Producing words in a foreign language: Can speakers prevent interference from their first language?*

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Two picture-word interference experiments were conducted to investigate whether or not words from a first and more dominant language are activated during lexical access in a foreign and less dominant language. Native speakers of Dutch were instructed to name pictures in their foreign language English. Our experiments show that the Dutch name of a picture is activated during initial stages of the process of lexical in English as a foreign language. We conclude that bilingual speakers cannot suppress activation from their first language while naming pictures in a foreign language. The implications for bilingual speech production theories are discussed.

It is a well-known fact that people can produce words in their first and more dominant language at a faster rate than in a foreign language.[1] Picture naming studies have shown that the production of a word in a foreign language requires considerably more time than in a first language (e.g., Chen & Leung, 1989; Kroll & Curley, 1988; Potter, So, von Eckardt, & Feldman, 1984). However, it is still unclear why a speaker needs more time to retrieve words in a foreign language. Is it more difficult to produce words in a foreign language merely because we do not use them on a daily basis? Or do we need more time because there is interference from the first language? In this study we will focus on the second question. We will report two picture-word interference experiments in which we investigated whether or not words from the first language Dutch are activated during lexical access in English as a foreign language, in an experimental setting in which participants are discouraged from accessing lexical representations in their first language Dutch.

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[1] From now on, we will also use the phrase "the first language" when we actually mean "the first and more dominant language", and the phrase "the foreign language" when we mean "the foreign and less dominant language". Thus, in this study the first language Dutch is always more dominant than the foreign language English.

By studying the involvement of the first language during lexical access in a foreign language, we address one of the most remarkable abilities of bilinguals. During the production of speech, bilinguals are able to produce words only in the language in which they intend to express their thoughts. Some bilingual speech production models account for this ability by assuming that elements (rules and representations) that belong to a language system form a subset which can be activated or deactivated in its entirety (e.g., De Bot & Schreuder, 1993; Green, 1986, 1993, 1998; but see also Poulisse & Bongaerts, 1994). Green (1986, 1993), for instance, proposes that an external control device called "the Specifier" regulates the activation level of lexical representations in each of a bilingual's languages. When a language is chosen for production, the activation level of lexical representations in that language is increased, while the activation level of lexical representations in a bilingual's other languages is decreased. We will further discuss these bilingual speech production models in relation to our results in the general discussion.

In this study we investigate whether interference from a first and more dominant language occurs during the process of lexical access in a foreign language. During the process of lexical access, conceptual structures are mapped onto lexical representations. Most speech production theories assume that the process of lexical access comprises two steps:

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lemma selection and phonological encoding (e.g., Butterworth, 1989; Dell, 1986; Garrett, 1988; Kempen & Huybers, 1983; Levelt, 1989, 1992; Levelt, Roelofs & Meyer, in press). During the lemma selection process, semantically and syntactically appropriate lexical items are selected from the mental lexicon. The phonological word forms are accessed during the stage of lexeme retrieval, which is part of the process of phonological encoding. Phonological encoding also involves subsequent computations on these word forms that are necessary for the production of words in connected speech (see Levelt & Wheeldon, 1994). Although most speech production theories agree upon the existence of the lemma selection and lexeme retrieval processes, there still is much debate about the relationship between lemma selection and lexeme retrieval (Dell, 1986; Dell & O'Seaghdha, 1991, 1992; Levelt, 1989; Levelt et al., in press; Schriefers, Meyer & Levelt, 1990). Discrete two-stage models of lexical access hold the view that the process of lemma selection strictly precedes the process of lexeme retrieval, without feedback (Levelt, 1989; Levelt et al., in press; Levelt et al., 1991; Schriefers et al., 1990; Van Turennout, Hagoort, & Brown, 1997). In contrast, interactive models of lexical access assume that the process of lexeme retrieval starts before the lemma selection process has been completed, and that the lexeme retrieval process can affect the lemma selection process (Dell, 1986; Dell & O'Seaghdha, 1992; Harley, 1993; O'Seaghdha & Marin, 1997). The primary aim of this study is to investigate whether lexical representations from a first language are activated during lexical access in a foreign language, and not whether lexical access proceeds in discrete non-interactive stages or in temporally overlapping and interactive stages. To simplify matters, we will initially present and discuss our experiments within a discrete two-stage model of lexical access. However, we will discuss our results within alternative models of lexical access in the general discussion.

To investigate whether or not words from a first language are activated during lexical access in a foreign language, we conducted two picture-word interference experiments. In picture-word interference tasks, participants are instructed to name pictures that are presented on a computer screen, usually with a prespecified name in a given language. Participants are instructed to *name* the pictures as quickly and accurately as possible, and to *ignore* a visually or auditorily presented interfering stimulus (IS). This IS may be phonologically (*doll*) or semantically (*cat*) related to the name of the picture (*dog*), or there may be no relationship at all (*bed*). Naming latencies for pictures accompanied by related ISs are compared to naming latencies for pictures accompanied by unrelated ISs.

Semantically related ISs are assumed to affect only the lemma selection part of the naming response preparation (e.g., Levelt et al., 1991; Roelofs, 1992; Schriefers et al., 1990, but see also Starreveld & La Heij, 1995, 1996). The presentation of a semantically related IS has been found to slow down the initiation of the naming response relative to the presentation of an unrelated IS. Semantic interference effects of auditory ISs are only observed when the auditory ISs are presented prior to the presentation of the pictures (e.g., Schriefers et al., 1990). For a detailed account of how a semantically related IS may slow down the initiation of the naming response in picture-word interference tasks, see Roelofs (1992).

The presentation of a phonologically related IS has been found to speed up the initiation of the naming response relative to an unrelated IS. Phonological facilitation effects of auditory ISs are usually only observed when the auditory IS is presented simultaneously with or shortly after the presentation of the picture (e.g., Schriefers et al., 1990). Until recently, phonologically related ISs were assumed to facilitate the lexeme retrieval process only (e.g., Lupker & Katz, 1981; Lupker & Williams, 1989; Meyer & Schriefers, 1991; Schriefers et al., 1990; Starreveld & La Heij, 1995, 1996). However, that assumption has now been challenged by Jescheniak and Schriefers (submitted), who claim that a phonologically related IS cannot only facilitate the lexeme retrieval process, but the lemma selection process as well.

In a recent study (Hermans, Bongaerts, De Bot & Schreuder, submitted) we obtained evidence which supports the claim that phonologically related ISs can facilitate the lemma selection process. In three picture-word interference experiments we tracked the time-course of identical facilitation, phonological facilitation, and semantic interference in the first and more dominant language Dutch and in English as a foreign and less dominant language. In one experiment, native speakers of Dutch were instructed to name pictures in their foreign language English. Pictures of objects, for example, *plate*, were accompanied by identical ISs, by phonologically related ISs such as *place*, by semantically related ISs such as *dish*, or by unrelated ISs such as *chest*. The time interval between the onset of the auditory IS and the presentation of the picture, the stimulus onset asynchrony (SOA), was varied. The onset of the auditory IS preceded the presentation of the picture by 300 ms (SOA −300 ms), by 150 ms (SOA −150 ms), coincided with the presentation of the picture (SOA 0 ms), or followed the presentation of the picture by

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150 ms (SOA +150 ms). We found that identical ISs facilitated the initiation of the naming response at every SOA, and that semantically related ISs slowed down the initiation of the naming response at SOA's −300, −150, and 0 ms. More importantly, phonological facilitation was observed at every SOA. Thus, we did not only observe phonological facilitation at late SOAs, but at early SOAs as well.

In a further experiment, we replicated these results with third-year students of English, whose lexical proficiency in English as a foreign language was significantly higher than those of the participants in the previous experiment. We claimed that the early phonological facilitation effects in English as a foreign language can only be accounted for within a discrete two-stage model of lexical access if we assume that phonologically related ISs facilitate the lemma selection process of the English name of the picture at early SOAs. Like Jescheniak and Schriefers (submitted), we proposed that an IS such as *place* does not only activate the lexeme and the lemma of *place*, but also the lexeme and the lemma of the phonological competitor *plate*. A phonologically related IS such as *place* can therefore facilitate both the lemma selection and lexeme retrieval parts of the naming response preparation of a picture of a *plate*. Additionally, we proposed two possible explanations why phonologically related ISs facilitate the lemma selection process in English as a foreign language (and not in the first and more dominant language Dutch).

First, we argued that a phonologically related IS facilitates the lemma selection process in English as a foreign language because the frequencies of English lemmas are, for native speakers of Dutch, generally low in comparison with the frequencies of Dutch lemmas. We suggested that a phonologically related IS facilitates the lemma selection process when the to-be-selected lemma has a low frequency, and is, therefore, difficult to select. A phonologically related IS may reduce this difficulty by activating the to-be-selected lemma.

An alternative interpretation is that a phonologically related IS facilitates the lemma selection process in a foreign language because it helps to overcome the selection bias for the more frequent semantically close not-to-be-selected translation equivalent from the first and more dominant language. This interpretation presupposes that lemmas from the first language and the foreign language are both activated during the lemma selection process in a foreign language. Thus, for native speakers of Dutch, the Dutch lemma *bord* (plate) and the English lemma *plate* are both activated when naming a picture of a *plate* in the foreign language English. Because the Dutch lemma *bord* has a high frequency in comparison with the English lemma *plate*, the Dutch lemma will start out with a higher activation level than the English lemma. A phonologically related English IS may facilitate the lemma selection process of the English name of a picture because it helps to overcome the higher activation level for the Dutch name of the picture (see Jescheniak & Schriefers (submitted) for a similar interpretation of early phonological facilitation in picture-word interference tasks). Thus, early phonological facilitation in a foreign language may reflect the activation of the more frequent not-to-be-selected semantically close lemma from the first and more dominant language.

Therefore, in the present study we investigated in two picture-word interference experiments whether, for native speakers of Dutch, the Dutch name of a picture is activated during the process of lexical access in the foreign language English. Thus we are interested in finding out whether the not-to-be-selected Dutch lemma *berg* (mountain) is activated during the lemma selection process of its English translation equivalent *mountain*, just as semantically related English lemmas such as *valley* are (Hermans et al., submitted).

We also investigated whether the Dutch name of a picture is activated during the lexeme retrieval process in English as a foreign language. Recent evidence suggests that in cases of strong competition during the lemma selection process, as is the case during the production of a word which has a near-synonym, both the to-be-selected lemma and its not-to-be-selected near-synonym are phonologically encoded (Jescheniak & Schriefers, 1997, submitted; Peterson & Savoy, 1998). Translation equivalents can be viewed as near-synonyms that belong to different languages: translation equivalents are semantically at least as closely related as near-synonyms. If the competition between the to-be-selected English lemma and the not-to-be-selected Dutch translation equivalent is as strong as the competition between near-synonyms, both lemmas may be phonologically encoded during picture naming in English as a foreign language.

To investigate whether there is interference from the first and more dominant language Dutch during the lemma selection and lexeme retrieval parts of the naming response preparation in English as a foreign language, pictures of, for example, a *mountain,* were paired with English ISs such as *bench* (Experiment 1) and with Dutch ISs such as *berm* (Experiment 2), which are phonologically related to the Dutch name of the picture (*berg* (mountain)). Like Jescheniak and Schriefers, we assumed that ISs such as *bench* and *berm* (from now on also referred to as Phono-Dutch

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Table 1. *Example of the experimental conditions in Experiments 1 and 2 (participants are instructed to produce the L2 name "mountain" in response to a picture of a mountain)*

Condition	Experiment 1: English (L2) ISs	Experiment 2: Dutch (L1) ISs
Phonological	mouth	mouw (sleeve)
Phono-Dutch	bench	berm (verge)
Semantic	valley	dal (valley)
Unrelated	present	kaars (candle)

ISs) do not only activate the lexemes and the lemmas of, respectively, *bench* and *berm*, but also the lexeme and the lemma of the phonological competitor *berg* (mountain). We therefore assumed that Phono-Dutch ISs can interfere with both the lemma selection and lexeme retrieval parts of the naming response preparation. Phono-Dutch ISs such as *bench* and *berm* may interfere with the lemma selection process by activating the not-to-be-selected Dutch lemma *berg,* which would make it harder to select the English lemma *mountain*. However, Phono-Dutch ISs may also interfere with the lexeme retrieval process. In the latter case, strong competition between the Dutch and the English lemma may result in the activation of both the Dutch lexeme *berg* and the English lexeme *mountain*. Additional activation of the not-to-be-produced Dutch lexeme makes it even harder to suppress it in order to produce the English name of the picture.

To determine at which level Phono-Dutch ISs interfere, pictures were also paired with semantically related ISs such as *valley*, phonologically related ISs such as *mouth*, and unrelated ISs such as *present*. The rationale is the following: if Phono-Dutch ISs slow down the initiation of the naming response at SOAs at which phonological facilitation but no semantic interference is observed, the interference from Phono-Dutch ISs is likely to be localized at the lexeme level. If a semantically related IS cannot interfere with the lemma selection process because participants are already at the phonological stage of the naming response preparation when the IS activates its semantic information, the interference from a Phono-Dutch IS can only be localized at the lexeme level. Similarly, if Phono-Dutch ISs interfere at SOAs at which semantic interference is observed, the interference is likely to be localized at the lemma level. Thus, our claim is that interference from Phono-Dutch ISs at SOAs at which semantic interference is also observed can be interpreted as interference at the lemma level, and that interference from Phono-Dutch ISs at SOAs at which no semantic interference is observed can be interpreted as interference at the lexeme level.

In sum, in Experiments 1 and 2 we investigated whether the Dutch name of a picture is activated during the lemma selection and lexeme retrieval processes of its English translation equivalent. In Experiment 1, native speakers of Dutch were instructed to name pictures in their foreign language English. Pictures were paired with auditorily presented English ISs which are phonologically related (*mouth*), semantically related (*valley*), or unrelated (*present*) to the English name of the picture (*mountain*), or by English ISs (*bench*) which are phonologically related to the Dutch name of the picture (*berg*). The ISs were tested at SOAs −300, −150, 0, and +150 ms. On the basis of the results obtained in the study described earlier (Hermans et al., submitted), we predicted semantic interference effects at SOAs −300, −150, and 0 ms, and phonological facilitation effects at every SOA. Furthermore, if the Dutch name of the picture is activated during the lemma selection process, we should observe interference from Phono-Dutch ISs at the same SOAs at which semantic interference is observed. Finally, if the Dutch name of the picture is not only activated during the lemma selection process, but is also phonologically encoded, we should observe interference from Phono-Dutch ISs at SOAs at which no semantic interference is observed.

Experiment 1

Method

Participants. Sixty-four undergraduates of the University of Nijmegen participated in Experiment 1. Their ages varied between eighteen and thirty years with a mean of twenty-three. All participants were native speakers of Dutch, and were paid for their participation. All participants had received at least five years of education in English as a foreign language at high school.

Materials. The target stimuli were twenty-four line drawings of common objects which were selected from the picture pool available at the Max Planck Institute for Psycholinguistics in Nijmegen. In addition, eight line drawings were selected from the same pool as practice items. An off-line study had shown that the intended name of the picture corresponded to the name which was spontaneously given most frequently to the picture.[2] For each of the line draw-

[2] In an off-line study we had verified that the intended name of the picture corresponded to the name which was spontaneously

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ings (e.g., of a mountain), four English words were selected to serve as ISs in the following test conditions: (1) Phono-Dutch (*bench*) (2) Phonological (*mouth*) (3) Semantic (*valley*) (4) Unrelated (*present*). ISs in the four test conditions were matched on number of letters, number of phonemes, number of syllables and log frequency per million as much as possible. Frequency counts were taken from the COBUILD written corpus using the CELEX database (Baayen, Piepenbrock & Van Rijn, 1993). The mean log lexeme frequencies in the Phono-Dutch, Phonological, Semantic, and Unrelated conditions were 1.3, 1.4, 1.4, 1.4 respectively, and the mean log lemma frequencies 1.4, 1.6, 1.6, and 1.5.

Care was taken that semantically related ISs were neither strongly associatively related to the name of the picture (for the need to control for the associative relationship of a semantically related IS and the name of the picture see La Heij, Dirkx & Kramer, 1990), nor phonologically related to the English or the Dutch name of the picture. The strength of the associative relationship between the semantically related ISs and the English names of the picture was relatively low: 0.03 (Kiss, Armstrong, Milroy & Piper, 1973).The materials are listed in Appendix A.

The English stimuli were spoken by a female native speaker of Dutch, who lived in England for many years and went to school there, and was designated as an excellent, native-like, speaker of English by various experts in English as a Foreign Language. The stimuli were digitally recorded in a sound studio at the Department of Language and Speech of the University of Nijmegen.

Design. The experimental design included one between-participant factor, SOA, with four levels: −300, −150, 0, and +150 ms, and one within-participant factor, Interfering Stimulus (IS), with four levels: Phono-Dutch, Phonological, Semantic, and Unrelated. SOA was varied between participants to keep the number of repetitions for each picture restricted to four. Each picture was presented four times to each participant, accompanied by four ISs which were presented auditorily. The twenty-four pictures were divided into four sets of six pictures each. The order in which ISs in the four test conditions were paired to the first, second, third and fourth presentation of the picture was different for each set of pictures. For example, pictures in the first set were first accompanied by an identical IS, then by a phonologically related IS, next by a semantically related IS, and finally by an unrelated IS. By counterbalancing the order of appearance of these conditions for the four sets, each condition appeared six times in combination with a first, second, third or fourth presentation of a set of pictures. Prime-target pairs were presented to the participants by means of lists in which the order of the items was fixed, with the restriction of a minimum of 10 trials between two presentations of the same picture. Half the participants at each SOA received a list in one order, the remaining participants in the reverse order.

Procedure. Participants were seated in front of a computer screen at a distance of about 60 cm. Stimulus presentation and recording of the naming latencies was computer controlled. Pictures, with a display size of approximately 90 mm * 90 mm, were presented in the center of a computer screen. The auditory stimuli were presented through a headphone. Naming latencies were measured from picture onset by a voicekey. The responses of the participants were digitally recorded.

Each participant was tested individually in a dimly illuminated room. The experiment consisted of three parts. In the first part of the experiment a booklet with thirty-two pictures was presented. Under each picture, the name of the picture was printed. Participants were instructed to use only these names to refer to the pictures. After participants had indicated that they had seen all drawings, they received another booklet with the same pictures, but now without the printed word, and were instructed to name these pictures. Next, a practice block was administered. Participants were allowed to ask questions after completing the practice block. Then, the experimental block was administered. A single trial looked as follows: an asterisk was presented as a fixation point for 500 ms at the position where the picture was to be presented with a delay of 500 ms. The picture was presented for 2000 ms. The onset of the auditory IS preceded the presentation of the picture by 300 ms (SOA = −300) or 150 ms (SOA = −150), coincided with the picture onset (SOA = 0) or followed the onset of the picture by 150 ms (SOA = +150). Time-out was set at 2000 ms. In addition, a pause of 1 second was inserted at the end of each trial. Each trial lasted 4 seconds.

In the second part of the experiment, the so-called Llex vocabulary test (Meara, 1994) was administered. This test has been found to be a good predictor of how proficient people are in listening, reading, and

given most frequently to the picture. In the off-line study, a set of twenty-four printed pictures was presented to twenty undergraduates from various disciplines of the University of Nijmegen. Participants were asked to write the names of the pictures in a space reserved for this purpose. The mean error percentage was only 6.4 per cent, indicating that the intended name of the picture was generally preferred by the participants. These results show that the name which was spontaneously given most frequently corresponded to the intended name, and that there was no more dominant semantically close competitor of the name of the picture.

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Table 2. *Experiment 1: mean response latencies (M in ms), standard deviations (SD in ms), and error percentages (E) in the Phonological, Phono-Dutch, Semantic, and Unrelated conditions, and the difference (Dif) for the Phonological, Phono-Dutch, and Semantic conditions relative to the Unrelated condition at each SOA (target English, interfering stimuli English)*

	SOA −300 ms			SOA −150 ms			SOA 0 ms			SOA +150 ms		
IS	M (SD)	E	Dif	M (SD)	E	Dif	M (SD)	E	Dif	M (SD)	E	Dif
Phonological	732 (130)	3.6	19	750 (159)	6.5	24	709 (140)	1.6	31	645 (121)	1.3	64
Phono-Dutch	765 (137)	4.2	−14	779 (154)	6.0	−5	768 (143)	4.2	−28	714 (132)	2.3	−5
Semantic	795 (171)	4.2	−44	793 (171)	6.2	−19	771 (169)	6.0	−31	699 (147)	5.2	10
Unrelated	751 (113)	5.5		774 (156)	5.7		740 (124)	1.3		709 (151)	1.6	

writing in a given language. The vocabulary test consisted of 300 lexical decision trials. English words and nonwords were randomly selected from a lexicon which consisted of a sample of 1000 words from the Threshold Level Vocabulary in English and 500 nonwords. Each participant received a unique subset from the lexicon. Participants were instructed to press the "yes" button if they knew the meaning of the printed word and the "no" button if they did not. The experiment was individually paced; immediately after participants had made a decision, the next printed string was presented on the screen. The aim of administering the Llex vocabulary test was to determine whether the level of lexical proficiency was similar for the groups of participants at each SOA.

In the third part of the experiment, participants had to fill in a questionnaire. This questionnaire was based on a questionnaire developed by Grosjean (personal communication), and adapted to the Dutch situation. The aim of administering the questionnaire was to get more information about the language history of our participants, and their proficiency in English as a foreign language. Some results of this questionnaire are shown in appendix B. The experiment lasted about 30 minutes.

Results and discussion

The mean score on the Llex vocabulary test was 83.8. Participants with a score higher than 80 on the vocabulary test perform within the range of native speakers of English, and can thus be characterized as having a high level of lexical proficiency in English. Mean scores on SOA −300, −150, 0, and +150 ms were 84.8, 81.5, 83.3, and 85.5 respectively. Unpaired t-tests showed that the mean scores at each SOA did not differ from the scores at other SOAs (all p's > .1). Thus, the participants of Experiment 1 were highly proficient in English as a foreign language, and more importantly, the level of lexical proficiency of the participants at each SOA did not differ significantly from the level of lexical proficiency of participants at other SOAs.

Trials on which participants produced mouth clicks, stuttered, hesitated during the production of the response, gave an incorrect response, or produced no response within the time limit of 2000 ms were marked as errors. The same held for responses from trials in which a technical error had occurred. In all, 5.5 per cent of the data were classified as errors. 4.1 per cent of the data (74 per cent of the errors) were considered to be true errors: hesitations, stuttering, incorrect responses and no responses. Naming latencies which deviated more than two standard deviations from the item and participant mean in the relevant condition and errors were replaced by estimates, following Winer (1971). Substitutions of incorrect responses amounted to 5.5 per cent of the data, estimate substitutions of extreme naming latencies to 2.1 per cent. In total, 7.6 per cent of the data were replaced by estimates. Table 2 lists the mean naming latencies, the standard deviations, and the true error percentages (without technical errors and mouth clicks).

Analyses of the naming latencies

Analyses of variance were conducted on the naming latencies with Participants and Items as random factors and IS as within-participant and within-item

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factor, and SOA as between-participant and within-item factor. The main effects of SOA (F_1 (3,60) = 4.69, MSE = 17893, $p < .01$, F_2 (3,69) = 50.39, MSE = 2497, $p < .001$) and IS (F_1 (3,180) = 53.13, MSE = 728, $p < .001$, F_2 (3,69) = 14.55, MSE = 3987, $p < .001$), and the interaction between SOA and IS (F_1 (9,180) = 3.46, MSE = 728, $p < .005$, F_2 (9,207) = 3.14, MSE = 1203, $p < .005$) reached significance in the by-participant and by-item analyses. Subsequent analyses testing the effect of IS at each SOA separately showed that IS was significant at SOA −300 ms (F_1 (3,45) = 18.73, MSE = 617, $p < .001$, F_2 (3,69) = 10.30, MSE = 1684, $p < .001$), at SOA −150 ms ((F_1 (3,45) = 10.32, MSE = 486, $p < .001$, F_2 (3,69) = 3.79, MSE = 1987, $p < .05$), at SOA 0 ms (F_1 (3,45) = 14.49, MSE = 943, $p < .001$, F_2 (3,69) = 8.61, MSE = 2381, $p < .001$), and at SOA +150 ms (F_1 (3,45) = 18.46, MSE = 866, $p < .001$, F_2 (3,69) = 15.52, MSE = 1546, $p < .001$).

Post-hoc analyses applying Duncan tests (alpha = .05) to the item and participant means of each level of IS for each SOA separately showed that for SOA −300 ms, the Semantic condition differed from the Phonological, Phono-Dutch, and Unrelated condition in the by-participant and by-item analyses. Furthermore, the Phonological condition differed from the Phono-Dutch condition in the by-participant and by-item analyses, and from the Unrelated condition in the by-participant analysis. No significant differences were found for the Phono-Dutch and the Unrelated conditions. For SOA −150 ms, the Semantic condition differed from the Phonological condition in the by-participant and by-item analyses, and from the Unrelated condition in the by-participant analysis. The Phonological condition also differed from the Phono-Dutch condition in the by-participant and by-item analyses, and from the Unrelated condition in the by-participant analysis. Again, no significant differences were found for the Phono-Dutch and the Unrelated conditions. For SOA 0 ms, the Semantic condition differed from the Phonological and the Unrelated conditions in the by-participant and by-item analyses. Furthermore, the Phonological condition differed from the Unrelated and Phono-Dutch conditions in the by-participant and by-item analyses. More importantly, the Phono-Dutch condition differed from the Unrelated condition in the by-participant analysis. For SOA +150 ms, the Phonological condition differed from the Phono-Dutch, Semantic, and Unrelated conditions in the by-participant and by-item analyses. No differences were found between the Phono-Dutch, the Semantic, and the Unrelated condition.

Analysis of repetition effects

In Experiment 1, pictures were presented four times to each participant, accompanied by four different auditory ISs. To investigate whether and how the repetition of pictures affected the magnitude of the effects that occurred at each SOA, several additional analyses of variance were conducted. We defined the factor BLOCK with two levels: BLOCK-1 (first and second presentation of a picture) and BLOCK-2 (third and fourth presentation of a picture). We were interested in finding out whether there were any interactions between the factor BLOCK and the phonological facilitation effect, the phono-Dutch interference effect, or the semantic interference effect at each SOA. Any significant interaction would reveal that the repetition of pictures affected our experimental results.

The phonological facilitation effect did not interact with the factor BLOCK at SOA −300, −150, and 0 ms (all p's > .1), but there was a significant interaction between the phonological facilitation effect and the factor BLOCK at SOA +150 ms in the by-participant analysis ($p_1 < .05$, $p_2 > .1$). Analyses for each BLOCK separately at SOA +150 ms showed that the phonological facilitation effect was significant for BLOCK-1 (p_1 and $p_2 < .05$) and for BLOCK-2 and (p_1 and $p_2 < .05$). The magnitude of the phonological facilitation effect was significantly larger in BLOCK-1 (86 ms) than in BLOCK-2 (43 ms). Neither the phono-Dutch interference effect nor the semantic interference effect interacted with BLOCK at any SOA (all p's > .1). The repetition of pictures only affected the magnitude of the phonological facilitation effect at SOA +150 ms. We can conclude therefore that our main results were not affected by the repetition of pictures.

Analyses of list composition effects

The stimuli in Experiment 1 were presented to the participants by means of two lists in which the order of the items was fixed. To investigate whether there were any list composition effects, analyses of variance were conducted with IS as within-participant and within-item factor, and SOA and LIST as between-participant and within-item factor. These analysis revealed that the main effect of LIST showed a trend towards significance in the by-item analysis only (F_1 (1,56) < 1, F_2 (1,23) = 2.96, MSE = 6359, $p < .1$). The interaction between SOA and LIST reached significance in the by-item analysis (F_1 (3,56) < 1, F_2 (3,69) = 3.20, MSE = 2348, $p < .05$), reflecting the fact that LIST was significant at SOA −300 in the by-item analysis (F_1 (1,59) < 1, F_2 (1,23) = 9.04, MSE = 2325,

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$p < .01$), showed a trend towards significance in the by-item analysis at SOA −150 ms (F_1 (1,59) < 1, F_2 (1,23) = 3.60, MSE = 2824, $p < .1$), but failed to reach significance at SOAs 0 ms (F_1 (1,59) < 1, F_2 (1,23) < 1) and +150 ms (F_1 (1,59) < 1, F_2 (1,23) = 2.34, MSE = 3020, $p > .1$) More importantly, neither the two-way interaction between LIST and IS (F_1 (3,168) = 1.13, MSE = 1204, $p > .1$, F_2 (3,69) < 1) nor the three-way interaction between LIST, IS, and SOA (F_1 (9,168) < 1, F_2 (9, 207) < 1) reached significance in the by-participant or by-item analyses.

Analyses of the error percentages

Analyses of variance were also conducted for the error percentages (only true error percentages), with IS as within-participant and within-item factor, and SOA as between-participant and within-item factor. The main effects of SOA reached significance in the by-item analysis only (F_1 (3,60) = 1.61, MSE = 63.5, $p > .1$, F_2 (3,69) = 6.18, MSE = 24.9, $p < .005$). Furthermore, the main effect of IS (F_1 (3,180) = 4.42, MSE = 14.86, $p < .01$, F_2 (3,69) = 2.67, MSE = 36.90, $p < .1$) and the interaction between SOA and IS (F_1 (9,180) = 2.21, MSE = 14.86, $p < .05$, F_2 (9,207) = 2.22, MSE = 22.24,p <.05) reached significance in the by-participant and by-item analyses. Subsequent analyses showed that IS failed to reach significance at SOA −300 ms (F_1 (3,45) < .1, F_2 (3,69) < .1) and SOA −150 ms (F_1 (3,45) < .1, F_2 (3,69) < .1), but reached significance in the by-participant and by-item analyses at SOA 0 ms (F_1 (3,45) = 5.08, MSE = 15.75, $p < .005$, F_2 (3,69) = 5.58, MSE = 21.49, $p < .005$), and at SOA +150 ms (F_1 (3,45) = 4.36, MSE = 11.69, $p < .01$, F_2 (3,69) = 3.57, MSE = 21.35, $p < .05$).

Post-hoc analyses applying Duncan tests (alpha = .05) to the item and participant means of each level of IS for SOAs 0 and +150 ms showed that for SOA 0 ms, the Semantic condition differed from the Phono-Dutch and Unrelated conditions in the by-participant and by-item analyses. Furthermore, the Phonological condition differed from the Unrelated condition in the by-item analysis. At SOA +150 ms, the Semantic condition differed from the Phonological, Phono-Dutch, and Unrelated conditions in the by-participant and by-item analyses.[3]

[3] Because distractors hardly ever induce systematic speech errors in picture-word interference experiments (Levelt et al., in press), we do not wish to report extensively on the type of errors participants made in the various conditions in experiments 1 and 2. Nevertheless, sometimes (in 9 per cent of the true errors) participants incorrectly produced either the Dutch name (e.g., berg) of a picture (e.g., mountain) or the first phoneme(s) of the Dutch name of a picture (e.g., be ...). More interestingly, these errors were usually produced in the Phono-Dutch condition.

Discussion

Four important results were obtained in Experiment 1. First, the presentation of a phonologically related IS facilitated the initiation of the naming response at every SOA. Second, reliable semantic interference effects were obtained at SOAs −300, −150, and 0 ms. Both these findings are replications of an earlier study in which we also found phonological facilitation at SOAs −300, −150, 0, and +150 ms, and semantic interference at SOAs −300, −150, and 0 ms (Hermans et al., submitted). Third, no evidence was found for the claim that the Dutch name of the picture is phonologically encoded, as indicated by the absence of significant interference in the Phono-Dutch condition at SOA +150 ms. Fourth, significant interference in the Phono-Dutch condition was obtained at SOA 0 m, but not at SOAs −300 and −150 ms. Thus we found some support for the claim that the more frequent Dutch name of the picture is activated during the lemma selection process, and no support for the claim that its phonological form is activated during the lexeme retrieval process.

Our claim that an *English* Phono-Dutch IS such as *bench* can activate the *Dutch* name of the picture (*berg* (mountain)) is based upon the assumption that there is a sufficient overlap between the phonetic realizations of the initial phonemes of the English Phono-Dutch IS and the Dutch name of the picture. However, this may not be the case. One possible explanation for the absence of reliable interference effects in the Phono-Dutch condition is that the mismatch between the phonetic realizations of the English Phono-Dutch ISs and the Dutch name of the picture is large enough to prevent the Dutch name of the picture from being strongly activated by the English Phono-Dutch IS.

This alternative interpretation was explored in Experiment 2, in which native speakers of Dutch were again instructed to name pictures in their foreign language English. Unlike Experiment 1, pictures were paired with *Dutch* ISs which were either phonologically related (*mouw* (sleeve)), semantically related (*dal* (valley)), or unrelated (*kaars* (candle)) to the English name of the picture (*mountain*), or phonologically related (*berm* (verge)) to the Dutch name of the picture (*berg*). The ISs were tested at SOAs −300, −150, 0, and +150 ms. The rationale was the same as in Experiment 1: we claimed that interference in the Phono-Dutch condition at SOAs at which semantic interference is also observed can be interpreted as interference at the lemma level, and that interference in the Phono-Dutch condition at SOAs at which no semantic interference is observed can be interpreted as interference at the lexeme level.

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On the basis of the results obtained in Experiment 1, we assumed that there is a relatively small overlap between the phonetic realizations of the initial phonemes of the *English* name of a picture of a *mountain* and a phonologically related *Dutch* IS such as *mouw*, whereas there is an almost complete overlap between the phonetic realizations of the initial phonemes of the *Dutch* name of a picture of a mountain (*berg*) and a *Dutch* Phono-Dutch IS such as *berm*. We therefore predicted that a phonologically related Dutch IS should not or only slightly speed up the initiation of the naming response in English because of the mismatch between the phonetic realizations of a phonologically related *Dutch* IS and the *English* name of the picture. In contrast to Experiment 1, phonological facilitation effects should therefore be small or even absent in Experiment 2. Furthermore, if the Dutch lemma is activated during the lemma selection process of the English name of the picture, we should observe strong and reliable interference effects from Dutch Phono-Dutch ISs at SOAs −300, −150, and 0 ms in Experiment 2. Finally, if the Dutch name of the picture is activated during the lexeme retrieval process, interference effects should be observed in the Phono-Dutch condition at SOA +150 ms.

Experiment 2

Method

Participants. Sixty-four undergraduates of the University of Nijmegen participated in Experiment 2. Their ages varied between eighteen and thirty-three years with a mean of twenty-three. All participants were native speakers of Dutch, and were paid for their participation. All participants had received at least five years of education in English as a foreign language at high school. None of the participants had participated in Experiment 1.

Materials. The same thirty-two line drawings were used as in Experiment 1. Pictures were accompanied by Dutch words which were either phonologically related (*mouw* (sleeve)), semantically related (*dal* (valley)), or unrelated (*kaars* (candle)) to the English name of the picture (*mountain*), or phonologically related (*berm* (verge)) to the Dutch name of the picture (*berg*). ISs in the four test conditions were matched on number of letters, number of phonemes, and number of syllables, and on log frequency per million as much as possible. Frequency counts were taken from the INL corpus using the CELEX database (Baayen et al., 1993). The mean log lexeme frequencies in the different test conditions were 1.0, 1.2, 1.2, and 1.2 respectively, and the mean log lemma frequencies 1.0, 1.3, 1.4, and 1.4. The semantically related words were the Dutch translation equivalents of the semantically related English words that were used in Experiment 1. The materials are listed in Appendix C.

The Dutch stimuli were spoken by the same female native speaker of Dutch as in Experiment 1. The stimuli were digitally recorded in a sound studio at the Department of Language and Speech of the University of Nijmegen.

Design. The design was identical to the one used in Experiment 1.

Procedure. The procedure was identical to the one used in Experiment 1.

Results and discussion

The mean score on the Llex Vocabulary test was 83.4. Mean scores on SOA −300, −150, 0, and +150 ms were 82.5, 81.9, 82.9, and 86.2 respectively. Unpaired t-tests showed that these scores of the groups of participants did not differ from the scores at other SOAs (all p's > .1). In addition, the scores obtained in Experiment 2 did not differ from the scores obtained in Experiment 1 (t (126) = .33, p > .1). As in Experiment 1, the group of participants can, on the basis of their scores on the vocabulary test, be characterized as having a high level of lexical proficiency in English.

Application of the same criteria as in Experiment 1 led to the replacement of 5.8 per cent errors and 2.1 per cent outliers. 4.8 per cent of the data (83 per cent of the errors) were classified as true errors (cf. Experiment 1). Table 3 lists the mean naming latencies and standard deviations, and the true error percentages in each condition.

Analyses of the naming latencies

Analyses of variance were conducted on the naming latencies with Participants and Items as random factors and IS as within-participant and within-item factor, and SOA as between-participant and within-item factor. The main effects of SOA (F_1 (3,60) = 3.49, MSE = 27974, p < .05, F_2 (3,69) = 104.65, MSE = 1401, p < .001) and IS (F_1 (3,180) = 14.34, MSE = 1022, p < .001, F_2 (3,69) = 4.84, MSE = 4545, p < .005) were significant in the by-participant and by-item analyses. Most importantly, the interaction between SOA and IS reached significance in the by-item analysis and showed a trend towards significance in the by-participant analysis (F_1 (9,180) = 1.79, MSE = 1022, p < .1, F_2 (9,207) = 2.59, MSE = 1055, p < .01). Subsequent analyses testing the effect of IS at each SOA separately showed that IS was significant at SOA −300 ms (F_1 (3,45) = 3.33, MSE = 755, p < .05, F_2 (3,69) = 1.73, MSE = 2180, p =

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Table 3. *Experiment 2: mean response latencies (M in ms), standard deviations (SD in ms), and error percentages (E) in the Phonological, Phono-Dutch, Semantic, and Unrelated conditions, and the difference (Dif) for the Phonological, Phono-Dutch, and Semantic conditions relative to the Unrelated condition at each SOA (target English, interfering stimuli Dutch)*

	SOA −300 ms			SOA −150 ms			SOA 0 ms			SOA +150 ms		
IS	M (SD)	E	Dif	M (SD)	E	Dif	M (SD)	E	Dif	M (SD)	E	Dif
Phonological	763 (152)	4.1	−8	738 (149)	4.4	−5	759 (197)	4.1	−10	654 (117)	2.0	35
Phono-Dutch	785 (154)	6.5	−30	771 (151)	5.7	−38	784 (191)	5.7	−35	696 (126)	5.2	−7
Semantic	772 (151)	4.6	−17	770 (162)	6.2	−37	768 (168)	3.9	−19	702 (139)	4.1	−13
Unrelated	755 (145)	5.7		733 (131)	5.7		749 (161)	5.0		689 (120)	3.6	

.17), at SOA −150 ms (F_1 (3,45) = 6.65, MSE = 978, $p < .005$, F_2 (3,69) = 4.54, MSE = 2148, $p < .01$), and at SOA +150 ms (F_1 (3,45) = 13.32, MSE = 571, $p < .001$, F_2 (3,69) = 9.19, MSE = 1442, $p < .001$), and showed a trend towards significance in the by-item analyses at SOA 0 ms (F_1 (3,45) = 1.96, MSE = 1784, $p = .13$, F_2 (3,69) = 2.45, MSE = 2140, $p < .1$).

Post-hoc analyses applying Duncan tests (alpha = .05) to the item and participant means of each level of IS for each SOA separately showed that for SOA −300 ms, the Phono-Dutch condition differed from the Unrelated condition in the by-participant and by-item analyses, and from the Phonological condition in the by-participant analysis. No significant differences were found for the Phonological, Semantic, and Unrelated conditions. For SOA −150 ms, the Phono-Dutch condition differed from the Unrelated and Phonological conditions in the by-participant and by-item analyses. The Semantic condition also differed from the Phonological and Unrelated conditions in the by-participant and by-item analyses. For SOA 0 ms, the Phono-Dutch condition differed from the Unrelated condition in the by-participant and by-item analyses. No differences were found for the Semantic, Phonological, and Unrelated conditions. For SOA +150 ms, the Phonological condition differed from the Phono-Dutch, Semantic, and Unrelated conditions in the by-participant and by-item analyses. No differences were found for the Phono-Dutch, Semantic, and Unrelated conditions.

Analyses of repetition effects

In Experiment 2, pictures were presented four times to each participant, accompanied by four different auditory ISs. We conducted several additional analyses of variance to determine whether and how the repetition of pictures affected our results. We defined the factor BLOCK with two levels: BLOCK-1 (first and second presentation of a picture) and BLOCK-2 (third and fourth presentation of a picture). As in Experiment 1, we were interested in finding out whether there were any interactions between the factor BLOCK and the phonological facilitation effect, the phono-Dutch interference effect, or the semantic interference effect at each SOA.

The factor BLOCK did not interact with the phonological facilitation effect at any SOA (all p's > .1). The phono-Dutch interference effect interacted with the factor BLOCK only at SOA 0 ms and only in the by-participant analysis ($p_1 < .05$, $p_2 > .1$). Separate analyses revealed that the phono-Dutch interference effect was significant in BLOCK-1 (p_1 and $p_2 < .05$), but not in BLOCK-2 (p_1 and $p_2 > .1$). The semantic interference effect also interacted with BLOCK only at SOA 0 ms in the by-participant analyses ($p_1 < .05$, $p_2 > .1$) Separate analyses revealed that the semantic interference effect was significant in BLOCK-1 (p_1 and $p_2 < .05$), but not in BLOCK-2 (p_1 and $p_2 > .1$). We can therefore conclude that our main results were not affected by the repetition of pictures.

Analyses of list composition effects

The stimuli in Experiment 2 were presented to the participants by means of two lists. To investigate whether there were any list composition effects, analyses of variance were conducted with IS as within-participant and within-item factor, and SOA

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and LIST as between-participant and within-item factor. These analysis revealed that the main effect of LIST failed to reach significance (F_1 (1,56) < 1, F_2 (1,23) = 1.67, MSE = 3914, $p > .1$). The interaction between SOA and LIST reached significance in the by-item analysis (F_1 (3,56) < 1, F_2 (3,69) = 47.44, MSE = 1674, $p < .001$), reflecting the fact that LIST was significant in the by-item analysis at SOA −300 (F_1 (1,59) < 1, F_2 (1,23) = 70.93, MSE = 1632, $p < .001$), at SOA 0 ms (F_1 (1,59) < 1, F_2 (1,23) = 21.76, MSE = 4260, $p < .001$), and at SOA +150 ms (F_1 (1,59) < 1, F_2 (1,23) = 29.48, MSE = 1233, $p < .001$), but failed to reach significance at SOA's −150 ms (F_1 (1,59) < 1, F_2 (1,23) < 1). More importantly, neither the two-way interaction between LIST and IS (F_1 (3,168) = 1.24, MSE = 940, $p > .1$, F_2 (3,69) < 1) nor the three-way interaction between LIST, IS, and SOA (F_1 (9,168) < 1, F_2 (9, 207) = 1.04, MSE = 1598, p > .1) reached significance in the by-participant or by-item analyses.

Analyses of the error percentages

Analyses of variance were also conducted for the error percentages (only true error percentages), with IS as within-participant and within-item factor, and SOA as between-participant and within-item factor. The main effects of SOA reached significance in the by-item analysis only (F_1 (3,60) = 1.33, MSE = 46.03, $p >.1$, F_2 (3,69) = 4.46, MSE = 20.54, $p < .01$). Furthermore, the main effect of IS was significant in the by-participant analysis (F_1 (3,180) = 3.67, MSE = 16.32, $p < .05$, F_2 (3,69) < 1). The interaction between SOA and IS (F_1 (9,180) < 1, F_2 (9,207) < 1) failed to reach significance in the by-participant and by-item analyses.

Post-hoc analyses applying Duncan tests (alpha = .05) to the participant means of each level of IS collapsed over SOA showed that the Phonological condition differed from the Phono-Dutch, Semantic, and Unrelated conditions.

Discussion

The results obtained in Experiment 2 can be summarized as follows: First, phonological facilitation was found at SOA +150 ms only. Thus, a phonologically related Dutch IS did not speed up the initiation of the naming response at SOAs −300, −150, and 0 ms. More importantly, significant interference effects in the Phono-Dutch condition were observed at SOAs −300, −150, and 0 ms, but not at SOA +150 ms. These results demonstrate that the not-to-be-selected Dutch lemma is activated during the lemma selection process of its English translation equivalent, but that the Dutch lemma is not phonologically encoded. Third, a semantically related Dutch IS slowed down the initiation of the naming response significantly at SOA −150 ms. This finding suggests that even semantically related Dutch lemmas are activated during the lemma selection process of English words.

General discussion

Can we suppress activation of lexical candidates in our first language when we have to name pictures in a foreign language? We investigated this question in two picture-word interference experiments, in which native speakers of Dutch were instructed to name pictures in their foreign language English. More specifically, we investigated whether lexical representations from the first and more dominant language Dutch are activated during the lemma selection and/or lexeme retrieval parts of the naming response preparation in English as a foreign language.

In Experiment 1, pictures were paired with English ISs which were either phonologically related (*mouth*), semantically related (*valley*), or unrelated (*present*) to the English name of a picture of a *mountain*, or phonologically related (*bench*) to the Dutch name of a picture of a mountain (*berg*). Like Jescheniak and Schriefers (submitted), we assumed that an IS such as *bench* not only activates the lexeme and the lemma of *bench*, but also the lexeme and the lemma of the phonological competitor *berg*. We thus assumed that Phono-Dutch ISs such as *bench* can interfere with both the lemma selection and lexeme retrieval parts of the naming response preparation of the English name of a picture of a mountain. A Phono-Dutch IS such as *bench* may interfere with the lemma selection process by activating the not-to-be-selected semantically close Dutch lemma *berg*, which would make it harder to select the English lemma *mountain*. However, Phono-Dutch ISs may also interfere with the lexeme retrieval process. In the latter case, strong competition between the Dutch and the English lemma may result in the activation of both the Dutch lexeme *berg* and the English lexeme *mountain*. Activation of the not-to-be-pronounced Dutch lexeme makes it harder to suppress it in order to produce the English name of the picture. We claimed that interference in the Phono-Dutch condition at SOAs at which semantic interference is also observed can be interpreted as interference localized at the lemma level, and that interference in the Phono-Dutch condition at SOAs at which no semantic interference is observed can be interpreted as interference localized at the lexeme level.

In Experiment 1, some support was found for the

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claim that the Dutch name of a picture is activated during the lemma selection process of its translation equivalent in the foreign language English: an English Phono-Dutch IS significantly slowed down the initiation of the naming response at SOA 0 ms. Furthermore, we obtained no evidence that the not-to-be-selected Dutch name of a picture is phonologically encoded: an English Phono-Dutch IS did not slow down the initiation of the naming response at SOA +150, the only SOA at which no semantic interference was observed. To account for the absence of reliable interference effects in the Phono-Dutch condition, we suggested that there is a relatively small overlap between the phonetic realizations of the initial phonemes of the *English* Phono-Dutch ISs and the *Dutch* names of the pictures. This relatively small overlap is insufficient to activate the lemma and the lexeme of the Dutch name of a picture.

This interpretation was investigated in Experiment 2, in which native speakers of Dutch were again instructed to name pictures in their foreign language English. However, this time, pictures were paired with *Dutch* ISs which were either phonologically related (*mouw* (sleeve)), semantically related (*dal* (valley)), or unrelated (*kaars* (candle)) to the English name of a picture of a *mountain*, or phonologically related (*berm* (verge)) to the Dutch name of a picture of a mountain (*berg*). As in Experiment 1, we claimed that interference in the Phono-Dutch condition at SOAs at which semantic interference is also observed can be interpreted as interference at the lemma level, and that interference in the Phono-Dutch condition at SOAs at which no semantic interference is observed can be interpreted as interference at the lexeme level.

We assumed that the overlap between the phonetic realizations of the initial phonemes of the *English* name of a picture of a *mountain* and a phonologically related *Dutch* IS such as *mouw* is small in comparison with the almost complete overlap between the phonetic realizations of the initial phonemes of the *Dutch* name of a picture of a mountain (*berg*) and a *Dutch* Phono-Dutch ISs such as *berm*. On the basis of these assumptions, we predicted that a phonologically related Dutch IS should not or only slightly speed up the initiation of the naming response in the foreign language English. Furthermore, we claimed that, if the Dutch name of a picture is activated during the lemma selection process in English as a foreign language, we should observe strong and reliable interference effects from Dutch Phono-Dutch ISs at SOAs −300, −150, and 0 ms in Experiment 2. Finally, if the Dutch name of a picture is activated during the lexeme retrieval process in the foreign language English, interference effects should be observed at SOA +150 ms.

Unlike the results of Experiment 1, phonological facilitation was found at SOA +150 ms only. More importantly, we found reliable interference effects in the Phono-Dutch condition at every SOA at which semantic interference was observed in Experiment 1. Experiment 2 demonstrates that the Dutch name of a picture is activated during the lemma selection process of its English translation equivalent, but that the Dutch name of a picture is not phonologically encoded. Interestingly, we also obtained some evidence which suggests that even semantically related Dutch words are activated during the lemma selection process of English words.

On the basis of the results obtained in Experiments 1 and 2, we argued that the absence of reliable interference effects in the Phono-Dutch condition in Experiment 1 was caused by the relatively small overlap between phonetic realizations of the initial phonemes of an *English* Phono-Dutch IS such as *bench* and the Dutch name of a picture of a mountain (*berg*). However, there is an alternative interpretation for the results obtained in Experiments 1 and 2. Grosjean (1982, 1997, 1998) has argued that bilinguals are always situated at some point on the so-called ''bilingual continuum''. When bilinguals are at the monolingual end of this continuum, only one of a bilingual's languages is activated. In contrast, both a bilingual's languages are activated when bilinguals are at the bilingual end of the continuum. More importantly, Grosjean has argued that the position at which a bilingual is situated on the continuum depends upon background variables such as the subject of conversation, information about the listener, and the (experimental) setting in which the conversation takes place. Thus, following Grosjean's line of argument, it could be argued that the position at which participants were situated on the bilingual continuum in Experiments 1 and 2 was affected by the experimental settings. Participants named pictures in their foreign language English while trying to ignore auditory English ISs in Experiment 1, and while trying to ignore auditory Dutch ISs in Experiment 2. One might therefore claim that the participants of Experiment 2 were more in a bilingual mode than the participants of Experiment 1. We might have observed unreliable interference effects in the Phono-Dutch condition in Experiment 1 and reliable interference effects in the Phono-Dutch condition in Experiment 2, because the first language Dutch was more strongly activated in Experiment 2 than in Experiment 1. However, we did not only observe different interference effects in the Phono-Dutch condition in Experiments 1 and 2, but also different

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facilitation effects in the Phonological condition. We found that phonologically related English ISs facilitate the initiation of the naming response at every SOA, while phonologically related Dutch ISs facilitate the initiation of the naming response at SOA +150 ms only. It is unclear how an interpretation in terms of the position of participants on the bilingual continuum can account for these asymmetrical phonological facilitation effects.

In the introduction we briefly discussed how current bilingual speech production models account for the ability of bilingual speakers to produce words only in the language in which they intend to express their thoughts (e.g., De Bot & Schreuder, 1993; Green, 1986, 1993; Poulisse & Bongaerts, 1994; Poulisse, 1997). Some bilingual speech production models assume that lexical representations from a language form a subset which can be activated or deactivated in its entirety (e.g., De Bot & Schreuder, 1993; Green, 1986, 1993). The activation level of lexical representations in a language is increased when that language is chosen for production, and decreased when another language is selected for production. Furthermore, the extent to which a language can be deactivated depends upon how frequently that language is used. Languages that are frequently used cannot be completely deactivated, while languages that are infrequently used can be completely deactivated. Green (1986, 1993) and de Bot and Schreuder (1993) assume that a bilingual can produce words only in the language in which he or she intends to speak because the activation level of lexical representations in that language is higher than the activation level of languages not chosen for production (see Poulisse & Bongaerts (1994) for a slightly different proposal).

In our experiments, we obtained evidence to support this assumption. First, the semantic interference effects of English ISs in Experiment 1 were more reliable than the semantic interference effects of Dutch ISs in Experiment 2. Second, and more importantly, research has shown that during the production of a word which has a near-synonym, the not-to-be-produced word is activated during the later stages of the naming response preparation of the to-be-produced word (Jescheniak & Schriefers, 1997, submitted; Peterson & Savoy, 1998). Jescheniak and Schriefers suggested that both word forms are phonologically encoded because there is extreme competition at the lemma level. Although translation equivalents are semantically at least as closely related as near-synonyms, the Dutch name of a picture is only activated during the initial stages of the process of lexical access in English as a foreign language. Thus, the competition between near-synonyms that belong to different languages (translation equivalents) is less extreme than the competition between near-synonyms that belong to the same language. Thus, our experiments suggest that lemmas from the language chosen for production are more strongly activated than lemmas from other languages, even though the language not chosen for production is a first and more dominant language.

At the same time, our experiments show that the Dutch name of a picture is activated during the lemma selection process of its translation equivalent in English as a foreign language. This finding is consistent with Green's (1986, 1993) and de Bot and Schreuder's (1993) claim that lexical representations from the first and more dominant language cannot be completely deactivated during the production of speech in a foreign language. Therefore, semantically close lemmas from the first language will be activated to some degree during the lemma selection process in a foreign language.

Until now, we have discussed and interpreted our results within a discrete two-stage model of lexical access. Thus we have assumed that the process of lexeme retrieval only starts when the lemma selection process has been completed. However, that assumption is neither shared by alternative models of lexical access, such as interactive models (Dell, 1986; Harley, 1993) or cascaded models (Peterson & Savoy, 1998), nor consistent with some results obtained in picture naming studies (Jescheniak & Schriefers, submitted; O'Seaghdha & Marin, 1997; Peterson & Savoy, 1998). In contrast to discrete two-stage models of lexical access, interactive and cascaded models hold the view that the process of lexeme retrieval is initiated before the lemma selection process has been completed. Thus, cascaded and interactive models of lexical access assume that there is a temporal overlap between the lemma selection and lexeme retrieval processes. Furthermore, interactive models of speech production assume that the lexeme retrieval process can affect the lemma selection process. According to interactive activation models, lexical access proceeds as follows: lexical access starts when conceptual representations become activated (for instance, as the result of the presentation of a picture), and spread their activation to lemmas which match these conceptual representations. These lemmas, in turn, spread their activation to corresponding word forms as soon as they become activated. Therefore, not only the word form of the eventually produced lemma (e.g., cat) becomes activated, but also the word forms of semantically related lemmas (e.g., dog). Subsequently, these activated word forms (e.g., cat) spread their activation back, not only to the corresponding lemma (e.g.,

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cat), but also to lemmas of phonologically related word forms (e.g., rat, cap).

Because interactive models of lexical access assume that the process of lexeme retrieval is initiated immediately when lemmas become activated, interactive models of lexical access can account for early phonological facilitation in picture-word interference tasks in the following way: during the early stages of the process of lexical access of a picture of a *mountain*, lemmas that (partially) match the conceptual representations become activated (e.g., mountain, valley), and immediately spread their activation to the corresponding lexemes (mountain, valley). The presentation of a phonologically related ISs such as *mouth* will facilitate the retrieval of the word form *mountain*. Thus, according to interactive models of lexical access, early phonological facilitation may be localized at the word form level.

However, interactive models of lexical access also assume that a word form such as *cat* spreads its activation backward to the lemma level, not only to the lemma *cat*, but also to lemmas of phonologically related word forms such as *rat* and *cap* (Dell & O'Seaghdha, 1992). Thus, interactive models of lexical access explicitly assume that an activated word form also spreads its activation to lemmas of phonologically related words. For instance, a word form such as *mouth* not only spreads its activation to the lemma *mouth,* but also the word forms and the lemmas of *mouse* and *mountain*. Therefore, phonologically related ISs such as *mouth* can facilitate the lemma selection part of the naming response preparation of *mountain*. In other words, according to interactive models of lexical access, early phonological facilitation effects can be localized at the word form level, at the lemma level, or at both levels.

Interactive models of lexical access can account for the early phono-Dutch interference effects in a very similar way. First, the interference effects of Phono-Dutch ISs at early SOAs may be localized at the word form level. During the initial stages of the naming response preparation in a foreign language, lemmas that (partially) match the conceptual specification become activated, and spread their activation to corresponding word forms. Thus, during the initial stages of the naming response preparation of a picture of a *mountain* in English as a foreign language, both the English lemma *mountain* and the Dutch lemma *berg* become activated, and spread their activation the word forms *mountain* and *berg*. The presentation of the Dutch IS *berm* or the English IS *bench* will activate the Dutch word form *berg* more strongly, which makes it harder to produce the English name of a picture. Second, the interference effects of Phono-Dutch ISs at early SOAs may be localized at the lemma level. The presentation of Phono-Dutch ISs such as *berm* and *bench* leads to the activation of the lemma of the Dutch name of the picture, which is also activated as a consequence of the presentation of the picture. Preactivation of the Dutch lemma *berg* by the IS *bench* or *berg* will make it harder to select to English name of the picture.

Thus, according to interactive models of lexical access, early phonological facilitation and early phono-Dutch interference can either be localized at the word form level, at the lemma level, or at both levels. More importantly, while early semantic interference may be localized the lemma level, early phono-Dutch interference may be localized at the word form level within an interactive model of lexical access. Thus, only within a discrete two-stage model on lexical access, we can compare performance in the semantic condition to the performance in the Phono-Dutch condition to determine the locus of the phono-Dutch interference effect. Although it is unclear within an interactive view on lexical access whether or not the early phono-Dutch interference effect itself is localized at the lemma level, our results still show that Dutch name of a picture is activated during the initial stages of the naming response preparation of its translation equivalent in English as a foreign language. Thus, although the early interference effect of Phono-Dutch ISs such as *berm* and *bench* itself may be localized at the word form level, the interference effect is observed because the Dutch lemma *berg* is activated as consequence of the presentation of a picture of a *berg*, and spreads its activation to the word form *berg*. In other words, we claim that our conclusion that Experiments 1 and 2 show that the Dutch lemma is activated during the lemma selection part of the naming response preparation of the English name of the picture is valid both within a discrete two-stage and within an interactive model of lexical access. However, within an interactive model of lexical access, the results of our experiments could also be interpreted as showing that not only the Dutch lemma, but also the Dutch word form is activated during the initial stages of the naming response preparation of the English name of the picture.

In short, in two picture-word interference tasks we demonstrated that the Dutch name of a picture is activated during the initial stages of the process of lexical access of its translation equivalent in the foreign language English. Apparently, speakers cannot prevent their first language from interfering with the production of speech in a foreign language. In a task in which the speaker is explicitly discouraged from accessing representations in his or her first and more dominant language, a bilingual speaker

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will indeed behave like a monolingual during the later stages of the process of lexical access. However, during the initial stages of the process of lexical access in a foreign language, a bilingual speaker cannot prevent interference from the first language.

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Appendix A

Stimulus materials used in Experiment 1

Picture's name	Phonological	Phono-Dutch	Semantic	Unrelated
fence	fellow	health	gate	knife
doll	dock	pox	bear	flag
skirt	skill	rocket	coat	punch
mountain	mouth	bench	valley	present
leaf	league	black	branch	chain
plate	place	box	dish	chest
glasses	glider	bridge	lens	chapter
bottle	bottom	flesh	cup	vessel
witch	wing	hedge	dwarf	globe
dog	dot	holiday	goat	nail
peacock	people	power	chicken	blanket
ferry	feather	pocket	ship	salad
belt	belly	reef	leather	jaw
snail	snare	slack	beetle	bag
cloud	clock	watch	sky	lion
flower	flavor	blues	garden	curtain
letter	lettuce	breeze	stamp	fairy
trousers	trout	bruise	shirt	falcon
snake	snow	slab	worm	cross
pin	pig	span	button	bill
frog	front	kitchen	lizard	hole
brush	brother	body	cloth	church
key	keel	slaughter	door	train
square	squad	veal	triangle	paint

Appendix B

The mean self-estimations of language use and age of acquisition of the participants of Experiment 1 and 2 for reading, writing, speaking, and listening in the foreign language English. The mean self-estimations of Ability in each skill is the mean score language on a 5–point scale (1 = equally good as in the first language Dutch, 5 = much worse than in the first language Dutch). The mean self-estimations of Study (hours a week using the foreign language English for study ends) and Hobby (hours a week using the foreign language English for purposes other than study ends) is the mean score on a 5–point scale (1 = less than one hour a week, 5 = more than 10 hours a week). The mean self-estimation of Age of Acquisition (AOA) for each skill is the mean estimated age at which participants began to acquire this skill.

	Use						Acquisition	
	Ability		Study		Hobby		AOA	
Skill	Exp 1	Exp 2	Exp 1	Exp 2	Exp 1	Exp 2	Exp 1	Exp 2
Reading	2.7	2.6	2.3	2.3	1.3	1.6	11.7	11.1
Writing	3.6	3.3	1.3	1.2	1.3	1.2	12.1	11.3
Speaking	3.4	3.1	1.4	1.2			11.4	9.7
Listening	2.6	2.7	2.5	2.7	3.0	3.0		

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Appendix C

Stimulus materials used in Experiment 2

Picture's name	Phonological	Phono-Dutch	Semantic	Unrelated
fence	fan (fan)	held (hero)	poort gate)	pijp (pipe)
doll	dolk (dagger)	pols (wrist)	beer (bear)	tand (tooth)
skirt	scalp (scalp)	rots (rock)	jas (coat)	druif (grape)
mountain	mouw (sleeve)	berm (verge)	dal (valley)	kaars (candle)
leaf	lied (song)	blik (tin)	tak (branch)	hoed (hat)
plate	plan (plan)	borst (chest)	schaal (dish)	trap (stairs)
glasses	gletscher (glacier)	bron (well)	lens (lens)	eend (duck)
bottle	botsing (collision)	fluit (flute)	kopje (cup)	klink (handle)
witch	wind (wind)	hert (deer)	dwerg (dwarf)	rits (zip)
dog	dorp (village)	horst (hurst)	geit (goat)	mes (knife)
peacock	piste (ring)	paus (pope)	kip (chicken)	verf (paint)
ferry	festijn (feast)	post (mail)	schip (ship)	stip (dot)
belt	berk (birch)	riet (reed)	leer (leather)	park (park)
snail	sneeuw (snow)	slag (blow)	kever (beetle)	kroon (crown)
cloud	klauw (claw)	wolf (wulf)	hemel (sky)	fiets (bycycle)
flower	flauwte (faint)	bloed (blood)	tuin (garden)	stok (stick)
letter	lente (spring)	brood (bread)	postzegel (stamp)	kruis (cross)
trousers	trauma (trauma)	broer (brother)	hemd (shirt)	leeuw (lion)
snake	snee (incision)	slaaf (slave)	worm (wurm)	trein (train)
pin	pint (pint)	spek (bacon)	knoop (button)	koek (biscuit)
frog	front (front)	kinkel (lout)	hagedis (lizard)	spiegel (mirror)
brush	brug (bridge)	borrel (drink)	doek (cloth)	varken (pig)
key	kier (chink)	sluier (veil)	deur (door)	tempel (temple)
square	score (score)	virus (virus)	driehoek(triangle)	deken (blanket)

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