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Visual Word Recognition in Bilinguals: Evidence From Masked Phonological Priming

Marc Brysbaert, Goedele Van Dyck, and Marijke Van de Poel
University of Leuven

Bilingual written language representation was investigated with the masked phonological priming paradigm. Pseudohomophonic and control primes of French target words were used to show that Dutch–French bilinguals exhibit the same pattern of phonological and orthographic priming as native French speakers, which suggests that the same processes underlie first- and second-language processing. It was also found that for bilinguals, but not monolinguals, it is possible to prime a target word of the second language with a homophonic stimulus (either word or nonword) of the first language. This interlingual phonological priming effect was of the same size as the intralingual priming effect. Implications for theories of bilingual written language representation and for the interpretation of the masked phonological priming paradigm are discussed.

Traditionally, research on bilingualism has been based on the assumption that words of different languages are stored in separate lexicons. The major question within this framework is how one should conceive of the connections between the lexicons. Weinreich (1953), for instance, distinguished among three possible organizations: coordinate, compound, and subordinate. In the coordinate organization, the two languages of the bilingual are completely divided, both at the "lexical" and the "semantic" level (the latter terms are reformulations in current terminology). In the compound organization, the languages are distinct at the lexical level but share semantic representations. Finally, in the subordinate organization, words of the second (less proficient) language have access to the semantic, conceptual system only after translation to the first language. The idea of separate lexicons that have access to a shared semantic system also prevails in current models of bilingualism (e.g., De Groot, 1993; Kroll, 1993; Snodgrass, 1993).

However, throughout the history of research on bilingualism there has been evidence that interactions exist at the lexical level and thus that the assumption of distinct lexicons may not be correct. Some of the early evidence in visual word recognition comes from Altenberg and Cairns (1983) and Nas (1983). Altenberg and Cairns (1983) showed that English monolinguals took less time to reject nonwords in a lexical decision task when the nonwords contained an illegal sequence of letters in English (e.g., *pflok*) than when they did not (e.g., *twoul*). In contrast, the rejection time of English–German bilingual participants depended additionally on whether the letter string was illegal in German (e.g., *pflok* is a legal sequence of letters in German) even though the task involved decisions only about English words.

In a first experiment, Nas (1983) looked at how Dutch–English bilinguals processed Dutch words in an English lexical decision task. He found that these Dutch words took considerably longer to reject than control nonwords, despite the fact that the words were chosen so that they did not result in the phonological representation of an existing word if the English grapheme–phoneme conversion rules were applied (in case the English lexical decision task required prior phonological recoding of the visual stimulus). In a second experiment, Nas showed that nonwords written according to the English orthography but resulting in homophones of existing Dutch words (e.g., *snay,* which according to the English letter-to-sound correspondences sounds like the Dutch word *snee* [*cut*]) resulted in longer rejection times than did control nonwords. Nas interpreted these results as (a) evidence for the existence of a common store for Dutch and English words and (b) evidence against a single-route model of word recognition based on the phonological code only (because otherwise the findings of the first experiment could not be explained, as the Dutch words did not sound like English or Dutch words when they were translated according to the English letter–sound correspondences; but see below).

Scarborough, Gerard, and Cortese (1984) published findings contradictory to those of Nas (1983). Using Spanish–English bilinguals, Scarborough et al. found that participants rejected words of the nontarget language with the same speed as they rejected regular nonwords. This was true when the target language was the participants' first language as well as when it was their second language. Scarborough et al. argued that this result implied that bilinguals were selectively accessing the lexicon required for the experimen-

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Marc Brysbaert, Goedele Van Dyck, and Marijke Van de Poel, Department of Psychology, University of Leuven, Leuven, Belgium.

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Correspondence concerning this article should be addressed to Marc Brysbaert, who is now at the Department of Experimental Psychology, University of Ghent, Henri Dunantlaan 2, B-9000 Ghent, Belgium.

tal task and processing the nontarget language words as nonwords. The fact that the rejection latencies to the nontarget language words did not show a word frequency effect added further support to the conclusion. Grainger (1993) tried to reconcile the contradictory findings by pointing to the fact that in the study by Scarborough et al. (1984) participants may have used nonlexical characteristics of words (such as orthographic cues) to reject the nontarget words. Indeed, the orthographic similarity between English and Dutch is considerably greater than the orthographic similarity between English and Spanish.

Evidence for the use of language-specific orthographic cues by bilinguals has been reported by Grainger and Beauvillain (1987). These authors had French–English bilinguals decide whether a stimulus was a word in either of their two languages. Grainger and Beauvillain's main research interest was a comparison between (a) decision latencies in pure lists containing words from one language only and (b) mixed lists containing words from both languages (together with the same legal nonwords). The results showed that latencies to words in the mixed lists were slower than latencies to the same words in the pure language lists but that this increased difficulty in word recognition only occurred directly after a language switch. Moreover, the disruptive effects of switching languages were absent for target words containing language-specific orthographic cues (e.g., the beginning letters *wh,* which mark a word as English and not as French). Apparently, the individuals were able to use certain orthographic cues present in the target language to offset the negative effects of a switch in language. In the same vein, Beauvillain (1992) found, in French–English bilinguals but not in monolinguals, shorter latencies for language-specific words than for language-nonspecific words (language-specific words were words with bigram frequencies higher in the target language than in the nontarget language; e.g., *cream* is specific for English, whereas *trade* is not).

When orthographic cues do not distinguish the languages, the situation is different. Grainger and Dijkstra (1992) demonstrated that when bilinguals are performing a monolingual lexical decision task, activation of the lexical representations of the other language cannot be prevented. These authors demonstrated this by looking at the impact of "neighbors" (words that can be formed by changing one letter of the target word). Words that had more neighbors in the irrelevant language than in the target language ("traitors") took longer to accept than words that had an equivalent number of neighbors in both languages ("neutral"), and these in turn led to longer latencies than did words that had more neighbors in their own language ("patriots"). Likewise, Beauvillain and Grainger (1987) found that priming FIVE with *four* facilitated lexical decision regardless of whether the prime was presented in a block of French (*four* in French means "oven") or English primes. Thus, context is not powerful enough to limit perceptual processing to only one language.

On the basis of the above evidence, Grainger (1993; Grainger & Dijkstra, 1992) proposed two alternative models that are not based on the ideas that bilingualism is characterized by two distinct lexicons and that prior to lexical access one of the lexicons is selected for input. First, in the bilingual activation verification model, incoming orthographic information initially activates lexical representations in both languages independent of the language context. It is only in later selection–verification processes that language context information can come into play. For instance, this information can guide the verification process to the appropriate lexical system and thus effectively diminish the total number of possible candidates by about half. Second, in the bilingual interactive activation model, letter representations activated by sensory input from the printed word send activation on to lexical representations in both languages. These lexical representations then send activation on to supralexical "language nodes," activated word nodes from each language providing excitatory input to the corresponding language node. The model is interactive in the sense that higher level nodes can feed information back to lower level units: An activated language node will send back excitatory input to all the word nodes in that language and inhibitory input to all the word nodes of the other language (in addition, the word nodes can inhibit each other as well; see, e.g., Dijkstra, Van Heuven, & Grainger, in press).

The question of at what stage of processing the language code exerts its influence becomes especially important in light of some recent developments in the area of monolingual visual word recognition. Evidence is accumulating that prior to lexical access a number of language-specific processes take place. In particular, it has been argued that lexical access requires the recoding of the visual stimuli into a phonological representation (see Berent & Perfetti, 1995, for a recent review). According to some authors (e.g., Lukatela & Turvey, 1991; Perfetti, Bell, & Delaney, 1988; Van Orden, 1987), this recoding is prelexical and automatic. The latter feature is especially important because it implies that the recoding cannot be suppressed and, therefore, should happen for all languages mastered by an individual. Such a state of affairs would be more in line with a relatively late language-selection model than with an early language-selection model.

Doctor and Klein (1992) reported some evidence relevant to the possibility of simultaneous multiple phonological coding. They asked English–Afrikaans bilinguals to indicate whether a presented letter string was a word in either of their two languages. They found that lexical decision responses were slower and less accurate for interlingual homophones than for other words. Interlingual homophones are words that are spelled differently but pronounced in the same way (e.g., *lake* and *lyk*). Doctor and Klein interpreted their finding as evidence for (a) language-independent grapheme-to-phoneme translations and (b) a momentary conflict between the orthographic word representations raised by the two lexical entries of the phonological code. This conflict would slow down the spelling check that follows the activation of the phonological representation. It may be noted that the results of Nas (1983), discussed earlier, could be reinterpreted in this way if simultaneous grapheme–

phoneme translations in the first and second languages are accepted as occurring.

Other suggestive evidence for the use of phonology in bilingual visual word recognition has been reported by Gollan, Forster, and Frost (1997, Experiments 1 and 2). They had Hebrew–English and English–Hebrew bilinguals perform a lexical decision task in their second language. Prior to the target word, the translation of the word in the participant's native language was presented for 50 ms. Gollan et al. reported a robust translation priming effect. In addition, the effect was significantly larger for "cognates" than for "noncognates" (cognates are translation-equivalent words that also share phonological and orthographic properties across languages, e.g., *train–trein* in English–Dutch). The larger translation priming effect for cognates in Hebrew–English (and vice versa) is surprising because there is virtually no orthographic overlap between a Hebrew word and its English translation (the letters are different, and Hebrew is written from right to left). Therefore, Gollan et al. hypothesized that the increased translation priming effect with cognates was due to the shared phonology between prime and target. It is interesting that the effect was obtained only when primes were in the dominant language and targets in the nondominant language. No priming effect was found in the reverse condition (Experiments 3 and 4). Gollan et al. attributed this asymmetrical cognate effect to a greater reliance on phonology in second-language reading than in native-language reading.

In what follows, we further examine the issue of automatic phonological coding in bilingual visual word recognition by looking at masked phonological priming (Humphreys, Evett, & Taylor, 1982; Perfetti & Bell, 1991). In this paradigm, a target word is preceded by a prime that is presented too briefly to be identified. The primary question is whether the target word is more likely to be recognized when it is preceded by a homophonic prime than when it is preceded by a graphemic control that shares the same number of letters with the target word but not the same number of sounds. Humphreys et al. (1982) first demonstrated such a phonological priming effect with word primes (e.g., the tachistoscopically presented target word HAIR was more likely to be recognized when it was preceded by *hare* than by *harn*). Perfetti and Bell (1991) later reported that the effect could be replicated with nonword primes (e.g., *creap*–CREEP vs. *crelp*–CREEP) provided that the prime was presented for longer than 35 ms (see Ferrand & Grainger, 1993, and Van Cauteren, 1997, for similar results in French and Dutch). Because in the masked priming procedure primes are not recognized, the effects can hardly be due to expectancy.

Usually, a third condition is added to the above conditions. In this condition, the target word is presented with an unrelated prime that has no letters (on matching positions) in common (e.g., *food*–HAIR in Humphreys et al., 1982, and *olarn*–CREEP in Perfetti & Bell, 1991). Although this condition has often been used to estimate the impact of the orthographic similarity between prime and target (i.e., by subtracting the score in the unrelated condition from the score in the graphemic control condition), such a characterization is not entirely correct, because the graphemic controls and the unrelated controls differ not only in the number of graphemes they share with the target word but also in the number of phonemes they have in common (e.g., the phonemic overlap between *crelp* and CREEP is larger than that between *olarn* and CREEP). The major purpose of this condition, therefore, is to ensure that the primes have exerted an influence on target-word recognition in case no difference is obtained between homophonic primes and graphemic control primes.

After having demonstrated the phonological priming effect repeatedly in French, Ferrand and Grainger (1994; Grainger & Ferrand, 1996) replaced the condition with unrelated control primes with a condition with homophonic but orthographically dissimilar primes, to get a better estimate of the effect of orthographic similarity between prime and target. Instead of using the nonword primes *lont* (homophonic), *lonc* (graphemic control), and *tabe* (unrelated control) with the target word LONG (Ferrand & Grainger, 1993), they used the nonword primes *fain* (homophonic and orthographically similar prime), *faic* (nonhomophonic but orthographically similar prime), and *fint* (homophonic but orthographically dissimilar prime) with the target word FAIM. This allowed them to investigate the true effects of phonological and orthographic similarity (i.e., by comparing the *fain* and *faic* conditions, and the *fain* and *fint* conditions, respectively). Grainger and Ferrand (1996) reported 72% target recognition after homophonic and orthographically similar primes, 55% target recognition after nonhomophonic but orthographically similar primes, and 50% target recognition after homophonic but orthographically dissimilar primes, yielding a net phonological priming effect of $72 - 55 = 17\%$ and a net orthographic priming effect of $72 - 50 = 22\%$. Such a manipulation is, of course, only possible in languages with fairly unrestricted phoneme–grapheme correspondences and transparent grapheme–phoneme correspondences, such as French, so that the same sounds can be represented by quite different sequences of letters that all have the same pronunciation.

The experiments reported here served two purposes. First, we attempted to replicate the results of Grainger and Ferrand (1996) with Dutch–French bilinguals to see whether the impact of phonological and orthographic priming differs for participants performing the task in their second language and participants performing it in their native language. It is not inconceivable that the importance of the grapheme–phoneme translation system is limited to the native language, because this language was initially learned as a spoken language, whereas second-language acquisition happens mostly in school and depends more on reading. So, it could be that no phonological priming effect will be found for bilinguals performing the task in their second language. Note that exactly the opposite assumption was made by Gollan et al. (1997) to explain their asymmetrical cognate effect: According to them, we should find a stronger phonological priming effect in the nondominant language than in the dominant language (see above).

Our second question was whether it is, in addition, possible to prime a word of the second language (for our participants, French) with a homophonic stimulus of the first language (either a Dutch word [Experiment 1] or a nonword that according to the Dutch spelling–sound correspondences sounds like the French target word [Experiment 2].[1] An example of an interlingual homophone pair for a Dutch–English bilingual is the combination *wijd*–WAIT (*wijd* is a Dutch word that means "wide" and sounds like *wait*). As mentioned before, an interlingual phonological priming effect can be expected on the basis of models that postulate automatic prelexical phonological encoding of written words (see also Grainger, 1993).

It is obvious that high selection standards must be adhered to in the construction of stimulus materials to ensure that any interlingual phonemic priming effect is due to the overlap of the phonemic codes of the different languages and not to a larger orthographic and phonemic similarity between prime and target in the target language. For instance, from the above *wijd*–WAIT example it should be clear that no prime–target pairs can be chosen that on the basis of the English letter-to-sound conversions would result in homophonic primes as well (e.g., *kus*–CUSS; *kus* in Dutch means "kiss"). The only way to be sure about the suitability of the materials is to compare the performance of bilinguals with that of monolinguals. As a result, in both of the experiments reported here we included a condition in which our stimulus materials were seen by French individuals who had no experience with Dutch.

Experiment 1

In Experiment 1 we investigated how French monolinguals and Dutch–French bilinguals performed in a masked priming task with French–French stimuli that were borrowed from Grainger and Ferrand (1996, Appendix A; see also Ferrand & Grainger, 1994) and with Dutch–French stimuli that were specifically selected for this experiment (see the *Materials* section). By the term "French monolinguals" we refer to individuals who have French as their native language and do not understand Dutch, although they may have experience with English or another language.

Method

Participants. The French monolingual participants were 30 students from the Université René Descartes in Paris, France. They reported that French was their native language and that they were not familiar with the Dutch language. They were tested in Paris. The Dutch–French bilingual participants were 40 students of the University of Leuven and the Vrije Universiteit van Brussel. Of the 40 participants, 32 had started to learn French between the ages of 8 and 11 years. The other 8 participants grew up in a bilingual environment but had Dutch as their first language. For different reasons (see below), the data of 4 additional participants were discarded. As a further test of the bilingualism of our participants, after the experiment was finished we asked them to translate the 36 French words that had been presented in the Dutch–French condition. On average, they could do so for 28 of the 36 words (i.e., 78%). It may be noted, however, that some of the target words were very low-frequency words (see the Appendix). All participants had normal or corrected-to-normal vision and were unaware of the research hypotheses.

Materials. For the French–French stimuli, we used the stimuli listed in Grainger and Ferrand (1996, Appendix A). These stimuli consisted of 30 four-letter words and three types of nonwords. The first type of nonword consisted of pseudohomophones that were created by changing one letter (usually the last) of the target word (e.g., *fain*–FAIM). The second type of nonword was the graphemic control of the first type; that is, these nonwords shared the same letters with the target word, but the letter that had been changed did not preserve the phonemic representation of the target word (e.g., *faic*–FAIM). Finally, the last type of nonword included pseudohomophones that had only one letter in the same position as the target word (e.g., *fint*–FAIM). As indicated above, the phonological priming effect is measured by comparing the effects of Prime Types 1 and 2, which have the same number of letters in common with the target but not the same number of sounds; the orthographic priming effect is estimated by comparing Prime Types 1 and 3, which are both pseudohomophones but share a different number of letters with the target. The average printed frequency of the word targets of the French–French stimuli was 260 occurrences per million (Grainger & Ferrand, 1996, p. 627).

The Dutch–French stimuli originally consisted of a list of 36 French words for which there exist Dutch homophonic words. However, during the analyses, we discovered that for 6 of these items the homophonic prime overlapped semantically with the target (e.g., COQ primarily means "cock" but has a secondary meaning of "ship's cook," which is related to the Dutch word *kok,* meaning "cook"). Therefore, the results are based on the remaining 30 trials (see the Appendix).[2] The target words were matched with three types of Dutch word primes. The first type consisted of the corresponding homophones (e.g., *wie*–OUI; translation: *who*–YES). The second type consisted of the graphemic controls, which had the same letters in common but not the same number of sounds (e.g., *jij*–OUI; translation: *you*–YES). Finally, primes of the third type consisted of unrelated control words (e.g., *dag*–OUI; translation: *day*–YES). Because Dutch has more restricted phoneme–grapheme correspondences than French, it was impossible to construct Grainger and Ferrand's (1996) condition of homophonic but orthographically dissimilar primes. Furthermore, given that the present study was the first to look at interlingual phonemic priming in visual word recognition, it seemed safer to include the usual unrelated control condition (e.g., Perfetti & Bell, 1991) in case we would not find a difference between the homophonic condition and the graphemic control condition. Care was taken (a) to avoid homophonic pairs that according to the French letter-to-sound conversions would have been homophonic pairs as well, (b) to match the log frequency of the three types of Dutch words (based on the CELEX counts; Baayen, Piepenbrock, & van Rijn, 1993), (c) to avoid any semantic overlap between the Dutch and the French words, and (d) to make sure that none of the Dutch words formed an existing French word. The mean printed frequency of the

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[1] Although we use the term "interlingual homophones" in this text to refer to words (and nonwords) of two languages that sound the same, it may be questioned whether these stimuli are real homophones. If both were pronounced by native speakers, it would probably be possible to pick up some differences between them (e.g., the *r* is pronounced differently in French and in Dutch). These differences are likely to be smaller when a Dutch–French bilingual pronounces both stimuli (and to some extent adapts the pronunciation of one language to the pronunciation of the other).

[2] Average target recognitions for these six trials were 32% (homophonic), 18% (graphemic), and 23% (unrelated) for the monolinguals and 29%, 12%, and 13% for the bilinguals.

30 target words of the Dutch–French stimuli was 366 per million (*Trésor de la Langue Française,* 1971).

Procedure. Participants were tested individually in a quiet room. First, the instructions (in French) were presented on the computer screen. They mentioned that 12 practice trials and 66 test trials would be presented. At the beginning of a trial, two vertical lines appeared in the center of the screen together with the message that the participant had to press on the space bar in order to start a trial. Five hundred milliseconds after the participant had pressed on the bar, a premask consisting of a row of seven horizontally aligned # signs was presented, with the second # sign appearing in the gap between the vertical lines. The premask stayed on for 500 ms and was followed by a prime for 42 ms, a target word for another 42 ms, and a postmask that remained on the screen until the end of the trial. The prime appeared in lowercase letters, the target in uppercase letters. Primes and targets were always presented with their second letters between the vertical lines. Previous research (Brysbaert, 1994; Brysbaert, Vitu, & Schroyens, 1996) had shown that this is the optimal viewing position for short Dutch and French words. The postmask consisted of seven horizontally aligned capital Xs. The reason the premask and the postmask differed was that (for the bilingual participants) we wanted to present the targets of the second language for the same duration as we presented the primes of the first language in order to avoid greater conspicuousness of the primes than of the targets (usually, primes are presented for 42 ms and targets for 28 ms [e.g., Grainger & Ferrand, 1996]; see also the present Experiment 2). It turned out that the # signs were more effective masks for lowercase letters, and the Xs were more effective masks for uppercase letters.

Participants were warned that on each trial a nonword and a short French word would be presented, and they were asked to type in the word and then, if possible, the nonword. The computer was programmed in such a way that for the word answers (but not the nonword answers), the letters typed in by the participant were automatically converted to uppercase letters on the screen. This was important because otherwise some of the word answers would have required the typing of accent marks. The experiment started with a list of 12 practice trials, which had the same composition as the experimental trials (i.e., six Dutch primes that were homophones or controls and six French nonwords that followed the criteria outlined above). After these trials, participants received feedback about the number of words and nonwords correctly reported. They were told that low scores were normal, especially for the nonwords. Then they were given a random permutation of the 30 French–French and the 36 Dutch–French stimulus combinations, which were mixed together. Each participant got a different permutation and saw each target with only one type of prime (Latin square design).

During the experiment, we replaced participants who had fewer than 7 correct identifications of the 66 target words in the test session. On the basis of this criterion, the data of 3 bilingual participants were discarded. After the experimental session was finished, bilingual participants were asked whether they had noticed that from time to time a Dutch word had been presented instead of a nonword. One participant said he had noticed, so his data were discarded from the analyses as well. Some other participants had reported one or more of the Dutch primes when asked for a nonword, but they said they had done so because they could not think of any nonwords.

Results

The probability of correct target word identification as a function of language group and stimulus type is shown in Table 1. Because of the different research questions addressed by the French–French and the Dutch–French stimuli (see the introduction), the results of both types of stimuli are discussed separately.

French–French stimuli. In 2 × 3 analyses of variance (ANOVAs) with the variables of language group and prime type, there were significant main effects of language group, $F_1(1, 68) = 3.74$, $MSE = 0.070$, $p < .06$ (analysis by participants), $F_2(1, 29) = 15.09$, $MSE = 0.019$, $p < .01$ (analysis by materials), and prime type, $F_1(2, 136) = 32.35$, $MSE = 0.032$, $p < .01$, $F_2(2, 58) = 14.05$, $MSE = 0.061$, $p < .01$, but no interaction effect, $F_1(2, 136) < 1$, $MSE = 0.032$; $F_2(2, 58) < 1$, $MSE = 0.021$. Duncan's multiple range test indicated that the orthographic priming effect of 22% was significant both in the analysis by participants and in the analysis by materials (both *p*s < .01) but that the phonological priming effect of 8% did not reach significance in the analysis by materials ($p_1 < .01$, $p_2 < .11$). However, planned comparisons between the conditions involved in the net phonological priming effect revealed significance: $t_1(68) = 2.67$, $p < .005$ (one-tailed); $t_2(29) = 2.02$, $p < .03$ (one-tailed).

Pooled over participants, the number of primes reported by the French monolinguals was 9 for the pseudohomophones with a large orthographic overlap (from a total of 300), 10 for the graphemic controls, and 3 for the pseudohomophones with a small orthographic overlap. For the bilinguals, these numbers were, respectively, 11, 10, and 12 (from a total of 400).

Dutch–French stimuli. In 2 × 3 ANOVAs with the variables of language group and prime type, there were again significant main effects of language group, $F_1(1, 68) = 6.90$, $MSE = 0.065$, $p < .02$, $F_2(1, 29) = 25.52$, $MSE = 0.016$, $p < .01$, and Prime type, $F_1(2, 136) = 9.26$, $MSE = 0.022$, $p < .01$, $F_2(2, 58) = 3.22$, $MSE = 0.048$, $p < .05$, but no significant interaction effect, $F_1(2, 136) = 1.23$, $MSE = 0.022$; $p > .20$, $F_2(2, 58) = 1.74$, $MSE = 0.017$, $p > .15$. The effect of prime type was largely due to the (less

Table 1
Probability of Correct Target Word Identification as a Function of Language Group and Stimulus Type: Experiment 1

Stimulus type	Monolinguals	Bilinguals
French–French stimuli		
fain–FAIM	.59	.50
faic–FAIM	.50	.43
fint–FAIM	.34	.28
Net phonological priming effect	.09	.07
Net orthographic priming effect	.25	.22
Dutch–French stimuli		
wie–OUI	.35	.30
jij–OUI	.36	.23
dag–OUI	.26	.17
Net phonological priming effect	−.01	.07

interesting) condition with unrelated primes. Therefore, we repeated the analyses with only two levels of prime type (homophonic vs. graphemic control). The main effect of language group remained significant, $F_1(1, 68) = 6.06$, $MSE = 0.049$, $p < .02$, $F_2(1, 29) = 12.02$, $MSE = 0.022$, $p < .01$, but the effect of prime type disappeared, $F_1(1.68) < 1$, $MSE = 0.026$, *ns*, $F_2(1, 29) < 1$, $MSE = 0.036$, *ns*. The interaction effect now was significant by materials, $F_2(1, 29) = 4.72$, $MSE = 0.013$, $p < .04$, but not by participants, $F_1(1, 68) = 2.10$, $MSE = 0.026$, $p > .15$. Because we had precise predictions at the onset of the study, we could legitimately run planned comparisons on the difference between the homophonic condition and the graphemic control condition for each language group separately. Needless to say, the negative effect of -1% for the monolingual group was not significant, $t_1(29) = -0.31$, $t_2(29) = -0.32$. However, the 7% difference in bilinguals was significant both in the analysis by participants, $t_1(39) = 2.02$, $p < .03$ (one-tailed) and in that by materials, $t_2(29) = 1.98$, $p < .03$ (one-tailed).

From a total of 300 observations per condition, the French monolinguals reported 3 Dutch homophonic primes, 2 Dutch graphemic controls, and 1 unrelated control. For the bilinguals, these numbers were, respectively, 10, 13, and 2 (from a total of 400).

Discussion

Two questions were addressed in Experiment 1. First, we wanted to know whether the phonological and orthographic priming effects reported by Grainger and Ferrand (1996) would be the same when the target language was the participants' second language. As can be seen in Table 1, this was the case. The phonological priming effect equalled 9% in monolinguals and 7% in bilinguals; the orthographic priming effects were, respectively, 25% and 22%. A less fortunate aspect of the data was that our experimental procedure seems to have reduced the net phonological priming effect (Grainger & Ferrand reported an effect of 17%), so that the effect was only significant in a planned comparison test. This is probably because the targets in our experiment were presented for longer durations and were followed by a different postmask than in the experiment of Grainger and Ferrand (see Ferrand & Grainger, 1993, for the time course of the orthographic and the phonological priming effects in the masked priming paradigm).

Our second question was whether the intralingual phonological priming effect would extend to an interlingual situation. In the latter condition, the homophony between prime and target is caused by applying two different sets of grapheme–phoneme correspondences. Therefore, the homophonic effect can be obtained only (a) if both sets of correspondences are activated simultaneously and interact with one another and (b) if the participant masters both languages. So, for these interlingual stimuli, we expected no "homophone" advantage for French monolinguals because for them the homophony between the Dutch and the French words cannot be determined. For these participants, the sequence of letters of the Dutch words results in a different pronunciation (e.g., the pronunciation of the letter sequence *dier* is /diːr/ in Dutch but /die/ in French; a comparable Dutch–English example would be *mee*–MAY).

Our results confirmed the existence of interlingual phonological priming: There was no difference in target recognition for French monolinguals when the targets were preceded by a Dutch homophone (35%) than when they were preceded by a Dutch graphemic control (36%). However, the Dutch–French bilinguals showed an interlingual priming effect (7%) that was of the same magnitude as their intralingual priming effect. This strongly suggests that for Dutch–French bilinguals, in the process of written French word recognition the Dutch phonology is automatically activated.

However, before we discuss the implications of the interlingual phonological priming effect (see the General Discussion), it is necessary to address two possible criticisms of Experiment 1. First, it may be objected that, after all, the evidence for the phonological priming effects is rather weak in terms of statistical reliability. As mentioned above, we believe this is due to the change in stimulus presentation we had to introduce in order to avoid the bilingual participants' recognizing the Dutch word primes. Second, it may be objected that the Dutch–French stimuli differed for the two language groups not only in terms of the phonemic overlap between prime and target but also in terms of their lexical status. For the bilinguals, both prime and target were words; for the monolinguals, the primes were nonwords.

We had three reasons for choosing Dutch words rather than nonwords in the interlingual condition. First, Perfetti and Bell (1991) had shown that with masked phonological priming the same results are obtained with word and nonword primes if prime duration is long enough (i.e., more than 35 ms). Second, there is no question about the pronunciation of words and, hence, the amount of phonemic overlap between prime and target in the different conditions. Finally, word stimuli guarantee that similar primes are used in all conditions. For a particular homophonic word pair (e.g., *wie*–OUI), there are only a few graphemic control words that (a) have about the same frequency and (b) have the same letters in common with the target. With nonword stimuli, there are in principle hundreds of alternatives available.

However, if one wants to make the claim that phonological effects in written word recognition are nonlexical, then word stimuli always are a risk. It could be argued that the interlingual phonological priming effect is a result of interactions within the participant's input lexicon or, indeed, among the two input lexicons of a bilingual. Alternatively, it could be argued that the French monolinguals did not show an interlingual phonological priming effect because for them the primes were less familiar and, hence, needed more time to activate a phonological representation. This argument is similar to the one needed to explain why nonword primes require longer exposure durations than word primes to evoke a phonological priming effect (Perfetti & Bell, 1991). For these reasons, the interlingual finding would be considerably strengthened if we could repeat it using Dutch nonword primes in the interlingual stimulus condition.

Experiment 2

Two changes were introduced in this experiment. First, the Dutch–French stimuli were changed so that all primes were nonwords. Second, we used Grainger and Ferrand's (1996) presentation procedure in order to find out whether it elicited a larger phonological priming effect. This was possible because we no longer used word primes (see the *Procedure* section of Experiment 1).

Method

Participants. The French monolinguals were 30 students from the Université René Descartes (different from those of Experiment 1). They reported not being familiar with the Dutch language and were tested in Paris. The Dutch–French bilinguals were 30 students from the University of Leuven (different from those of Experiment 1). All but 2 followed academic courses to get a degree in French. Five of them grew up in a bilingual environment; the others had started to learn French between the ages of 8 and 11 years. Their mastery of French vocabulary was evidenced by the fact that they translated, on average, 35 of the 36 target words of the Dutch–French condition of Experiment 2 (see the Appendix). None of the participants failed to reach the criterion of 7 correct word identifications on a total of 66 test trials.

Materials and procedure. Thirty-six new Dutch–French stimuli were composed (see the Appendix). First, we selected French words with a pronunciation that could reliably be represented as a Dutch nonword according to the Dutch spelling-to-sound rules. Then, for each of these words, a graphemic control and an unrelated control were assembled. For these controls, we tried to avoid letter sequences that were unacceptable in either Dutch or French. Two native French speakers checked our stimuli to ensure (a) that no prime formed a French word and (b) that no Dutch pseudohomophone sounded like the French target word when pronounced according to the French grapheme–phoneme correspondences. The average frequency of the French target words was 440 per million (*Trésor de la Langue Française,* 1971).

The procedure of Experiment 1 was used except for the following changes. The premask and the postmask each consisted of a row of six # signs (instead of, respectively, seven # signs and seven Xs). The target words were presented for 28 ms (instead of 42 ms); prime duration remained at 42 ms. Finally, the participants were not told that two stimuli would be presented and were not asked to type in the nonword. The instructions just told them to try to identify the words presented in uppercase letters.

Results

The probability of correct target word identification as a function of language group and stimulus type is presented in Table 2. As in Experiment 1, we discuss the findings separately for the French–French and the Dutch–French stimuli.

Table 2
Probability of Correct Target Word Identification as a Function of Language Group and Stimulus Type: Experiment 2

Stimulus type	Monolinguals	Bilinguals
French–French stimuli		
fain–FAIM	.44	.53
faic–FAIM	.28	.45
fint–FAIM	.16	.25
Net phonological priming effect	.16	.08
Net orthographic priming effect	.28	.28
Dutch–French stimuli		
soer–SOURD	.24	.41
siard–SOURD	.33	.34
chane–SOURD	.09	.16
Net phonological priming effect	−.09	.07

French–French stimuli. ANOVAs by participants and by materials with the variables of language group and prime type revealed significant main effects of language group, $F_1(1, 58) = 11.59$, $MSE = 0.049$, $p < .01$, $F_2(1, 29) = 14.96$, $MSE = 0.038$, $p < .01$, and prime type, $F_1(2, 116) = 53.70$, $MSE = 0.022$, $p < .01$, $F_2(2, 58) = 18.11$, $MSE = 0.064$, $p < .01$, but no reliable interaction, $F_1(2, 116) = 1.53$, $MSE = 0.022$, $p > .20$, $F_2(2, 58) = 2.41$, $MSE = 0.014$, $p > .05$. Duncan's multiple range test revealed that the orthographic priming effect of 28% was significant both in the analysis by participants and the analysis by items ($ps < .01$). The same was true for the phonological priming effect of 12% ($p_1 < .01, p_2 < .02$).

Dutch–French stimuli. All effects were significant in the ANOVAs of the Dutch–French stimuli: language group, $F_1(1, 58) = 8.84, MSE = 0.036, p < .01, F_2(1, 35) = 17.86$, $MSE = 0.021$, $p < .01$; prime type, $F_1(2, 116) = 56.60$, $MSE = 0.015, p < .01$, $F_2(2, 70) = 17.42$, $MSE = 0.058$, $p < .01$; interaction, $F_1(2, 116) = 6.22, MSE = 0.015, p < .01$, $F_2(2, 70) = 7.85$, $MSE = 0.014$, $p < .01$. The main effect of prime type was entirely due to the unrelated control condition, because it disappeared when the analysis was restricted to the homophonic and the graphemic control conditions: language group, $F_1(1, 58) = 6.97, MSE = 0.036$, $p < .02$, $F_2(1, 35) = 16.61$, $MSE = 0.018, p < .01$; prime type, $F_1(1, 58) < 1, MSE = 0.015$, *ns,* $F_2(1, 35) < 1, MSE = 0.049$, *ns;* interaction, $F_1(1, 58) = 12.54, MSE = 0.015, p < .01$, $F_2(1, 35) = 12.45$, $MSE = 0.017$, $p < .01$. Planned comparisons showed that the performance of the monolinguals was reliably worse in the homophonic condition than in the graphemic control condition, $t_1(29) = -2.73, p < .02$, $t_2(35) = -2.22$, $p < .05$. The better performance of the bilinguals in the homophonic condition than in the graphemic control condition was reliable in the analysis by participants, $t_1(29) = 2.25, p < .05$, but not in the analysis by materials, $t_2(35) = 1.48, p > .10$.

Discussion

Our primary objective in Experiment 2 was to see whether we could replicate the interlingual phonological priming effect using nonwords as primes. The results showed that this was indeed possible, although the findings were slightly more complicated than we had anticipated at the outset of the experiment. What happened is that for the French monolinguals, the Dutch homophonic nonwords interfered more with target recognition than did the Dutch graphemic control nonwords, so that performance was worse in the condition with Dutch pseudohomophones. In retrospect, this is probably because the Dutch graphemic control stimuli followed the French graphotactic constraints more closely than did the Dutch homophonic stimuli. A Dutch–English analogue of this characteristic would be something like *plij*–PLAY (homophonic condition) versus *pluy*–PLAY (graphemic control condition; see the Appendix). More important, however, for the Dutch–French bilinguals, the Dutch pseudohomophonic primes elicited better target word recognition than did the graphemic control primes, despite the fact that the former were less French-like. Together with the findings of Experiment 1, this strongly suggests that the bilingual participants used Dutch spelling-to-sound conversions in the recognition of printed French target words.

Experiment 2 further showed that having the target word presented for a shorter duration than the prime stimulus resulted in larger priming effects, especially for the effects that were due to the phonological similarity between prime and target. Our findings with French monolingual participants now closely resemble those reported by Grainger and Ferrand (1996; see also the introduction) even though their participants performed, on average, much better than ours. As a matter of fact, it may be noted that in Experiment 2 the French monolinguals performed worse than their bilingual colleagues (the reverse was true in Experiment 1).

There is some suggestion that the intralingual phonological priming effect was slightly smaller when the target language was the participants' second language than when it was their native language (cf. 7% vs. 9% in Experiment 1 and 8% vs. 16% in Experiment 2). However, given our finding of interlingual phonological priming, this finding must be treated with caution. It is not impossible that, on average, the phonemic similarity between Grainger and Ferrand's (1996) homophonic and orthographic control primes was greater for the bilinguals than for the monolinguals, because the former took into account not only the French phonology but also the Dutch phonology and maybe one or two more phonologies (in Belgium, most university students are reasonably familiar with English, and because of their studies some of our bilingual participants were acquainted with one other Romance language as well). Thus, it could well be that the phonological similarity between the nonword *faic* (with no fixed pronunciation) and the target word FAIM was larger for the bilinguals than for the monolinguals. This would explain why the bilinguals' performance was so good for the *faic*–FAIM stimulus trials. Note, however, that the tendency for a smaller intralingual phonological priming effect in the nondominant language than in the dominant language does not agree with Gollan et al.'s (1997) assumption of more reliance on phonology in second-language reading.

General Discussion

In the present experiments, we first examined whether visual word recognition in a second language is based on the same principles as visual word recognition in a native language. The starting point was Grainger and Ferrand's (1996; Ferrand & Grainger, 1994) finding of phonological and orthographic priming effects in French. Using the masked priming procedure, they showed that the probability of recognizing a French target word depended on both the phonological and the orthographic similarity between the target and a previously presented nonword prime. Grainger and Ferrand interpreted this finding as evidence for a model of visual word recognition that assumes a simultaneous activation of orthographic and phonological representations that interact with one another and have access to a common semantic store.

Because the importance of phonological recoding in visual word recognition is often explained by referring to the fact that a child first learns a language in the auditory modality, we wondered whether the phonological priming effect would be obtained in a non-native language that is usually acquired when the (visual) reading processes are well established. Our data indicate that this is indeed the case. In two experiments with bilingual participants recognizing target words in their second language, we found a significant phonological priming effect that was not reliably smaller than that found for native speakers. This adds further evidence to recent proposals of a central role of phonological recording in visual word recognition (e.g., Lukatela & Turvey, 1991; Perfetti et al., 1988; Van Orden, 1987).

Besides the phonological priming effect, we also replicated Grainger and Ferrand's (1996) orthographic priming effect: The target word FAIM was more likely to be recognized when it was preceded by the orthographically similar pseudohomophone *fain* than by the orthographically dissimilar pseudohomophone *fint*. Furthermore, the magnitude of the orthographic priming effect was the same for monolinguals and for bilinguals performing the task in their second language. In line with Grainger and Ferrand, we interpret this finding as evidence that visual word recognition is not entirely based on a phonological code.[3]

In the second part of the study, we showed that it is possible to facilitate target-word recognition not only with primes that are homophonic according to intralingual spelling–sound correspondences but also with primes that are homophonic according to spelling–sound correspondences of another language known to the individual. This finding further reinforces the growing body of evidence that the lexicons of a bilingual should not be considered two separate entities that are connected only by a shared semantic system

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[3] Although the orthographic priming effect inevitably seems to point to the involvement of orthographic information in the activation of stored word representations, it should be noted that this view is not generally held (C. A. Perfetti, personal communication, September 1996). An alternative interpretation may be that *fain* activates FAIM more than *fint* does because it has a higher phonological-to-orthographic consistency. If phonological recoding is not a purely feedforward operation but involves feedback mechanisms as well, then one has to look at phoneme-to-grapheme consistencies in addition to grapheme-to-phoneme consistencies (Stone et al., 1997). It could be that *-ain* is a more frequent spelling of the sounds conveyed by the body *-aim* than the spelling *-int*.

or by direct links between words that are translations of one another. Rather, written words of different languages are treated in important aspects as if they were written words of the same language. This has already been suggested by a number of findings in lexical decision tasks. First, it has been shown that the legality of nonwords depends not only on the phonotactic rules of the target language but also on the phonotactic rules of the nontarget language (Altenberg & Cairns, 1983). Second, words from a nontarget language take unusually long to reject as nonwords in a monolingual lexical decision task except when there are distinct orthographic cues about the language of the words (Nas, 1983, Experiment 1; Scarborough et al., 1984). Third, interlingual pseudohomophones are more difficult to reject in a monolingual lexical decision task (Nas, 1983, Experiment 2). Finally, the time to accept a word in a monolingual decision task depends on the balance between neighbors in that language and neighbors in another language known to the participants (Grainger & Dijkstra, 1992).

A problem with the lexical decision task, however, is that researchers no longer believe that it taps only lexical processes. There is evidence that lexical decisions are also influenced by semantic factors (e.g., Balota & Chumbley, 1984) and partly depend on a familiarity check (Besner & McCann, 1987). So there may be some concern about the exact interpretation of the above findings. This is less so for a study by Beauvillain and Grainger (1987), who showed that "interlingual homographs" (i.e., words written the same but pronounced differently in the two languages) primed subsequent words not only when presented in the appropriate-language context (*four*–FIVE in a list of English primes) but also when presented in an inappropriate-language context (*four*–FIVE in a list of French primes). A criticism of this study, however, might be that the target words were presented for much longer durations than the primes, so the manipulation of the language context by changing the language of the primes may not have been effective enough (French, 1996).

None of the above objections applies to the present findings. The masked priming technique is known to tap into the first stages of word processing (i.e., prelexical and lexical; Berent & Perfetti, 1995), and the cross-language phonological priming effect can hardly be ascribed to the fact that something in the research design prompted the recoding of the primes in a language other than the target language. When participants were asked about the identity of the primes (Experiment 1), all but 1 complained that they were unable to see anything and were merely guessing. Furthermore, only for 12 of the 66 trials was phonological recoding in the nontarget language helpful.

Our findings indicate that when bilinguals read written words in their second language, there is activation of phonological codes according to the spelling–sound correspondences of both the target language and the native language. Furthermore, all phonological codes contribute to the recognition process. Such a finding is not in line with many current ideas about bilingualism. For a start, most models of bilingual written word processing have not (yet) considered the importance of phonology in visual word recognition. Second, all models that postulate the existence of two independent language systems do not predict language interactions at such an early, prelexical, stage of visual word recognition. On the basis of these models, one would instead expect (a) that phonological coding of visual stimuli is limited to the target language because the system can be tuned to the input, or (b) that because of acquisition characteristics, phonological coding occurs only in the native language, or (c) that recoding happens in both languages simultaneously but that the phonological information remains within the language system. An example of the last type would be a model of bilingual visual word recognition that postulates two separated phonological input lexicons, each of which requires automatic phonological recoding of the visual input before word representations can be activated.

Alternatively, our data are completely in line with a relatively simple model that assumes phonological coding of visual words to happen independently of language and simultaneously for all grapheme–phoneme correspondences mastered by an individual (see also Doctor & Klein, 1992). Although this view may seem extreme, we believe it does not require a considerably increased complexity of the grapheme-to-phoneme conversion system. For a start, many letters have the same pronunciation in different languages (this is especially true for consonants). Second, language-particular sounds are often represented by distinct sequences of letters (e.g., the French grapheme *eau* does not exist in Dutch words except for a few French loan words). Finally, ambiguities in letter–sound correspondences are not uncommon and certainly not restricted to cross-language situations, as everybody who has ever learned to read English knows (e.g., the different pronunciations of *wind*).

At this point, it may be interesting to note that Bijeljac-Babic, Biardeau, and Grainger (1997) recently reported other evidence of interlingual interactions at the first stages of visual word recognition. They made use of Segui and Grainger's (1990) finding that processing of a low-frequency target word is hampered more when the word is preceded by a tachistoscopically presented high-frequency orthographic neighbor (i.e., a word that differs from the target by a single letter, such as *blue*–BLUR) than when it is preceded by an orthographically dissimilar control word. Segui and Grainger expected this orthographic inhibition effect on the basis of simulations run on McClelland and Rumelhart's (1981) interactive activation model. Testing highly proficient bilinguals, Bijeljac-Babic et al. (1997) replicated the effect in a cross-language condition with primes from the participants' second language and targets from the participants' first language. Highly proficient French–English bilinguals experienced more problems processing the French target word AMONT when it was preceded by the tachistoscopically presented English word *among* than when it was preceded by the control word *drive*. No effect was found for monolinguals and beginning bilinguals. It may be noted that although neighborhood effects are usually stated in terms of orthographic overlap, a recent study by Peereman and Content (1997) showed that phonological similarity is involved as well.

Thus, it looks as if the initial steps of visual word recognition are shared by all (alphabetic) languages known to an individual. Undoubtedly, there must be inhibition of word representations belonging to the nontarget language at some stage of processing so that cross-language confusion is avoided, but the evidence suggests that this stage occurs later than is usually assumed. Following Grainger and Dijkstra's (1992) bilingual interactive activation model, Bijeljac-Babic et al. (1997) hypothesized that cross-language inhibition starts only after some word representations have been activated in the lexicon. These word representations send information to the higher level language nodes, which influence the ongoing competition between activated word candidates via top-down connections. At first sight, we need not postulate the language selection stage to occur as late in the process as Bijeljac-Babic et al. postulate, in order to account for our data. In a pure serial bottom-up model, the phonological codes generated according to the different grapheme-to-phoneme conversions only need to activate the matching lexical representation of the word in the target language. This does not preclude the possibility that all lexical representations of the nontarget language have been deactivated because of language tuning. However, the question is whether simultaneous phonological recoding according to different languages is possible on a pure feedforward basis or requires feedback mechanisms from higher levels of processing (see Stone, Vanhoy, & Van Orden, 1997, for evidence of feedback mechanisms in the solution of English intralingual grapheme-to-phoneme ambiguities). If feedback is needed, then the interpretation of our cross-language phonological priming effect may also require a temporal activation of lexical representations belonging to the nontarget language—for instance, to establish the coherence loop between spelling and sound (Stone et al., 1997).

To conclude the discussion of the interlingual phonological priming effect, it may be useful to keep in mind that we have shown priming from a first language to a second. Further research is needed to establish whether words of a second language can prime those of a first and, perhaps more important, what level of proficiency in the second language is needed for this to occur. Is the dual phonological recoding already present for someone who just has some introductory experiences with the pronunciation of the second language, or does it require considerable knowledge of the vocabulary? Finding the former would point to a serial bottom-up model; evidence for the latter would be more in line with an interactive model. In this respect, it may be important to note that Gollan et al. (1997) found translation priming with primes of the dominant language but not with primes of the nondominant language—not even with cognates, where a contribution of the phonological overlap between prime and target was assumed to work (see the introduction).[4]

Finally, the present findings also have implications for the interpretation of the masked priming technique and for theories that bear on the importance of phonology in visual word recognition. As for the former, the presence of an interlingual phonological priming effect for bilingual participants and the absence of the same effect for monolingual participants clearly indicate that the effect is due to the phonology of the stimulus. This runs counter to Davis and Forster's (1994) criticism that masked priming effects are due to the overlap of low-level letter features. Furthermore, finding an interlingual phonological priming effect in a task in which the primes were not consciously recognized and the construction of the stimulus list did not favor phonological encoding is a clear indication that the activation of the phonological code is a mandatory part of visual word recognition. This contradicts a previously published result of Brysbaert and Praet (1992), who, using the backward masking technique (in which the target word is presented before the nonword stimulus), found that phonological encoding in Dutch takes place only when the majority of trials have large phonemic overlap between target and mask. However, a new series of studies from our laboratory, both in English and in Dutch, has shown that the difficulty of obtaining a pseudohomophone effect in Dutch is related more to the nature of the task than to the composition of the stimulus list. In particular, we have found that, contrary to the case with English, the pseudohomophone effect is difficult to obtain with the backward masking technique in Dutch but readily appears with the masked priming technique, irrespective of the percentage of trials that include a homophonic prime (Van Cauteren, 1997). These findings are in line with models of visual word recognition that assume a mandatory role of phonological representations in visual word recognition.

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[4] It is also interesting to note that the few participants of our study who had learned French from birth showed an interlingual phonological priming effect that was (nonsignificantly) smaller than that of the bilinguals who started to learn French around the age of 10. Their net interlingual phonological priming effect was .03 in Experiment 1 and −.03 in Experiment 2, whereas the net interlingual phonological priming effects were .09 and .11 for the late learners in Experiments 1 and 2, respectively. That is, the pattern of the early bilinguals seems to fall somewhere between that of the late bilinguals and that of the monolinguals. It is not clear from the data whether this can be attributed to the age of nondominant language acquisition or to the proficiency level of the participants.

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(*Appendix follows*)

Appendix

Dutch–French Stimuli of Experiments 1 and 2

Experiment 1				Experiment 2			
Target	Homophonic	Graphemic control	Unrelated control	Target	Homophonic	Graphemic control	Unrelated control
APTE	abt	alt	olm	SOURD	soer	siard	chane
BASE	baas	baan	rook	RIRE	rier	rine	bomp
BATTE	bad	bak	pil	SAUCE	soos	sour	moir
BOUC	boek	boot	deel	NUQUE	nuuk	nuus	vees
BOULE	boel	beul	haak	FOULE	foel	fole	gart
CANE	kan	dan	mug	MOULE	moel	mols	nars
CLOQUE	klok	slot	smal	FOUR	foer	forg	mels
COULE	koel	doel	daad	POUR	poer	poir	dalk
COURS	koer	roer	fooi	AMOUR	amoer	amoir	eleen
CRANE	kraan	graan	stoom	BILE	biel	bilg	muns
DIRE	dier	diep	taak	PILE	piel	pilm	ruum
DOSE	doos	doen	haat	AVARE	avaar	avauw	omont
DURE	duur	durf	pijn	SAC	sak	saf	dif
HUILE	wiel	zeil	boon	FACE	fas	fane	gol
ILE	iel	iep	gok	TRACE	tras	trare	snuc
MARE	maar	maal	veel	PUCE	puus	puir	reir
NEZ	nee	nek	oud	CUITE	kwiet	brite	broms
OUI	wie	jij	dag	DROLE	drool	droul	stane
PART	paar	paal	hoog	VITE	viet	vits	hols
PATTE	pad	pak	fel	PLUME	pluum	plums	graap
PIRE	pier	piek	kolf	CRIME	kriem	treim	plous
PLACE	plas	pias	huur	CAVE	kaaf	zaar	zoor
POTE	poot	poos	jurk	TOUTE	toet	taute	lifs
POULE	poel	poen	gist	FOU	foe	for	har
RAME	raam	raad	punt	TROU	troe	tron	pnal
RAVE	raaf	rank	tolk	VOUS	voe	vost	zart
ROUTE	roet	roes	haai	CLOU	kloe	blon	bren
TOUT	toe	tor	dag	COUPE	koep	roop	dijf
VOUTE	voet	volk	hard	DOUCE	does	doire	zair
ZONE	zoon	zoen	kans	LUNE	luun	luin	gair
				FAUTE	foot	feute	zors
				HUIT	wiet	gait	koem
				SITE	siet	sive	cord
				SOURCE	soers	soork	weelk
				ROLE	rool	roge	gauf
				CORPS	kor	nort	nult

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