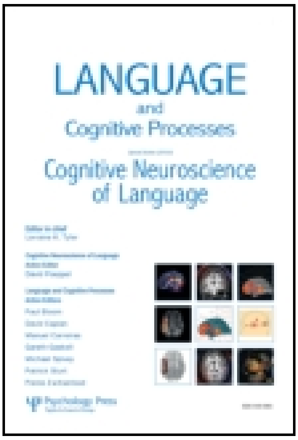

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Lexical activation in bilinguals' speech production is dynamic: How language ambiguous words can affect cross-language activation

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Lexical activation in bilinguals' speech production is dynamic: How language ambiguous words can affect cross-language activation

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Is the bilingual language production system a dynamic system that can operate in different language activation states? Three experiments investigated to what extent cross-language phonological co-activation effects in language production are sensitive to the composition of the stimulus list. L1 Dutch–L2 English bilinguals decided whether or not a particular phoneme was part of the L2 English name of the picture. The phoneme was either part of the English name of the picture (/b/ or /t/ in *bottle*), the Dutch name of the picture (/f/ in *fles* [bottle], the cross-language condition), or was not part of either the English or Dutch names of the picture (/p/, the unrelated condition). In Experiment 1, we added a set of filler pictures with noncognate names in Dutch and English.

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In contrast, the filler pictures in Experiment 2 all had cognate names in Dutch and English. In Experiment 3 the fillers consisted of a mixture of pictures with cognate (25%) and noncognate (75%) names. Cross-language phonological co-activation appeared sensitive to the composition of the stimulus list: Phonological co-activation effects were observed in Experiments 2 and 3, but not in Experiment 1. The results indicate that the bilingual language production system dynamic and can operate in different modes, depending upon the composition of the stimulus list. We discuss implications for experimental paradigms used in the field of bilingual language production, and for current bilingual language production models.

Keywords: Bilingualism; Cross-language activation.

In the last two decades, many studies on the comprehension and production of language in bilinguals have shown that both of the bilinguals' two languages are active and available, even when the bilingual is performing a task in one language only (for reviews, see Dijkstra, 2005 (word recognition) and Kroll, Bobb, Misra, & Guo, 2008 (word production)). In producing speech there is brief activation of the word in the other language, i.e., the translation equivalent, that can extend all the way to the level of phonology (Colomé, 2001; Costa & Caramazza, 1999; Costa, Caramazza, & Sebástian-Gallés, 2000; Costa, Colomé, Gómez, & Sebastián-Gallés, 2003; Costa, Miozzo, & Caramazza, 1999; Gollan & Acenas, 2004; Hermans, Bongaerts, De Bot, & Schreuder, 1998; Hoshino & Kroll, 2008; Kroll, Dijkstra, Janssen, & Schriefers, 2000; Lee & Williams, 2001; Meuter & Allport, 1999).

However, the activation of a bilinguals' two languages in language production and comprehension may not be an "all or none" concept (e.g., Dijkstra & Van Hell, 2003; Grosjean, 1998, 2001; Kroll, Bobb, & Wodniecka, 2006). Under certain circumstances, only one of the two languages may be activated (and the bilingual system may thus operate as a language-selective system), or words from the two languages may be activated to a different extent. Some recent studies indeed suggest that the bilingual language system is a dynamic system that can operate in different language activation states, depending on factors like the bilingual's relative proficiency in each of the languages (e.g., Jared & Kroll, 2001; Van Assche, Duyck, Hartsuiker, & Diependaele, 2009; Van Hell & Dijkstra, 2002), linguistic cues emanating from a word or sentence presented prior to the target word (e.g., Dimitropoulou, Duñabeita, & Carreiras, in press; Duyck, Van Assche, Drieghe, & Hartsuiker, 2007; Libben & Titone, 2009; Schwartz & Kroll, 2006; Van Hell & De Groot, 2008), specific task demands (e.g., Dijkstra, De Bruijn, Schriefers, & Ten Brinke, 2000; Macizo & Bajo, 2006), or the composition of the stimulus list (e.g., Dijkstra, Van Jaarsveld, & Ten Brinke, 1998; Van Heuven, Dijkstra, & Grainger, 1998).

The majority of studies that investigated factors that potentially affect relative language activation focused on visual word recognition. As pointed out by Costa and Santesteban (2004a), processes involved in language production and language comprehension are different enough to warrant caution against generalising experimental results across these two modalities (see also Costa, 2005; French & Jacquet, 2004). In language comprehension, language membership is (partly) encoded in the input itself, and is not directly controlled by the listener or reader. In language production, speakers themselves intentionally select the language in which they desire to express their communicative intention. Speakers directly use language information to select and produce words in the appropriate language only. Costa and Santesteban (2004a) argued that these differences may imply that the control a speaker can exert on the activation state of the bilingual language system may be different from the control a listener or a reader can exert. So, the implications of studies that have investigated how factors like the composition of the stimulus list affect the activation state of the bilingual language comprehension system do not necessarily apply to language production.

In the present study, we studied different language activation states of the bilingual language system in language production. Specifically, we studied the extent to which cross-language effects in L2 production are affected by variations in the amount of language ambiguous words in the stimulus list. As of yet, this question received little attention in the bilingual language production literature. We used the phoneme monitoring task (e.g., Weeldon & Levelt, 1995) that was introduced by Colomé (2001) to study cross-language activation in bilinguals. In this often-cited study, Colomé asked Catalan–Spanish bilinguals to decide whether or not a particular phoneme was part of the Catalan name of the picture. The phoneme was either the first or second consonant of the Catalan name of the picture (/t/ in *taula* (table)), the first consonant of the Spanish name of the picture (/m/ in *mesa* (table)) or not part of either the Catalan or Spanish names of the picture (/f/). It appeared that Catalan–Spanish bilinguals took more time to correctly reject a phoneme when that phoneme was the first consonant of the Spanish name of the picture compared to an unrelated phoneme. Colomé (2001) concluded that the Spanish name of the picture was phonologically co-activated during the phoneme monitoring task in Catalan. She argued that the results are consistent with bilingual models that assume that words from both languages are activated up to the phonological level during language production.

In the phoneme monitoring task as used by Colomé (2001), cross-language activation can be studied without the presence of stimuli from the other language. This is in sheer contrast to, for instance, paradigms like the picture–word interference task in which distractor words from the language not needed for production are presented to study the process of lexical selection in bilinguals (Costa & Caramazza, 1999; Costa et al., 1999; Hermans et al., 1998). Similarly, several picture naming studies have used pictures with cognate names, translation equivalents that have similar orthographic and phonological forms in both languages (e.g., the English–Dutch translations *apple–appel)* to study cross-language activation during language production (Costa et al., 2000; Hoshino & Kroll, 2008; Kroll et al., 2000). In line with the proposals by Grosjean (1998, 2001) and Kroll et al. (2006), the presence of distractor words from the language not needed for production or the presentation of cognate pictures in these studies may have an effect on the activation state of both a bilingual's languages.

In the present study we investigated to what extent the bilingual language production system is a dynamic system that can operate in different language activation states, depending on the stimulus list composition. In three phoneme monitoring experiments we manipulated the proportion of the filler pictures with cognate and noncognate names. Note that in the Colomé (2001) study, filler pictures were used to decrease the proportion of trials in which the target phoneme was the first consonant of the Spanish name of the picture. Although these filler pictures were not described in the materials section, personal communication with Colomé (July, 2008) indicated that her filler materials comprised of a mixture of noncognates and cognates, with a larger proportion of noncognates than cognates. We hypothesise that the presence of pictures with cognate names in the bilingual's two languages may have had an effect on the activation state of both languages.

In each experiment of this study, L1 Dutch–L2 English bilinguals were asked to decide whether or not a particular phoneme was part of the English name of a picture. The phoneme was either part of the English name of the picture (/b/ or /t/ in *bottle*), the first consonant of the Dutch name of the picture (/f/ in *fles* (bottle), the cross-language condition), or not part of either the English or Dutch names of the picture (/p/ in *fles* (bottle), the unrelated condition). In Experiment 1, a set of filler pictures was added which had exclusively noncognate names in English and Dutch. In Experiment 2, these fillers were replaced by pictures that had cognate names in English and Dutch. Finally, in Experiment 3 the filler pictures were comprised of a mixture of pictures with cognate and noncognate names. The rationale was that the presence of filler pictures with cognate names in English and Dutch should lead to an increase in the activation of the L1 Dutch during the experiment. If the bilingual language system is a dynamic system that can operate in different language activation states, depending on the stimulus list composition, the magnitude of phonological co-activation effects should vary as a function of the proportion of pictures with cognate names in the filler materials.

EXPERIMENT 1: PHONEME MONITORING WITH EXCLUSIVELY NONCOGNATE FILLERS

Method

Participants

Thirty undergraduates, 6 males and 24 females, of the Radboud University Nijmegen took part. All participants were native speakers of Dutch, and learners of English as a second language. Their average age was 22;8 (range 18;8–38;7). All participants had received instruction in English as a second language in primary education from grade 5 onwards (around age 10). After the experiment, participants conducted the L-lex vocabulary test (Meara, 1994). The average score on the L-lex vocabulary test was 76.2 ($SD = 12.8$, range 47–97); a 70–80 L-lex score is comparable to a 550–600 (paper-based) TOEFL score.

Materials

The materials consisted of 54 drawings of common objects. Twenty-four pictures were used in the experimental conditions, 24 pictures were used in the filler conditions, and 6 pictures were used as practice items. All 24 experimental pictures had an English name that had a noncognate translation equivalent in Dutch. All the pictures had names that started with a consonant in English and in Dutch. Appendix 1 lists the experimental pictures used in Experiments 1–3. The 24 filler pictures had a noncognate name in Dutch and English. Appendix 2 lists the filler pictures used in Experiments 1–3.

Design

The design, procedure and analyses were identical to the ones used by Colomé (2001; Experiment 2). Each picture in the experimental conditions was presented four times to each participant, once in each experimental condition. Examples of the four experimental conditions are listed in Table 1.

Two experimental conditions required an affirmative response. In the affirmative conditions, the target phoneme (e.g., /b/ and /t/; see Table 1) corresponded to the first consonant (first affirmative condition) or second/third consonant (second affirmative condition) of the L2 English name of the picture (*bottle*). In both affirmative conditions, the target phoneme did not appear in the L1 Dutch name of the picture (*fles* (bottle)). In the two negative conditions, the target phoneme (in this example: /f/ and /p/) was not part of the L2 English name of the picture. In the first negative condition, the cross-language condition, the target letter (/f/) was the first consonant of the L1 Dutch name of the picture (*fles* (bottle). In the second negative condition,

TABLE 1
Examples of the stimuli used in the experimental conditions in Experiments 1–3

	Description	*Picture*	*Phoneme*
Affirmative conditions			
Affirmative-1 condition	1st syllable onset in English	BOTTLE (fles)	B
Affirmative-2 condition	2nd / 3rd consonant in English	BOTTLE (fles)	T
Negative conditions			
Cross-language condition	1st syllable onset in Dutch	BOTTLE (fles)	F
Unrelated condition	Unrelated phoneme	BOTTLE (fles)	P

the unrelated condition, the letter (/p/) was not part of the L1 Dutch of the picture (*fles* (bottle).

Filler pictures were also presented four times to each participant. In the affirmative conditions, the letter appeared as the first or second consonant of the L2 English name of the picture, and was usually, but not always, also part of the L1 Dutch name of the picture. In the two negative conditions, the letters were not part of the L1 Dutch or L2 English names of the pictures. The experiment was divided into four blocks of 48 trials. Each picture was presented only once in each block. Sixteen different lists of experimental items were constructed.

Procedure

Participants were tested individually in a soundproof room. At the start of the experiment, participants were shown a booklet with the 54 pictures with their L2 English names written underneath. They were asked to study the names of the pictures. They then received the instruction for the experiment. They were told that a picture would be presented on the computer screen followed by a letter, and that they had to decide whether or not the phoneme associated with the letter was part of the English name of the picture by pushing one of two buttons on a button box. The experimental session was preceded by a practice session.

Each trial was as follows. A picture was presented on the computer screen for 400 ms, which was then replaced by a letter. The letter was presented for a duration of 600 ms and subsequently replaced by a blank screen. Reaction times were measured from the presentation of the letter. A trial lasted for a maximum of 2000 ms. The inter-stimulus time was set at 1500 ms. After the experiment, participants conducted the L-lex vocabulary task (Meara, 1994) and then completed a language questionnaire. A complete session lasted about 45 minutes.

TABLE 2
Mean response latencies (RT, in ms), standard deviation and accuracy scores (in percentages) in the four experimental conditions in Experiment 1

	RT	*SD*	*Accuracy*
Negative conditions			
Cross-language condition	917	297	88.61
Unrelated condition	922	334	91.53
Affirmative conditions			
Affirmative-1 condition	739	233	89.72
Affirmative-2 condition	867	279	79.44

Results

Response latencies that deviated more than two SDs from the participants' and items' means in each condition were classified as errors. This accounted for 1.70% of the data.

Table 2 lists the mean response latencies, the standard deviations and the percentages of correct responses in the four conditions. Analyses of variance were conducted on the data in the two critical negative conditions, the cross-language condition and the unrelated condition, with the factor Condition as within-subject and within-item factor. No significant effect of Condition was observed in the analyses of the response latencies, $F_1(1, 29) < 1$, $F_2(1, 23) < 1$, and in the analyses of the accuracy scores, $F_1(1, 29) = 3.17$, $MSE = 40.2$, $p = .085$, $F_2(1, 23) = 3.89$, $MSE = 26.2$, $p = .061$.

Next, analyses of variance were conducted on the data of the two affirmative conditions, the affirmative-1 (target phoneme is first consonant) and affirmative-2 (target phoneme is second/third consonant), with the factor Position as within-subject and within-item factor. A significant effect of Position was observed in the analyses of the response latencies, $F_1(1, 29) = 68.40$, $MSE = 3681.92$, $p < .001$, $F_2(1, 23) = 43.55$, $MSE = 4981.33$, $p < .001$, and in the analyses of the accuracy scores $F_1(1, 29) = 28.85$, $MSE = 54.92$, $p < .001$, $F_2(1, 23) = 13.32$, $MSE = 95.12$, $p < .01$.

Discussion

In Experiment 1, L1 Dutch–L2 English bilinguals conducted a phoneme monitoring task in their L2. Like Weeldon and Levelt (1995) and Colomé (2001), we found that the position of the consonant in the name of the picture significantly affected the accuracy and speed with which participants were able to make a correct "yes" decision. Thus, participants were faster and more accurate in detecting a target phoneme at the onset of the name of the picture in comparison to a target phoneme that was the second or third consonant of the name of the picture. The observation of this within-language phoneme position effect demonstrates that participants performed the phoneme monitoring task similarly (from left to right) to the participants in the Weeldon and Levelt (1995) and Colomé (2001) studies.

More importantly, we found that participants were not significantly slower or less accurate in rejecting a phoneme when that particular phoneme was the onset of the first syllable of the Dutch name of the picture in comparison to an unrelated phoneme. Overall, our results suggests that the L1 Dutch name of the picture is not phonologically co-activated during phoneme monitoring in the L2 English unbalanced bilinguals when the filler pictures are exclusively made up of pictures with noncognate names in Dutch and English.

In Experiment 2, these filler pictures were replaced by pictures with cognate names in English and Dutch. If the bilingual language system is a dynamic system that can operate in different language activation states, depending on the stimulus list composition, an interference effect in the cross-language condition should appear in Experiment 2.

EXPERIMENT 2: PHONEME MONITORING WITH EXCLUSIVELY COGNATE FILLERS

Method

Participants

Thirty-five Dutch–English bilinguals, 6 males and 29 females, all undergraduates of the Radboud University, participated. The participants were selected from the same population as Experiment 1, but none of them had participated in this experiment. The data of three participants (all females) were excluded from further analyses, as their average accuracy was below 75% (their mean errors rates in the experimental conditions were 27.1, 37.5, and 28.1%). The average age of the 32 remaining participants was 23;2 (range 18;3–29;1). All participants were native speakers of Dutch, and had received instruction in English as a second language in primary education from grade 5 onwards. After the experiment, participants conducted the L-lex vocabulary test (Meara, 1994). The average score on the L-lex vocabulary test of the 32 remaining participants was 78.7 ($SD = 9.2$, range 51–97). A t-test showed that the vocabulary scores of participants in Experiments 1 and 2 did not differ significantly $t(60) = 0.90$, $p > .1$.

Materials

In the experimental conditions, the same set of pictures was used as in Experiment 1. A new set of 24 filler pictures with cognate names in English and Dutch was selected. The full list of the filler pictures is listed in Appendix 1.

Design

The design was identical to that used in Experiment 1.

Procedure

The procedure was identical to that used in Experiment 1.

Results

Response latencies that deviated more than two *SD*s from the participants' and items' mean in the relevant condition were classified as errors. This accounted for 1.33% of the data.

Table 3 lists the mean response latencies, standard deviations and the accuracy scores in the four experimental conditions. Analyses of variance were conducted on the data of the two negative conditions, the cross-language condition and the unrelated condition, with the factor Condition as within-subject and within-item factor. Analyses of variance on the response latencies revealed a significant effect of Condition in the by-subject analysis that approached significance in the by-item analysis, $F_1(1, 31) = 6.62$, $MSE = 3137.89$, $p < .05$, $F_2(1, 23) = 3.66$, $MSE = 5793.21$, $p = .068$. In addition, a significant effect of Condition was observed in the analyses of the accuracy scores, $F_1(1, 31) = 9.55$, $MSE = 36.77$, $p < .01$, $F_2(1, 23) = 5.50$, $MSE = 48.04$, $p < .05$.

Next, analyses of variance were conducted on the data of the two positive conditions, the affirmative-1 (target first consonant) and affirmative-2 (target second/third consonant), with the factor Position as within-subject and within-item factor. A significant effect of Position was observed in the analyses of the response latencies, $F_1(1, 31) = 93.93$, $MSE = 3596{,}73$, $p < .001$, $F_2(1, 23) = 54.42$, $MSE = 4703.84$, $p < .001$, and the accuracy scores, $F_1(1, 31) = 27.11$, $MSE = 42.32$, $p < .001$, $F_2(1, 23) = 13.72$, $MSE = 62.61$, $p < .01$.

TABLE 3
Mean response latencies (RT, in ms), standard deviation and accuracy scores (in percentages) in the four experimental conditions in Experiment 2

	RT	*SD*	*Accuracy*
Negative conditions			
Cross-language condition	906	296	87.24
Unrelated condition	869	304	91.93
Affirmative conditions			
Affirmative-1 condition	703	231	89.45
Affirmative-2 condition	848	295	80.99

Discussion

In Experiment 2, we found that the position of the consonant in the (L2) name of the picture affected the accuracy and speed with which participants were able to make a correct "yes" decision. Participants were faster and more accurate in detecting a target phoneme at the onset of the L2 name of the picture in comparison to a target phoneme that was the second or third consonant of the L2 name of the picture. The observation of this within-language phoneme position effect again demonstrates that participants performed the phoneme monitoring task similarly (from left to right) to the bilinguals that participated to Experiment 1, and the participants in the Weeldon and Levelt (1995) and Colomé (2001) studies.

More importantly, participants were slower and less accurate in rejecting a phoneme in the L2 phoneme monitoring task when that particular phoneme was the onset of the first syllable of the L1 Dutch name of the picture. This finding replicates the effect reported by Colomé (2001) for Catalan–Spanish bilinguals, and suggests that the L1 name of the picture is phonologically co-activated during phoneme monitoring in the L2 when a bilingual context is created through the use of filler pictures with cognate names in Dutch and English.

The combined results of Experiments 1 and 2 suggest that the bilingual language production system is dynamic and can operate in different language activation states, depending on the composition of the stimulus list. When the stimulus list contains filler pictures that exclusively have noncognate names in Dutch and English (Experiment 1), the L1 Dutch picture names were not phonologically co-activated in the L2 English monitoring task. In contrast, when the stimulus list contains filler pictures that exclusively have cognate names in Dutch and English (Experiment 2), the phonological representations of the Dutch picture names are co-activated.

The findings of Experiments 1 and 2 raise the question how large the proportion of filler pictures with cognate names in phoneme monitoring tasks should be to affect the bilingual system in such a way that cross-language effects are observed. Connecting the findings of Experiments 1 and 2 to the study of Colomé (2001) may offer a first answer. Colomé found phonological co-activation of L1 Catalan during phoneme monitoring in L2 Spanish in highly proficient Catalan–Spanish bilinguals. In the Colomé study, the filler materials comprised of a mixture of pictures with noncognates and cognates names in Spanish and Catalan, with the proportion of filler pictures with noncognates names outnumbering the proportion of filler pictures with cognates names. On the basis of the combined results of Colomé and Experiments 1 and 2 of the present study, it may be tempting to conclude that a relatively small number of pictures with cognates names is already sufficient to affect the bilingual language system, and to move this system to a state in which the bilinguals' two languages are active. However, such a conclusion is premature, because the Dutch–English bilinguals tested in the present study differ from the Catalan–Spanish bilinguals tested by Colomé in terms of age of acquisition of the L2 and language proficiency in L2. To illustrate, the Catalan–Spanish bilinguals tested by Colomé usually start to acquire Spanish upon entering kindergarten (around age 4), or even at an earlier age. In contrast, the Dutch–English bilinguals tested in the present study learned English from 5th grade onwards, around the age of 10. Second, although the Catalan–Spanish bilinguals tested by Colomé, Costa, and colleagues and the Dutch–English bilinguals tested in the present study are both highly proficient in their L2, the Catalan–Spanish bilinguals typically attained a higher level of L2 proficiency than the Dutch–English bilinguals (for more details, see Costa et al., 2003). Variation in language learning history and L2 proficiency are factors that potentially affect the conditions under which (and the extent to which) cross-language activation occurs. We therefore conducted a third experiment in which the proportion of filler pictures with cognate names in English and Dutch was reduced to 25%.

EXPERIMENT 3: PHONEME MONITORING WITH 25% COGNATE AND 75% NONCOGNATE FILLERS

Method

Participants

Thirty-six Dutch–English bilinguals, 2 males and 34 females and all undergraduates of the Radboud University, participated. They were selected from the same population as Experiments 1 and 2, and none of them had participated in these experiments. The data of four participants (1 male and 3 females) were excluded from further analyses, as their average was below 75% (their mean errors rates across the experimental conditions were 26.0%, 44.8%, 29.2% and 29.2%). The average age of the 32 remaining participants was 20;1 (range 18;3–24;1). All participants were native speakers of Dutch, and had received L2 English language classes in primary education from grade 5 onwards. After the experiment, participants conducted the L-lex vocabulary test (Meara, 1994). The average score of the 32 participants on this test was 74.3 ($SD = 8.9$, range 48–87). *T*-tests showed that vocabulary scores of the participants in Experiment 3 did not differ significantly from the scores of participants in Experiment 1, $t(60) = 0.94$, $p > .1$, and Experiment 2, $t(62) = 1.58$, $p > .1$.

Materials

In the experimental conditions, the same set of pictures was used as in Experiments 1 and 2. A new set of 24 filler pictures was selected, 18 from the noncognate filler pictures used in Experiment 1 and 6 from the cognate filler pictures used in Experiment 2 (see Appendix 2). The proportion of cognates in the filler materials was thus 25%.

Design

The design was identical to that used in Experiments 1 and 2.

Procedure

The procedure was identical to that used in Experiments 1 and 2.

Results

Response latencies that deviated more than two SDs from the participants' and items' mean in the relevant condition were classified as errors. This accounted for 1.63% of the data.

Table 4 lists the mean response latencies, standard deviations, and accuracy scores. As in Experiments 1 and 2, analyses of variance were conducted on the data in the two negative conditions, the cross-language condition and the unrelated condition, with the factor Condition as within-subject and within-item factor. Analyses of variance on the response latencies revealed a significant effect of Condition, $F_1(1, 31) = 15.02$, $MSE = 3076.18$, $p < .01$, $F_2(1, 23) = 12.50$, $MSE = 3038.93$, $p < .01$. The effect of Condition was marginally significant in the analyses of the accuracy scores, $F_1(1, 31) = 3.51$, $MSE = 27.91$, $p = .070$, $F_2(1, 23) = 3.68$, $MSE = 19.91$, $p = .067$. Furthermore, analyses of variance were conducted on the data of the two

TABLE 4
Mean response latencies (RT, in ms), standard deviation and accuracy scores (in percentages) in the four experimental conditions in Experiment 3

	RT	*SD*	*Accuracy*
Negative conditions			
Cross-language condition	954	314	92.32
Unrelated condition	901	286	94.79
Affirmative conditions			
Affirmative-1 condition	763	258	91.28
Affirmative-2 condition	946	309	80.60

positive conditions, the affirmative-1 (target first consonant) and affirmative-2 (target second/third consonant), with the factor Position as within-subject and within-item factor. A significant effect of Position was observed in the analyses of the response latencies, $F_1(1, 31) = 142.24$, $MSE = 3637.19$, $p < .001$, $F_2(1, 23) = 136.58$, $MSE = 2940.44$, $p < .01$, and the accuracy scores, $F_1(1, 31) = 32.59$, $MSE = 56.06$, $p < .001$, $F_2(1, 23) = 24.80$, $MSE = 55.28$, $p < .001$.

Combined analyses of the cross-language effects obtained in Experiments 1–3

Additional analyses were conducted to investigate to what extent the cross-language effects we observed differed significantly from each other across the three experiments. First, analyses of variance were conducted on the response latencies in the two negative conditions, the cross-language condition, and the unrelated condition, with the factor Condition as within-subject and within-item factor and the factor Experiment as between-subject and within-item factor. These analyses showed a significant main effect of Condition, $F_1(1, 91) = 11.50$, $MSE = 3686.23$, $p < .01$, $F_2(1, 23) = 4.47$, $MSE = 7710.87$, $p < .05$. The main effect of Experiment approached significance in the by-item analysis, $F_1(2, 91) < 1$, $F_2(2, 46) = 2.91$, $MSE = 6571.22$, $p = .065$. More importantly, the interaction between Condition and Experiment was significant, $F_1(2, 91) = 3.10$, $MSE = 3685.67$, $p < .05$, $F_2(2, 46) = 4.90$, $MSE = 2556.56$, $p < .05$. Additional analyses revealed that the interaction between Condition and Experiment was significant in the comparison between Experiments 1 and 2, $F_1(1, 60) = 4.14$, $MSE = 4000.14$, $p < .05$, $F_2(1, 23) = 4.35$, $MSE = 3109.66$, $p < .05$, and Experiments 1 and 3, $F_1(1, 60) = 5.56$, $MSE = 3969.35$, $p < .05$, $F_2(1, 23) = 10.13$, $MSE = 2258.12$, $p < .01$, but not in the comparison between Experiments 2 and 3, F_1 $(1, 62) < 1$, $F_2(1, 23) < 1$.

Second, analyses of variance were conducted on the accuracy scores in the two negative conditions, the cross-language condition and the unrelated condition, with the factor Condition as within-subject and within-item factor and the factor Experiment as between-subject and within-item factor. These analyses revealed that the main effects of Condition, $F_1(1, 91) = 15.20$, $MSE = 34.87$, $p < .01$, $F_2(1, 23) = 7.41$, $MSE = 54.79$, $p < .05$ and Experiment, $F_1(2, 91) = 4.60$, $MSE = 64.87$, $p < .05$, $F_2(2, 46) = 4.93$, $MSE = 45.72$, $p < .05$, reached significance. The interaction between Condition and Experiment failed to reached significance, $F_1(2, 91) < 1$, $F_2(2, 46) < 1$. The separate accuracy analyses of the three experiments, and the means in Tables 2–4 show, however, that the accuracy data do not contradict the response latencies. Although the differences are less pronounced, the accuracy data actually follow the pattern of the response latencies.

Discussion

In Experiment 3, the filler pictures consisted of 25% pictures with cognate names and 75% pictures with noncognate names. As in Experiments 1 and 2, we found in the affirmative conditions that the response latencies and accuracy scores were sensitive to the position of the target phoneme in the word: Participants responded faster and more accurately when the target phoneme was the first consonant of the English name of the picture in comparison to the second/third consonant. Second, like in Experiment 2, we found that the correct rejection of a target phoneme was more difficult when that phoneme was the onset of the Dutch name of the picture. The combined analyses of the results in the two negative conditions, the cross-language condition and the unrelated condition, across the three experiments revealed that, with respect to the cross-language activation effect, only the response latency measure revealed a sensitivity to the proportion of fillers with cognate names. The combined results of the three phoneme monitoring experiments show that the proportion of fillers pictures with cognate names in phoneme monitoring tasks can affect the language activation state of the bilingual system. Interestingly, although the proportion of pictures with cognate names was much larger in Experiment 2 (100%) than in Experiment 3 (25%), the magnitude of the cross-language effects was similar in both experiments. This suggests that only a small proportion of cognate filler items suffice to co-activate the nontarget language.[1]

GENERAL DISCUSSION

A key finding in the literature on bilingual lexical access is that both a bilingual's languages are available in parallel during the production of words in one language. Are both languages always active, or can certain linguistic or situational factors influence the extent to which each of the two languages are active? In this study we examined whether the bilingual language system is a dynamic system that can operate in different language activation states, and obtained evidence in support of this idea. Three phoneme monitoring experiments were conducted with L1 Dutch–L2 English bilinguals in their L2 English. In the two critical negative conditions, the target phoneme was

[1] As suggested by a reviewer, an interesting question is *when* the nontarget language becomes active: Does co-activation of the nontarget language build up gradually in the course of the experiment, or is the nontarget language already fully active after the bilingual has been exposed to only a few cognate items? Because Experiment 3 contained too few cognate items, we could not reliably examine the temporal dynamics of cross-language activation by splitting the data into different blocks and compare cross-language activation in the first versus later blocks. The present study does show that only a few cognate items suffice to co-activate the nontarget language.

either the first consonant of the L1 Dutch name of the picture (/f/ in *fles* (bottle), the cross-language condition) or was not part of either the English or Dutch names of the picture (/p/, the unrelated condition). The rationale was that if the L1 Dutch name of the picture is phonologically co-activated during phoneme monitoring in the L2 English, rejection would be more difficult (e.g., longer response latencies and more errors) in the cross-language condition than in the unrelated condition (Colomé, 2001). To investigate whether the bilingual language system can operate in different language activation states, the proportion of cognate filler pictures was manipulated across three experiments. Importantly, the three experiments were identical in terms of the critical stimulus materials, task instructions and target language, and we only manipulated the proportion of filler items with cognate or noncognate names. When all filler pictures had noncognate names in Dutch and English, we obtained no evidence for phonological co-activation of the L1 Dutch name of the picture during phoneme monitoring in the L2 English (Experiment 1). In contrast, when all filler pictures had cognate names in Dutch and English, phonological co-activation effects were observed (Experiment 2). Experiment 3 showed that such a phonological co-activation effect can already occur with only 25% of cognate filler items.

Our study was inspired by the often-cited study by Colomé (2001) in which Catalan–Spanish bilinguals performed a phoneme monitoring task, and needed more time to reject a phoneme when that phoneme was the first consonant of the nontarget language as compared to an unrelated phoneme. In the literature on bilingual speech production, these findings are interpreted as strong evidence for the view that words from both languages are available in parallel up to the phonological level. However, Colomé's (2001) study included filler items to decrease the proportion of trials in which the target phoneme was the first consonant of the nontarget language name of the picture. These filler items were are mixture of cognates and noncognates, and we wondered whether Colomé's cross-language phoneme monitoring effects may have been driven by the cognates fillers, and, more generally, whether cross-language effects in language production are affected by the composition of the stimulus list. Our study indeed indicates that the extent to which cross-language effects are obtained in a phoneme monitoring task as used by Colomé (2001) depends on the composition of the stimulus list (in particular the proportion of cognate and noncognate fillers) and the variation in relative language activation that results from an exclusively monolingual L2 list or from a bilingual mixture of lexical items in L2 and L1. When the filler items included 25% cognates (Experiment 3, which came closest to Colomé's study) or 100% cognates (Experiment 2), we observed a cross-language phonome monitoring effect, indicating phonological co-activation of the L1 Dutch name of the picture during phoneme monitoring in the L2 English. In contrast, when all filler items were pictures with noncognate names (Experiment 1), no evidence for phonological co-activation of the L1 Dutch name was obtained. Importantly, in all three experiments we obtained a position effect in the affirmative conditions (see also Weeldon & Levelt, 1995): participants were faster and more accurate in correctly making a "yes" decision when the target phoneme was the first consonant of the L2 English name of the picture in comparison to the second or third consonant of the L2 English name of the picture. Our study puts the results of the Colomé study in a different light by showing that the basic findings are replicated only when a certain number of language ambiguous items (cognates) are included in the stimulus list. At a more general level, our findings together with those of Colomé (2001) support the notion that the bilingual speech production system is a dynamic system that can operate in different language activation states, depending upon factors like the composition of the stimulus list.

The fact that the findings of our Experiment 3 parallel those by Colomé (2001), even though the bilinguals tested in the two studies differ in L2 language learning history and L2 proficiency, suggests that the basic findings are quite robust and impervious to variations in language learning history and proficiency. This adds to earlier studies on language production with both populations that have yielded highly similar results regarding the cognate facilitation effect in picture naming (Costa et al., 2000; Kroll et al., 2000), the so-called "between-language semantic interference" and "between-language identity-facilitation" effects in picture-word interference tasks (Costa & Caramazza, 1999; Costa et al., 1999; Hermans, 2004; Hermans et al., 1998), and language switching costs in picture naming tasks (Costa & Santesteban, 2004b; Verhoef, Roelofs, & Chwilla, 2009). These findings suggest that language production in both populations is governed by the very same principles.

Our findings may also have implications for the experimental paradigms that have been used to study cross-language activation or competition in speech production. Consider, for instance, the picture-word interference studies that tested the predictions of language-selective and language-nonselective models of lexical access (Costa & Caramazza, 1999; Costa et al., 2003, 1999; Hermans, 2004; Hermans et al., 1998; Lee & Williams, 2001). In these paradigms, distractor words from the language not selected for production are used to study to what extent the language not-selected for production interferes with the lexical selection process in the language selected for production. Hermans et al. (1998), for instance, observed a cross-language semantic interference effect when L1 Dutch–L2 English bilinguals named pictures in English. Thus, they found that unbalanced L1 Dutch–L2 English bilinguals need more time to name a picture of a SKIRT in English when an L1 Dutch distractor like *broek* (trousers) is presented compared to an unrelated Dutch distractor like *hond* (dog). Hermans et al. (1998) took this finding to suggest that L1 words compete for selection during L2 picture naming. Looking at these results with the findings of the present study in mind, it seems likely that the presentation of Dutch distractor words in the Hermans et al. (1998) study has activated the Dutch lexicon. Possibly, the presence of Dutch distractor words has caused the bilingual language system to operate in a language-nonselective activation state (see also Grosjean, 1998). In other words, the results obtained by Hermans et al. may only provide justification for the claim that words from both a bilingual's languages compete for selection in this bilingual paradigm. Therefore, consistent with Grosjean's (1998) suggestion, we propose to consider the impact of the experimental tasks demands and the composition of the stimulus lists on the interpretations of results obtained in various language production studies more carefully.[2]

What are the implications for bilingual language production models if the bilingual language system is indeed a dynamic system that can operate in different language activation states? All current bilingual production models can account for parallel activation of both languages (for a review, see Kroll et al., 2006). However, the models differ in their assumptions on how the activation of words in the language not required for production affects the selection and production of words in the target language. Costa et al. (1999) proposed a language-selective model of language production in which lexical selection is somehow restricted to lexical candidates of the target language only. Although it is still not clear how a speaker can ignore activated candidates in the language not required for production, this model can account for the results we obtained in the present study. Variations in the magnitude of cross-language activation are not problematic for this model, as cross-language activation is simply ignored by the lexical selection mechanism. Other bilingual production models assume that activated lexical candidates can and do compete for selection. These models assume that lexical candidates from the language not required for production are either proactively or reactively suppressed (Green, 1998) or that the intention to speak in a language can increase the activation level of lexical candidates in the target language, or lower their selection threshold (Finkbeiner, Gollan, & Caramazza, 2006). Our results suggest that the amount of cross-language activation can vary as a function of, for instance, the composition of the stimulus list. Our results therefore imply that the mechanism responsible for

[2] Interestingly, Green (1988) estimated that approximately 65–70% of the translation equivalents in Catalan and Spanish overlap in orthographic/phonological form. Similarly, Van Hell (1998) estimated the proportion of Dutch–English cognates to be 50%. In other words, the natural presence of cognates in daily-life language production will also affect the extent to which both languages are activated, and will therefore resemble the experimental situations created in Experiments 2 and 3 much more than that of Experiment 1.

suppressing words also needs to be a mechanism that can dynamically be executed during language production, an implication that seems to fit well with Green's (1998) reactive inhibition mechanism.

In sum, we found that the phonological co-activation effect during phoneme monitoring in the L2 can be modulated by the presence of cognate and noncognate filler pictures in the experiment. This indicates that the bilingual language production system is much more dynamic than is currently assumed by most bilingual models of speech production, and that the bilingual system can operate in different language activation states.

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APPENDIX 1
Names of experimental pictures in Experiments 1, 2, and 3

	Condition			
English (Dutch)	*1st syllable onset*	*2nd/3rd consonant*	*1st syllable onset*	*Unrelated*
towel (handdoek)	T	W	H	B
pillow (kussen)	P	L	K	B
painter (schilder)	P	T	S	B
wedding (bruiloft)	W	D	B	S
lake (meer)	L	K	M	B
match (lucifer)	M	T	L	B
hairdresser (kapper)	H	D	K	M
mountain (berg)	M	T	B	F
farmer (boer)	F	M	B	L
basket (mand)	B	K	M	H
statue (beeld)	S	T	B	K
bottle (fles)	B	T	F	P
button (knoop)	B	T	K	S
horse (paard)	H	S	P	B
flower (bloem)	F	W	B	K
plate (bord)	P	L	B	M
fence (hek)	F	N	H	B
bike (fiets)	B	K	F	P
bull (stier)	B	L	S	K
submarine (duikboot)	S	M	D	H
diaper (luier)	D	P	L	F
trousers (broek)	T	S	B	L
wallet (portemonnee)	W	L	P	S
nail (spijker)	N	L	S	D

APPENDIX 2
Names of filler pictures in Experiments 1, 2, and 3

		Condition			
English (Dutch)	*Experiment*	*1st syllable onset*	*2nd/3rd consonant*	*Unrelated-1*	*Unrelated-2*
shark (haai)	1 & 3	S	K	W	F
present (cadeau)	1 & 3	P	S	L	W
prison (gevangenis)	1 & 3	P	N	D	T
bucket (emmer)	1 & 3	B	K	L	S
strawberry (aardbei)	1 & 3	S	T	L	N
squirrel (eekhoorn)	1 & 3	S	L	D	T
waiter (ober)	1 & 3	W	T	L	S
donkey (ezel)	1 & 3	D	K	S	T
dress (jurk)	1 & 3	D	S	W	T
field (akker)	1 & 3	F	L	W	M
hunter (jager)	1 & 3	H	T	L	D
kite (vlieger)	1 & 3	K	T	F	D
moustache (snor)	1 & 3	M	T	P	D
mailbox (brievenbus)	1 & 3	M	L	H	T
painting (schilderij)	1 & 3	P	T	W	K
suitcase (koffer)	1 & 3	S	T	P	W
desk (bureau)	1 & 3	D	S	N	T
butterfly (vlinder)	1 & 3	B	F	M	S
monkey (aap)	1	M	K	L	T
stroller (wandelwagen)	1	S	T	M	F
money (geld)	1	M	N	S	P
seatbelt (gordel)	1	S	B	H	F
lighthouse (vuurtoren)	1	L	H	M	D
window (raam)	1	W	D	L	S
lamb (lam)	2 & 3	L	M	K	T
moon (maan)	2 & 3	M	N	T	P
mouse (muis)	2 & 3	M	S	D	T
train (trein)	2 & 3	T	N	F	B
banana (banaan)	2 & 3	B	N	P	D
street (straat)	2 & 3	S	T	K	L
violin (viool)	2	V	N	D	T
house (huis)	2	H	S	L	N
needle (naald)	2	N	L	T	S
pirate (piraat)	2	P	T	N	L
sheep (schaap)	2	S	P	W	T
snow (sneeuw)	2	S	N	F	M
stone (steen)	2	S	T	H	F
teapot (theepot)	2	T	P	L	K
ship (schip)	2	S	P	M	D
nose (neus)	2	N	S	T	P
wheel (wiel)	2	W	L	P	S
dolphin (dolfijn)	2	D	L	K	B
thumb (duim)	2	T	M	L	W

APPENDIX 2 (*Continued*)

		Condition			
English (Dutch)	*Experiment*	*1st syllable onset*	*2nd/3rd consonant*	*Unrelated-1*	*Unrelated-2*
sun (zon)	2	S	N	W	T
foot (voet)	2	F	T	N	S
fish (vis)	2	F	S	W	K
spider (spin)	2	S	P	F	M
sock (sok)	2	S	K	L	W