expectation can be tested by comparing the performance of bilinguals when they are naming in their dominant language versus their nondominant language.

In Experiment 1, the language of the response (Spanish) for the bilingual group was their second, nondominant language. The cognate effect observed in that experiment reflects the influence of word properties of the dominant language on nondominant-language naming latencies. It has been argued (e.g., Kroll & Stewart, 1994) that the amounts of activation received by lexical items in dominant and in nondominant languages are different—nondominant language words are less strongly activated than their corresponding dominant-language words. This situation allows us to further test the assumptions made by the cascaded activation models. If the level of activation of the segmental nodes of nonselected words depends on the level of activation of their corresponding lexical nodes (as suggested by Peterson & Savoy, 1998), the cognate facilitation effect should be larger when picture naming is performed in the nondominant language. This prediction is based on the assumption that the activation level of the nonselected word is greater when it is a word in the dominant language than when it is a word in the second, nondominant language. We address this issue in the next experiment by investigating the naming performance of two groups of Catalan–Spanish bilinguals: Spanish-dominant and Catalan-dominant bilinguals.

Experiment 2: Spanish–Catalan Bilinguals Naming in Their Dominant and Nondominant Languages

The goal of Experiment 2 was to explore whether the cognate status of words affects the performance of bilingual speakers when naming in their dominant language, and if so, whether the magnitude of the effect is comparable to that obtained when speakers are using their second language. As we have discussed above, cascaded activation models of lexical access predict an interaction between the language of the response and the cognate status of words. This prediction is based on the assumption that the activation of the segmental units of nonselected words is proportional to the activation of their corresponding lexical nodes. Therefore, if the semantic system activates the lexical representations in the nondominant language to a lesser extent than their dominant-language counterparts, the cognate facilitation effect should be larger when naming in the nondominant language.

Method

Participants. Forty-six participants took part in this experiment. Half were Catalan–Spanish bilinguals recruited from the same population as in Experiment 1. All of these participants reported having good knowledge of the two languages but also reported being dominant in Catalan (see Appendix B). The other participants were also highly proficient Spanish–Catalan bilingual speakers. However, these participants reported being Spanish dominant: Spanish was their native language, and they did not have much contact with Catalan before the age of 6. These participants reported using Spanish more frequently than Catalan, but that they nonetheless use the two languages in their everyday life (see Appendix B). All participants were asked to name the pictures in Spanish.

Materials. Eighty pictures were selected as experimental stimuli. Forty of the pictures were the same as in Experiment 1. The remaining pictures were selected with the same criteria as those used in the previous experiment. The type of onset of the picture names in the two sets was controlled. The number of syllables of the pictures in the cognate and noncognate conditions was also controlled (mean number of syllables = 2.5 vs. 2.6; $F < 1$). The mean frequency of the picture names in the two sets of words was comparable (385 vs. 414, $F < 1$; Sebastian-Galles et al., 1996). Cognate translations shared at least their first segment, and 37 out of 40 shared at least the first syllable. Noncognate translations did not share their first phoneme. Ten of the 40 picture names shared the first vowel, but their first syllable had different structure. The grammatical gender of the pictures in the two languages was also controlled: only 5 out of 80 picture names had a different gender in the two languages (see Appendix D).

Procedure. The procedure was identical to that of Experiment 1. The only differences were the number of pictures included in each block and the randomization restrictions inside the block. Because no systematic manipulation of the picture name frequency was conducted in this experiment, this variable was not considered for the randomization process.

Table 2
Mean Reaction Time (RT; in Milliseconds) and Error Rates (ERs; in Percentages) for the Experimental Conditions in the Two Tasks: Experiment 2

Dominant language	Cognate			Noncognate			Difference
	RT	*SD*	ER	RT	*SD*	ER	
Standard naming							
Catalan							
Block 1	770	79	7.0	820	87	8.2	−50
Block 2	689	72	4.4	744	77	7.4	−55
Block 3	668	77	4.1	707	77	6.5	−39
Total	709		5.1	757		7.4	−48
Spanish							
Block 1	738	90	4.5	773	92	6.8	−35
Block 2	667	76	4.1	690	70	6.2	−23
Block 3	647	71	4.3	671	67	4.3	−24
Total	684		4.3	711		5.7	−27
Delayed naming							
Catalan	418	126	5.8	416	126	5.9	2
Spanish	415	119	5.9	415	119	6.0	0

Analyses. To exclude data points considered as errors, we applied the same criteria as in Experiment 1. Naming latencies derived from two pictures (one in each of the two sets) were excluded from the analyses because of the large number of errors they elicited (remo [oar] and lechuga [lettuce]); this resulted in 5.7% discarded data points. Separate analyses were carried out with participants and items as dependent variables, yielding F_1 and F_2 statistics, respectively. In these analyses, three variables were examined: group of participants (monolingual vs. bilingual), block repetition (three repetitions), and cognate status (cognates vs. noncognates).

Results and Discussion

Table 2 shows the distribution of mean response latencies and error rates for the two experimental conditions in the two tasks (regular and delayed naming). The main effect of block repetition was significant both in the naming latencies analyses, $F_1(2, 88) = 159.2$, $p < .001$, $MSE = 1{,}635.4$; $F_2(2, 152) = 317.2$, $p < .001$, $MSE = 1{,}425.4$, and in the error analyses, $F_1(2, 88) = 4.0$, $p < .04$, $MSE = 2.1$; $F_2(2, 152) = 6.3$, $p < .03$, $MSE = .9$. The main effect of the variable cognate status was significant both in the naming latencies analyses, $F_1(1, 44) = 114.4$, $p < .001$, $MSE = 865.7$; $F_2(1, 76) = 10.7$, $p < .002$, $MSE = 17{,}811.8$, and in the error analyses, $F_1(1, 44) = 19.6$, $p < .001$, $MSE = 2.9$; $F_2(1, 76) = 3.6$, $p < .05$, $MSE = 8.9$. The difference between groups of participants was significant only in the item analysis for naming latencies, $F_1(1, 44) = 2.6$, $p < .1$, $MSE = 32{,}047.9$; $F_2(1, 76) = 90.9$, $p < .05$, $MSE = 1{,}554.3$, and not significant in the error analyses, $F_1(1, 44) = 2.3$, $p < .13$, $MSE = 13.5$; $F_2(1, 76) = 3.5$, $p < .07$, $MSE = 8.4$.

The interaction between the variables group of participants (Catalan-dominant vs. Spanish-dominant) and cognate status (cognate vs. noncognate) is crucial for the issues addressed in this article. This interaction was significant in the naming latencies analyses, $F_1(1, 44) = 9.1$, $p < .004$, $MSE = 865.7$; $F_2(1, 76) = 8.0$, $p < .006$, $MSE = 1{,}554.3$, but not significant in the error analyses, $F_1(1, 44) = 2.8$, $p < .09$, $MSE = 2.9$; $F_2(1,$

76) < 1. This interaction suggests that the magnitude of the cognate effect for the naming latencies is different for the two groups of participants. The other interactions were not significant (all $Fs < 1$).

Post hoc analyses were carried out to further explore the interaction between the variables group of participants and cognate status. The magnitude of the cognate effects for the Catalan-dominant group, $F_1(1, 22) = 73.1$, $p < .001$, $MSE = 1{,}113.7$; $F_2(1, 76) = 14.0$, $p < .001$, $MSE = 10{,}802.3$, and the Spanish-dominant group, $F_1(1, 22) = 41.2$, $p < .001$, $MSE = 617.7$; $F_2(1, 76) = 6.1$, $p < .016$, $MSE = 8{,}563.7$, were both significant. Thus, although the cognate effect is obtained with both populations of participants, its magnitude is larger for the Catalan-dominant group than for the Spanish-dominant group, as indicated by the significant interaction in the analysis of variance reported above. The analyses of the delayed naming task showed no differences in either the error analyses or the naming latencies (all $ps > .2$).

The magnitude of the cognate effect for the Catalan dominant group obtained in this experiment seems to be larger than the effect obtained in Experiment 1 (48 ms vs. 23 ms). One may argue that the two new sets of pictures (cognate and noncognate) are not comparable in the ease with which they are recognized and that therefore this difference might be responsible for the observed effects in Experiment 2. Even if the sets of pictures in Experiments 1 and 2 were not comparable, it is not obvious how such a difference would account for the interaction between the cognate status of words and the group of participants. Nevertheless, we carried out a control experiment in which all the pictures of Experiment 2 were presented to 17 Spanish monolingual speakers. There is only one basic difference between the design of this control experiment and the design of Experiment 2. Because the repetition of the pictures did not interact with the cognate effect in Experiments 1 and 2, we decided to present the pictures only once during the experimental session. Nevertheless, as in the previous experiments, participants were familiarized with the whole set of pictures before the experiment started. All other details of the experiment were the same as in Experiment 2. Naming latencies were similar for the cognate set of pictures (749 ms) and noncognate set of pictures (752 ms), both $Fs < 1$). This result confirms that the two sets of pictures do not differ in terms of how easily they are recognized and named. Moreover, there were no differences in error rates.

We carried out a post hoc analysis of the naming latencies of the Catalan–Spanish bilingual groups with the subset of items ($N = 40$) that was used in Experiments 1 and 2. Experiment (Experiment 1 vs. 2) was a between-subject variable and cognate status (cognate vs. noncognate) was a within-subject variable. The results showed a significant effect of the cognate variable both in the subject and item analyses, $F_1(1, 43) = 31$, $p < .001$, $MSE = 691.3$; $F_2(1, 37) = 4.5$, $p < .044$, $MSE = 18{,}752.9$. Furthermore, as suggested by the lack of interaction between the cognate and the experiment variable (both $Fs < 1$), the magnitude of the cognate effect was similar for the two groups of participants.

In summary, the results of this experiment replicate and confirm those obtained in Experiment 1. Together, they suggest that the cognate status of words has a strong facilitation effect on bilinguals' naming performance. Furthermore, the cognate facilitation effect seems to be modulated by the language of the response, being larger when bilinguals are required to name the pictures in their nondominant language. The latter effect confirms the assumption that the amount of activation that reaches the phonological properties of nonselected words is proportional to the level of activation reached by the nonselected lexical nodes. It also confirms Kroll and Stewart's (1994) proposal that the amount of activation received by lexical items in the dominant language is greater than the amount received by the corresponding lexical items in the nondominant language.

General Discussion

The goal of this study was to evaluate a core property of the time course of activation in two classes of lexical access models, namely, whether activation flow is cascaded or strictly discrete. The crucial difference between these two proposals is whether nonselected lexical nodes activate their phonological segments. According to the discrete serial view, only selected lexical nodes propagate activation down to their phonological segments, whereas cascaded activation theories propose that both selected and nonselected lexical nodes send activation to their phonological segments. We tested these two assumptions about the lexical access process by exploring the naming performance of Spanish–Catalan bilinguals. Specifically, we took advantage of a unique property of the bilingual lexicon—the cognate status of words. We argued that if there is cascaded processing, cognate words should be named faster than noncognate words; the discrete serial activation view predicts no difference between cognate and noncognate words.

Two clear results were obtained. First, bilingual speakers named the pictures with cognate names faster than the pictures with noncognate names.[2] Second, the language of the response modulates the cognate facilitation effect. Although significant cognate facilitation effects were obtained in both the dominant and the nondominant language conditions, the magnitude of the effect was larger in the latter case. These effects are not the result of peculiar properties of the two sets of words and pictures, because the effects were not obtained when monolingual speakers were asked to name the pictures. Furthermore, when participants were asked to name the pictures in a delayed naming task, no difference was observed between the two sets of pictures. This indicates that the picture names included in the two sets triggered the voice key similarly. Thus, it seems reasonable to attribute the difference between the two sets of pictures to the cognate status of their names. The cognate facilitation effect we have documented supports the notion that nonselected lexical items send activation to their phonological segments, and therefore we must assume that activation flows between stages in a cascaded fashion.

Before discussing further the implications of these results, it is worth exploring whether we can explain the cognate effect without having to postulate cascaded processing. Here we consider two possible explanations of the cognate effect in the framework of discrete models of lexical access.

One possible explanation of the cognate facilitation effect is that it is due to the simultaneous selection of the target lexical node in

[2] The cognate facilitation effect is robust. Janssen (1999) and others (Kroll, Dijkstra, Janssen, & Schriefers, 1999) have replicated the effect with different languages (Dutch–English and English–French bilinguals) and a different paradigm (cued naming).

the response language and its translation in the nonresponse language. That is, the cognate facilitation effect could be explained in the same way that Levelt et al. (1999) proposed to account for the near-synonym effect reported by Peterson and Savoy (1998)—the multiple selection hypothesis. The selection of both the target word and its translation would allow activation to flow to the segmental content of the target word and its translation, with the consequence that the selection of the segmental content of cognates would be facilitated. The facilitation results from the target word and its translation sharing a substantial proportion of their phonological segments when they are cognates, making their selection relatively easy. However, there are two problems in extending the multiple selection account to the case of bilingual production. This account of the cognate facilitation effect makes two predictions that are not borne out by the speech production performance of bilinguals.

According to the discrete activation model proposed by Levelt et al. (1999), the selection of multiple lexical nodes is also assumed to be responsible for word blend errors in monolingual speakers. These errors occur very rarely, presumably because under normal circumstances only one lexical node is selected. Occasionally, however, the selection system fails and two nodes are selected, resulting in a blend error. These are far more likely to occur for words that have near-synonyms or words that are highly related in meaning (Fromkin, 1973; Hotopf, 1980). The proportion of such words in a language is not very large. For example, most words do not have near-synonyms. The situation is strikingly different in the case of bilingual speakers where "every" word in the target language has a "synonym" (its translation in the nonresponse language). As a consequence, each lexical selection trial provides a strong opportunity for multiple lexical selection and the production of a blend error. Thus, appealing to the multiple selection principle to explain the cognate facilitation effect would commit one to the prediction that bilingual speakers should produce very large numbers of cross-language word blends. However, this is not the case. In many naming experiments with bilingual speakers, we have never observed cross-language word blend errors.

The multiple selection hypothesis also predicts that bilingual speakers should produce copious cross-language intrusion errors. This prediction is based on plausible speculation about the process by which conflicts arising from multiple lexical node selection are resolved downstream. Presumably, multiple selections either result in blends or are resolved before a blend error is produced. In the case where the conflict is resolved in favor of a single word, how does this come about? One possibility is that the ultimate selection of only one lexeme (in Levelt et al.'s, 1999, model) is a random event (or perhaps guided by the relative frequencies of the two words). This implies that in such situations speakers occasionally produce a word different from the intended one. For example, monolingual speakers might sometimes produce *couch* even though *sofa* was the intended target. The occurrence of such intrusions should be far higher in the case of bilingual speakers. This is because, like the case of cross-language blend errors, there are far more opportunities for multiple lexical selection in bilingual than monolingual production. The occurrence of presumably rare selection errors in monolingual speakers would most likely go undetected, unless they are self-corrected. However, in the case of bilingual production the selection of the wrong word would result in a cross-language intrusion that would be detected immediately. Because there would presumably be many such errors, they should be strikingly apparent. However, bilinguals rarely produce cross-language intrusion errors. In many experiments with bilingual speakers we have observed very few such errors (0.11% in the experiments reported in this article).

However, cross-language intrusion errors might be avoided, even when multiple selection is allowed. This would require that we assume the existence of a powerful editor that monitors lexical selection and only allows further processing of those words that correspond to the target language. This monitoring system would function after lexical selection has taken place, thereby allowing activation to spread from the selected lexical nodes to their segmental contents. Because the editor operates after lexical selection, the selection of the nontarget lexical node can affect the retrieval of the phonological segments of the target node, thereby producing the observed cognate effect. However, the monitoring system would prevent the overt production of the nontarget lexical node by sorting out the selected nodes through a "language filter" that only allows the production of words that belong to the language being spoken. Although postulating the existence of a language filter solves the problem of cross-language intrusions, it raises problems of its own. First, it is not clear how such a device would work. At the very least it would require some way of "marking" word forms so that the filter can recognize the language to which they belong. Furthermore, filtering would have to involve not only the phonological form of the word but also its syntactic features (e.g., gender), which were presumably selected along with the lexical node. It is not clear how syntactic features can be "language marked." Second, it makes the process of lexical selection in bilingual language production highly dissimilar from that in monolingual language production. For example, whereas monolingual language production does not allow cascaded processing (except in the rare and anomalous case of multiple lexical selection), bilingual language production would routinely involve cascaded processing, at least for the translation of the target word. Third and most important, it renders the lexical selection process a mere formality because the real "selection" for output is carried out by the language filter system. That is, on this view, bilingual production always involves multiple lexical selection and then a second selection process through the language filter. This means that the actual selection process for the selection of the phonological content of the target word is carried out by the language filter. This proposal is clearly ad hoc and unparsimonious. It allows the spurious selection of multiple lexical nodes only to have to undo that work through a very powerful language filter of unspecified properties.

Another explanation of the cognate effect that does not require that we assume cascaded processing attributes the effect to syllable frequency. It may be argued that the frequencies of the syllables of cognate words are higher than those of noncognate words. For example, the syllable /CU/ is the first syllable of the cognate words *cuchara–cullera* (spoon), and therefore it is used every time the speaker refers to that utensil regardless of the language used. On the other hand, the initial syllable /ME/ of one of the words of the noncognate translation pair *mesa–taula* (table) is used only half of the time when the speaker refers to that piece of furniture (i.e., assuming that the two languages are used with equal frequency). This could suggest that, all other things being equal, *cuchara* is named faster than *mesa* because its first syllable is more frequent.

However, there are two problems with this argument. First, it is far from obvious that the frequencies of the syllables or segments that comprise the cognate words used in the experiments are higher than those of the noncognate words. This is because the token frequencies of the segments–syllables that comprise a word are a function of both the number of words that share those segments–syllables and their frequency of occurrence in the language. Merely noting that cognates share more segments than noncognate translations is insufficient to establish that the segments–syllables in cognates are more frequent than those in noncognates. Second, and more important, even if it were to be the case that the segments–syllables in cognates are of higher frequency than those in noncognates, it is unclear that this difference would be able to account for the cognate facilitation effect. This is because an account of the cognate effect in terms of segment–syllable frequency presupposes the existence of a syllable (or phoneme) frequency effect in picture naming. However, recent results reported by Levelt et al. (1999) indicate that naming latencies are unaffected by syllable and phoneme frequency.

In the introduction, we sketched one possible explanation for the cognate facilitation effect following the same rationale developed by Peterson and Savoy (1998). However, there are at least two different levels of representation at which we can locate the cognate facilitation effect. We consider first the possibility that the locus of the effect is at the level of phonological segments. According to this explanation, the difference between cognate and noncognate words arises at the level where speakers have to select the phonological segments for the target word. In the case of cognate words (e.g., *gato*—Spanish [cat]), some of the target's segmental elements (/g/, /a/, /t/) receive extra activation from its translation in the other language (e.g., *gat*—Catalan [cat]), thereby facilitating their selection. This is not the case for noncognate words (e.g., *mesa*—Spanish [table]), because the segmental properties of their translations (e.g., *taula*—Catalan [table]) are different from those of the target. Interestingly, this explanation may also account for the rare interlanguage speech errors in which two parts of words are blended.

The second explanation for the cognate facilitation effect locates the effect at the lexical rather than at the phonological segment layer. This explanation, however, requires the extra assumption of interactivity, namely, that activation flows in both directions between adjacent layers in the system (e.g., Dell, 1986; Harley, 1993). According to interactive models of speech production, the selection of the target lexical node is influenced not only by the activation coming from the semantic system, but also by the feedback activation it receives from the phonological segment layer. For example, when naming the picture of a cat, the lexical node *cat* is activated along with the nodes of semantically related (*dog, mouse,* etc.) and phonologically related words (*car, cap,* etc). The activation of the latter lexical nodes comes from the previous activation of the target's phonological elements (/k/, /æ/, /t/). These phonological units spread activation backwards to the lexical level, thereby re-activating the target word *cat* and also activating other lexical nodes with which they are linked, such as *car* and *cap.* If we assume that this interactive process applies to the two languages of a bilingual at the same time, then the cognate facilitation effect may be explained in the following way. When naming a cognate word (e.g., *gato*—Spanish [cat]), activation of the segmental units of the nonselected translation word (e.g., *gat*—Catalan, /g/, /a/, /t/) may spread some activation backwards to the lexical nodes in the response language (see Figure 3). One of the lexical nodes that would eventually receive some activation is the target's lexical node (*gato*—Spanish). This is because the target node and its translation share some phonological segments (/g/, /a/, /t/). Given this situation, the target's lexical node receives activation both from the semantic system and from the feedback activation from its phonological segments. In contrast, the lexical node of a noncognate target (e.g., *mesa*—Spanish [table]) would receive much less of this extra activation from the phonological segment layer, because there is almost no phonological overlap between the target word and its translation (e.g., *mesa*—Spanish, *taula*—Catalan [table]). Our data remain silent regarding which of these two explanations—forward-only cascaded activation or interactive activation—provides the best account for our results and those reported by Peterson and Savoy (1998) and Jescheniak and Schriefers (1998). Nonetheless, both accounts assume cascaded processing.

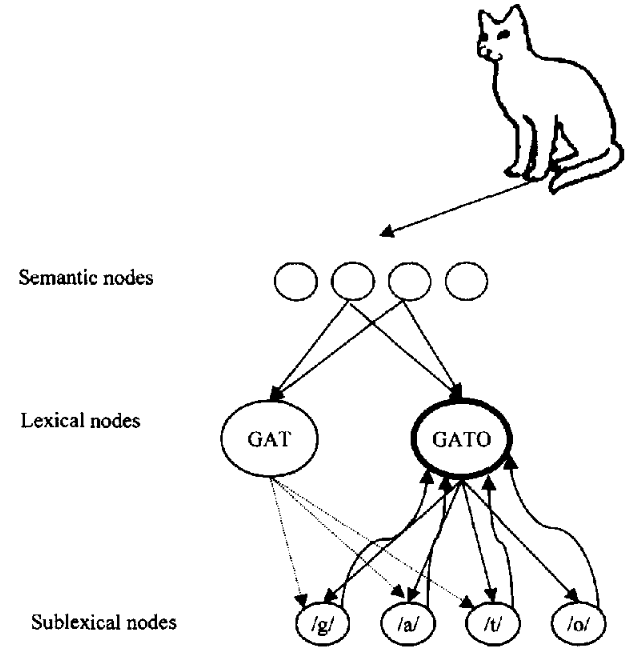

Figure 3. Schematic representation of lexical and sublexical access for cognate words according to an interactive model of speech production. The Catalan–Spanish pair *gat–gato* [cat] is illustrated. Activation is indicated by arrows.

The other main result reported in this study provides further support for the cascaded activation view of lexical access. We found that the cognate status of the pictures' names affects the performance of bilingual speakers more when they are naming in their nondominant than in the dominant language. As argued by Peterson and Savoy (1998), it is reasonable to suppose that the level of activation of the phonological segments of a word depends on the level of activation of its corresponding lexical node. That is, the larger the activation of the lexical node, the larger the activation of its phonological segments. This assumption has implications for the level of activation of the phonological segments in the two languages of a bilingual. Following a suggestion by Kroll and

Stewart (1994), it is widely accepted in the literature on bilingual processing that the links between the semantic system and the lexical nodes corresponding to the dominant language are stronger than the links between the semantic system and the lexical nodes of the nondominant language. A consequence of this assumption is that the lexical nodes of the dominant language achieve higher levels of activation than the lexical nodes of the nondominant language. Therefore, when a bilingual names a picture with a cognate name in the nondominant 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 nondominant language. When the naming task is conducted in the dominant language, the activation that is sent to the phonological units of its translation in the nondominant language is not as great as the activation that was sent by the dominant language lexical nodes in the previous case. This is because the strength of the connection between semantic representations and their corresponding lexical nodes is stronger for the dominant language than it is for the nondominant language. Thus, the effects of having a cognate translation should be larger when naming in the weaker language.

An alternative explanation can be given for the differential cognate facilitation effect for the two languages of a bilingual. This alternative explanation does not require the assumption of asymmetric activation of the lexical nodes in the two languages. Rather, it could be assumed that the two languages differ in terms of the connection strengths linking lexical nodes to their phonological segments. According to this explanation, the activation received by the phonological segments from lexical nodes in the dominant language is larger than the activation received from lexical nodes in the nondominant language for comparably activated lexical nodes in the two languages. Our results shed no light on which of these two explanations is more appropriate. It is even possible that both explanations may play a role in the asymmetric facilitation effects observed in Experiment 2. Once again, however, what is crucial here is that both accounts assume cascaded processing.

Together, the results of these experiments support the hypothesis that both selected and nonselected lexical items activate their phonological segments (Cutting & Ferreira, 1999; Jescheniak & Schriefers, 1998; Peterson & Savoy, 1998). Furthermore, as described in the introduction, these results cannot plausibly be explained by appeal to the multiple selection mechanism proposed by the discrete serial activation view (Levelt et al., 1999). In fact, as described in the introduction, independent evidence argues against the possibility that multiple selection might be responsible for the cognate facilitation effect observed in these experiments. Recent results obtained in our laboratory (Costa et al., 1999), with the same population of bilingual speakers tested in the present experiment, indicate that highly proficient bilingual speakers do not consider for selection the lexical nodes in the language not programmed for response. In these studies participants were able to ignore the activation of a highly activated competitor (the translation of the picture's name) during picture naming. We argue that this phenomenon indicates that lexical nodes that belong to the nonresponse language do not normally compete during lexical selection, thereby excluding the possibility that both the lexical node of the target response and that of its translation would be selected for production. Along the same lines, although allowing for competition across languages, Hermans et al. (1998) have argued that the lexical nodes of the nonresponse language are not selected.

In summary, we conclude that the cognate facilitation effect provides support for cascaded activation models and challenges the discrete serial activation models of lexical access.

References

Bock, J. K. (1995). Sentence production: From mind to mouth. In J. Miller & P. Eimas (Eds.), *Handbook of perception and cognition: Vol. 11. Speech, language and communication* (pp. 181–216). New York: Academic Press.

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

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

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.

Cutting, J. C., & Ferreira, V. S. (1999). Semantic and phonological information flow in the production lexicon. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 25,* 318–344.

De Bot, K. (1992). A bilingual production model: Levelt's speaking model adapted. *Applied Linguistics, 13,* 1–24.

Dell, G. S. (1986). A spreading activation theory of retrieval in sentence production. *Psychological Review, 93,* 283–321.

Dell, G. S., & O'Seaghdha, P. G. (1991). Mediated and convergent lexical priming in language production: A comment on Levelt et al. (1991). *Psychological Review, 98,* 604–614.

Dell, G. S., & O'Seaghdha, P. G. (1992). Stages of lexical access in language production. *Cognition, 42,* 287–314.

Dell, G. S., Schwartz, M. F., Martin, N., Saffran, E. M., & Gagnon, D. A. (1997). Lexical access in aphasic and nonaphasic speakers. *Psychological Review, 104,* 801–838.

Fromkin, V. (1973). *Speech errors as linguistic evidence.* The Hague, The Netherlands: Mouton.

Garrett, M. F. (1975). The analysis of sentence production. In G. Bower (Ed.), *The psychology of learning and motivation: Advances in research and theory* (Vol. 9, pp. 133–177). New York: Academic Press.

Garrett, M. F. (1976). Syntactic processes in sentence production. In R. Wales & E. Walker (Eds.), *New approaches to language mechanisms* (pp. 231–256). Amsterdam: North Holland Press.

Green, D. W. (1998). Mental control of the bilingual lexico-semantic system. *Bilingualism: Language and Cognition, 1,* 67–81.

Green, J. N. (1988). Spanish. In M. Harris & N. Vincent (Eds.), *The romance languages* (pp. 79–130). Oxford, England: Oxford University Press.

Harley, T. A. (1993). Phonological activation of semantic competitors during lexical access in speech production. *Language and Cognitive Processes, 8,* 291–309.

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), 213–230.

Hotopf, W. H. N. (1980). Semantic similarity as a factor in whole-word slips of the tongue. In V. A. Fromkin (Ed.), *Errors in linguistic performance: Slips of the tongue, ear, pen, and hand* (pp. 97–110). New York: Academic Press.

Humphreys, G. W., Riddoch, M. J., & Quinlan, P. T. (1988). Cascade processes in picture identification. *Cognitive Neuropsychology, 5*(1), 67–104.

Janssen, N. (1999). *Bilingual word production: The time course of lexical activation in a mixed language context.* Unpublished master's thesis, University of Nijmegen, Nijmegen, The Netherlands.

Jescheniak, J. D., & Levelt, W. J. M. (1994). Word frequency effects in speech production: Retrieval of syntactic information and of phonological form. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 20,* 824–843.

Jescheniak, J., & Schriefers, H. (1998). Discrete serial versus cascaded processing in lexical access in speech production: Further evidence from the coactivation of near-synonyms. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 24,* 1256–1274.

Kroll, J. F., Dijkstra, T., Janssen, N., & Schriefers, H. (1999, September). *Cross-language lexical activity during production. Evidence from cued picture naming.* Poster presented at 11th conference of the European Society for Cognitive Psychology, Gent, Belgium.

Kroll, J. F., & Peck, A. (1998). *Competing activation across a bilingual's two languages: Evidence from picture naming.* Paper presented at the 43rd Annual Meeting of the International Linguistic Association, New York, NY.

Kroll, J. F., & Stewart, E. (1994). Category interference in translation and picture naming: Evidence for asymmetric connections between bilingual memory representations. *Journal of Memory and Language, 33,* 149–174.

Levelt, W. J. M. (1989). *Speaking: From intention to articulation.* Cambridge, MA: MIT Press.

Levelt, W. J. M., Roelofs, A., & Meyer, A. S. (1999). A theory of lexical access in speech production. *Brain and Behavioral Sciences, 22,* 313–335.

Levelt, W. J. M., Schriefers, H., Vorberg, D., Meyer, A. S., Pechmann, T., & Havinga, J. (1991a). Normal and deviant lexical processing: Reply to Dell and O'Seaghdha. *Psychological Review, 98,* 615–618.

Levelt, W. J. M., Schriefers, H., Vorberg, D., Meyer, A. S., Pechmann, T., & Havinga, J. (1991b). The time course of lexical access in speech production: A study of picture naming. *Psychological Review, 98,* 122–142.

Meyer, A. S., & Schriefers, H. (1991). Phonological facilitation in picture–word interference experiments: Effects of stimulus onset asynchrony and types of interfering stimuli. *Journal of Experimental Psychology: Human Perception and Performance, 17,* 1146–1160.

Oldfield, R. C., & Wingfield, A. (1965). Response latencies in naming objects. *The Quarterly Journal of Experimental Psychology, 17,* 273–281.

Pallier, C., Dupoux, E., & Jeannin, X. (1997). EXPE: An expandable programming language for on-line psychological experiments. *Behavior Research, Methods, Instruments and Computers, 29,* 322–327.

Peterson, R. R., & Savoy, P. (1998). Lexical selection and phonological encoding during language production: Evidence for cascaded processing. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 24,* 539–557.

Potter, M. C., So, K.-F., von Eckhardt, B., & Feldman, L. B. (1984). Lexical and conceptual representation in beginning and more proficient bilinguals. *Journal of Verbal Learning and Verbal Behavior, 23,* 23–38.

Poulisse, N. (1997). Language production in bilinguals. In A. de Groot & J. Kroll (Eds.), *Tutorials in bilingualism: Psycholinguistic perspectives* (pp. 201–224). Mahwah, NJ: Erlbaum.

Roelofs, A. (1992). A spreading-activation theory of lemma retrieval in speaking. *Cognition, 42,* 107–142.

Roelofs, A. (1998). Lemma selection without inhibition of languages in bilingual speakers. *Bilingualism: Language and Cognition, 1,* 94–95.

Schriefers, H., Meyer, A. S., & Levelt, W. J. M. (1990). Exploring the time-course of lexical access in production: Picture–word interference studies. *Journal of Memory and Language, 29,* 86–102.

Sebastian-Galles, N., Marti, M. A., Cuetos, F., & Carreiras, M. (1996). *LEXESP: base de datos informatizada de la lengua espanola* [LEXESP: Computerized data base of Spanish language]. Universitat de Barcelona, Departamento de Psicologia Basica.

Starreveld, P. A., & La Heij, W. (1996). Time-course analysis of semantic and orthographic context effects in picture naming. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 22,* 896–918.

Appendix A

Description of Relevant Facts About the Bilingual Community From Which Participants Were Selected

Catalan and Spanish are both Romance languages. Nouns of both languages are overtly marked for gender (masculine vs. feminine) and number. The languages have different vowel repertoires: Spanish has a relatively small inventory of five vowels (/a/, /e/, /i/, /o/, /u/), which can be realized both in stressed and unstressed positions; Catalan has eight vowels (/a/, /e/, /ɛ/, /i/, /⊃/, /o/, /u/, and /ə/), with vowel reduction in unstressed position (a, e, and /ɛ/ are reduced to schwa /ə/, and /o/ is reduced to /u/). The consonant repertoire is also different: the consonants /θ/, /v/, and /x/ can be found only in Spanish, and the consonants /ʒ/, /ʃ/, /w/, /j/, and /z/ can be found only in Catalan. There are also differences in the orthographic systems: Only Spanish has the grapheme *ñ* and only Catalan has the graphemes *ï*, and *ç*. The phoneme /tʃ/ is realized by the graphemes *ch* and *tx* in Spanish and Catalan, respectively. Finally, in Catalan two signs are used to indicate stress (as in *é* and *è*) but only one in Spanish (*é*). In Catalonia, Catalan and Spanish are both official languages. The current education system requires that at the end of primary school (when students are 11–12 years old), children are able to read, write, speak, and understand both Catalan and Spanish. In high school, some classes are taught in Catalan and others in Spanish. At the university, classes and tests can be in either language; quite often half of the test is in Catalan, the other half in Spanish. Radio and television programs are broadcast in Catalan and in Spanish. Furthermore, some newspapers publish articles both in Catalan and in Spanish.

Appendix B

Language Usage and Skills of the Participants in Experiments 1 and 2

		Language usage						Language skills					
		Speaking		Reading		Writing		Speaking		Reading		Writing	
Experiment	Dominance (first language)	Cat	Span	Cat	Span	Cat	Span	Cat	Span	Cat	Span	Cat	Span
1	Cat	69.1	30.9	50.4	49.6	71.7	28.3	9.0	8.0	9.2	9.1	8.5	8.8
2	Cat	80.6	19.6	52.7	47.3	77.1	22.9	9.1	7.3	9.2	8.5	9.0	8.0
2	Span	26.7	73.3	42.7	57.3	42.5	57.5	7.2	9.4	8.4	9.6	7.8	9.9

Note. The language use and skill scores were obtained by a questionnaire administered after the experiment. Language use scores represent the percentage of the time using the two languages. Language skill scores were obtained using a 10-point scale (0 = *very bad,* 10 = *native speaker*). Cat = Catalan; Span = Spanish.

Appendix C

List of the Stimuli Used in Experiment 1

Low-frequency cognates			Low-frequency noncognates		
Spanish	Catalan	English	Spanish	Catalan	English
martillo	martell	[hammer]	calcetin	mitjo	[sock]
cuchara	cullera	[spoon]	zanahoria	pastanaga	[carrot]
camello	camell	[camel]	queso	formatge	[cheese]
ambulancia	ambulancia	[ambulance]	rana	granota	[frog]
tanque	tanc	[tank]	melocoton	pressec	[peach]
remo	rem	[oar]	muela	queixal	[tooth]
faro	far	[lighthouse]	pato	anec	[duck]
volcan	volca	[volcano]	tenedor	forquilla	[fork]
piramide	piramide	[pyramid]	cuchillo	ganivet	[knife]
violin	violi	[violin]	manzana	poma	[apple]

High-frequency cognates			High-frequency noncognates		
Spanish	Catalan	English	Spanish	Catalan	English
arbol	arbre	[tree]	rama	branca	[branch]
banco	banc	[bench]	hoja	fulla	[leaf]
brazo	braç	[arm]	ventana	finestra	[window]
casco	casc	[helmet]	mesa	taula	[table]
cruz	creu	[cross]	ojo	ull	[eye]
falda	faldilla	[skirt]	pajaro	ocell	[bird]
mano	ma	[hand]	perro	gos	[dog]
nube	nuvol	[cloud]	pierna	cama	[bed]
puerta	porta	[door]	silla	cadira	[chair]
soldado	soldat	[soldier]	sombrero	barret	[hat]

(*Appendix D follows*)

Appendix D

List of the Stimuli Used in Experiment 2

Cognates			Noncognates		
Spanish	Catalan	English	Spanish	Catalan	English
auriculares	auriculars	headphones	berenjena	alberginia	eggplant
avion	avio	plane	calcetin	mitjo	sock
banco	banc	bench	cama	llit	bed
bolsa	bossa	purse	camiseta	samarreta	shirt
bomba	bomba	bomb	cerdo	porc	pigeon
brazo	braç	arm	cubo	galleda	bucket
caja	caixa	box	cuchillo	ganivet	knife
camello	camell	camel	fresa	maduixa	strawberry
casa	casa	house	grifo	aixeta	faucet
casco	casc	helmet	hoja	fulla	leaf
coche	cotxe	car	lechuga	enciam	lettuce
cruz	creu	cross	lluvia	pluja	rain
cuchara	cullera	spoon	manzana	poma	apple
falda	faldilla	skirt	mariposa	papallona	butterfly
fantasma	fantasma	ghost	melocoton	pressec	peach
faro	far	lighthouse	mesa	taula	table
flecha	fletxa	arrow	muela	queixal	tooth
foca	foca	seal	mujer	dona	woman
gato	gat	cat	muñeca	nina	doll
gorra	gorra	cap	ojo	ull	eye
mano	ma	hand	pajaro	ocell	bird
martillo	martell	hammer	paloma	colom	pigeon
microfono	microfon	microphone	pañuelo	mocador	handkerchief
mosca	mosca	fly	pato	anec	duck
nube	nuvol	cloud	perro	gos	dog
percha	perxa	hanger	pierna	cama	leg
piramide	piramide	pyramid	queso	formatge	cheese
pistola	pistola	gun	rama	branca	branch
plancha	planxa	iron	rana	granota	frog
puerta	porta	door	red	xarxa	net
raqueta	raqueta	racquet	silla	cadira	chair
remo	rem	oar	sombrero	barret	hat
soldado	soldat	soldier	tenedor	forquilla	fork
tanque	tanc	tank	trigo	blat	wheat
vaca	vaca	cow	uva	raim	grape
violin	violi	violin	ventana	finestra	window
volcan	volca	volcano	zanahoria	pastanaga	carrot

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