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The Size of the Cross-Lingual Masked Phonological Priming Effect Does Not Depend on Second Language Proficiency

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Abstract

Using a masked phonological priming paradigm, Brysbaert, Van Dyck and Van de Poel (1999) showed that Dutch-French bilinguals perform better at identifying tachistoscopically presented L2 words (e.g. *oui* [yes]) when those words are primed by L1 words or nonwords that are homophonic to the L2 target word according to the L1 grapheme-phoneme conversion rules (e.g. *wie* [who]). They noted that this priming effect was smaller for balanced bilinguals than for less proficient bilinguals, although the interaction failed to reach significance. Findings of Gollan, Forster and Frost (1997) suggest that this could be attributed to a greater reliance on phonology in L2 reading, caused by a smaller proficiency in this language. However, in this study we show that the Dutch-French cross-lingual phonological priming effect is equally large for perfectly balanced and less proficient bilinguals. Our findings are in line with more recent work of Van Wijnendaele and Brysbaert (2002).

Keywords: bilingualism, cross-lingual masked phonological priming

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For many years, it has been assumed that the lexicons of every language mastered by a bilingual person are separate, autonomous systems. In older models of bilingual brain organization, such as the three models of Weinreich (1953), both languages are completely divided at the lexical level, while shared representations between languages may exist at the semantic level. This assumption was also made in more recent models of bilingualism, such as the word association model, the concept mediation model (Potter, So, Von Eckardt, & Feldman, 1984) and the revised hierarchical model of Kroll and Stewart (1994). This hypothesis is supported for example by the existence of double dissociations between both languages in bilingual aphasic patients (Fabbro, 1999).

However, recently there is a growing body of evidence suggesting that lexical representations of both languages may be situated within a unitary system, or that lexical selection is at least a relatively late process in visual word recognition. A somewhat older study which already pointed in that direction is that of Nas (1983). He showed that Dutch-English bilinguals performing an English lexical decision task rejected Dutch words significantly slower than control words. The same was true for English nonwords (e.g. *snay*) which are homophones of existing Dutch words (e.g. *snee*, translated *cut*) according to English grapheme-to-phoneme conversion rules. However, using Spanish-English bilinguals, Scarborough, Gerard and Cortese (1984) did not replicate the findings of Nas (1983). Grainger (1993) argued that the effect was absent in the latter study because the orthographic similarity between Dutch and English (two Germanic languages) is much larger than between Spanish and English. Consequently, participants were more likely to have performed the lexical decision task using nonlexical (e.g. orthographic) characteristics of the target words.

More recently, Bijeljac-Babic, Biardeau and Grainger (1997) found that recognition of low-frequency target words by French-English bilinguals is inhibited not only by intra-lingual, but also by cross-lingual high-frequency orthographic neighbour primes (e.g. recognition of the French word *amont* is more difficult after masked presentation of the English prime *among* than after the control word *drive*). Another group of studies favouring the integrated lexicon hypothesis makes use of interlingual homographs (words which exist in both languages but have different meanings, e.g. the English word *room* means *cream* in Dutch). De Groot, Delmaar and Lupker (2000) for example, showed that the processing of interlingual homographs in a translation recognition task was inhibited compared to the processing of matched control words. This was especially the case when the homograph reading to be selected was the less frequent of the two homograph's readings. Dijkstra, Timmermans and Schriefers (2000) showed that such frequency dependent inhibitory effects of interlingual homographs are also present in tasks which do not explicitly require simultaneous activation of both language systems (this is the case in a translation recognition paradigm as De Groot et al. used). This shows that the presence of both languages in the experimental stimuli is not a necessary condition to find cross-language lexical interactions. Moreover, Van Hell and Dijkstra (2002) recently showed that L2 and even L3 lexical knowledge influences L1 lexical access in an exclusive native language context, using a L1 lexical decision task with Dutch – English – French trilinguals. Even though no L2 of L3 words (e.g. homographs, Dijkstra et al., 2000, see earlier) were present in the experiment, they found that L1 lexical decision is faster for L2 and L3 near-cognates (i.e. translation equivalents which are nearly orthographically identical, e.g. *brood – bread*) than for control words. Hence, this strongly suggests that L1 lexical activation is influenced by activation in the lexical representations of L2 and L3 words. For a more comprehensive overview of studies favouring the unitary lexical system view, we refer to Dijkstra and Van Heuven

(1998; see also Brysbaert, 1998). For the present study, it is only important to conclude that several recent studies have provided evidence against an early lexical selection mechanism.

Based on this body of evidence and on the claim that visual word recognition implies automatic, prelexical phonological coding (e.g. Van Orden, 1987; see Frost, 1998, for a recent review), Brysbaert et al. (1999) reasoned that it is very likely that such an automatic (not strategically controlled) grapheme-to-phoneme conversion occurs for all grapheme-phoneme correspondences mastered by bilinguals. This conversion takes place before a language selection mechanism gets involved in the word recognition process. This is compatible with an earlier study of Doctor and Klein (1992) with English-Afrikaans bilinguals. They found that interlingual homophones (words which share the same pronunciation, but have a different spelling, e.g. *lake* and *lyk* [corps]) are processed slower and less accurately than control words in a lexical decision task. To investigate this hypothesis more directly, Brysbaert et al. made use of the masked phonological priming effect, which was first reported by Humphreys, Evett and Taylor (1982). In this study, they showed that recognition of a tachistoscopically presented target word (e.g. *mail*) is facilitated by presentation of a masked homophonic prime (e.g. *male*) relatively to a graphemic control prime (e.g. *mall*). The difference between recognition ratios in those two conditions will be referred to as the (net) phonological priming effect from this point on. Note that this priming effect can not easily be attributed to strategic factors, since participants are unable to perform above chance in deciding whether the prime was a word or not, even when they are asked to try to identify the prime (e.g. (e.g. Forster & Davis, 1984).

In a first experiment, Brysbaert et al. (1999) used a bilingual version of this paradigm, using French target words and Dutch primes: the target words (e.g *nez,* translation *nose*) were presented tachistoscopically preceded by either homophonic primes (e.g. *nee*, translated *no*, sounds like the French word *nez*), graphemic control primes (e.g. *nek*, translated *neck*), or unrelated primes (e.g. *oud,* translated *old*). Note that the L1 homophonic primes were only homophonic with the L2 target word according to L1 (Dutch) grapheme-to-phoneme conversion rules. They found that target recognition was equally well in the homophonic and graphemic control condition for French monolinguals, but not for Dutch-French bilinguals. The latter performed significantly better after seeing the homophonic prime, than after seeing the graphemic control prime. To counter the criticism that this effect could be due to interactions within the bilingual's input lexicon, or between two language-dependent input lexicons, these findings were replicated with Dutch nonwords in a second experiment (e.g. a French target *pour* [translation *for*], with *poer*, *poir* and *dalk* as respectively Dutch homophonic, graphemic control and unrelated nonword primes). These results are evidence for automatic, prelexical and language-independent phonological coding of orthographic stimuli. Similarly, recent research (Van Wijnendaele & Brysbaert, 2002) offers further support for strong phonological models of word recognition (e.g. Van Orden & Goldinger, 1994; Frost, 1998). Using Dutch-French bilinguals, they found that it is also possible to prime L1 words (e.g. *wie* [who]) with L2 homophonic primes (e.g. *oui* [yes[). Hence, it is not only the case that word forms are automatically phonologically coded according to L1 grapheme-to-phoneme conversion rules. The same applies for L2 grapheme-to-phoneme rules, even when performing a task in L1 (see further in this introduction). Such a result can not be easily explained by traditional dual-route models of visual word recognition (e.g. Coltheart, 1978; Coltheart, Rastle, Perry, Langdon, & Ziegler, 2001). A more detailed discussion of this study and further interpretation of the results within these models is beyond the scope of this paper (see Van Wijnendaele & Brysbaert, 2002).

A less discussed and analysed though very intriguing aspect of the Brysbaert et al. (1999) study is the observation that the cross-lingual phonological priming effect was smaller for participants who learned French from birth than for those who started to learn French around the age of 10. For the first group, the difference between the proportions of correctly identified targets in the homophonic and graphemic control condition was .00 (.03 en -.03 for respectively Experiments 1 and 2). For the late learners, the effect was .10 (respectively .09 and .11). However, the interaction of the cross-lingual phonological priming effect with second language proficiency failed to reach significance (no *p* values mentioned). It should be noted though that this issue was not of primary concern for Brysbaert et al., and that only eight out of 40 (Experiment 1) and five out of 30 (Experiment 2) participants were balanced bilinguals. Hence, their study was not optimally designed to find such an interaction. In this study, we will focus on this topic, and we will therefore present some data of larger groups of perfectly balanced and other bilinguals performing the task used in Brysbaert et al. This allows us to determine whether the finding of Brysbaert et al. may be due to the use of a limited sample of balanced bilinguals.

Finding this interaction effect would be in line with results found in a Hebrew-English masked translation study by Gollan, Forster and Frost (1997). They found that it is possible to prime L2 targets with L1 translation primes while the priming effect from L2 primes to L1 targets was much weaker and not consistent. Because their primes contained both non-cognates (semantic overlap) and cognates (semantically and phonologically, but not orthographically overlapping as Hebrew and English have different scripts), they attributed this observation to the fact that L2 reading may rely more on phonology than L1 reading. It is indeed plausible to assume that L2 target recognition is more susceptible to phonologically similar primes than L1 target recognition if this explanation is correct. Note that such cross-language priming asymmetries have also been reported more recently by Jiang and Forster (2001), though they explained this finding differently.

Gollan et al. (1997) also stated that this overreliance on phonology in L2 reading is caused by a smaller L2 proficiency relatively to L1. This hypothesis is congruent with their observation of a larger cognate effect for less proficient than for more balanced bilinguals: L2 target recognition was facilitated by presentation of L1 cognate primes relatively to L1 non-cognate (phonologically dissimilar) primes , and this facilitation effect was greater for less proficient bilinguals. Hence, the phonological overlap between the L1 cognate prime and the L2 target was of greater importance for less proficient bilinguals, suggesting a larger reliance on phonological codes. Thus, on the basis of these findings, one would also predict a negative correlation between the cross-lingual phonological priming effect obtained by Brysbaert et al. (1999) and L2 proficiency in our study: perfectly balanced bilinguals will rely less on phonology than other bilinguals when processing L2 target words. Therefore, L2 target recognition will be less influenced by presentation of homophonic L1 primes and the cross-lingual phonological priming effect will be smaller for balanced bilinguals, as found by Brysbaert et al..

However, while an interaction between L2 proficiency and the cross-language phonological priming effect may be expected on the basis of the Gollan et al. (1997) study, recent findings suggest the contrary: as noted earlier, Van Wijnendaele and Brysbaert (2002) found in a Dutch-French study that it is also possible to prime L1 targets with homophonic L2 primes. This priming effect was of the same magnitude as the cross-lingual phonological priming effect from L1 to L2 (Brysbaert et al., 1999). Moreover, both priming effects were not related to differences in word naming latencies between L1 and L2 ($r = -.17$, $p > .10$), a variable believed to reflect language proficiency (Van Wijnendaele & Brysbaert, 2002; La Heij, Hooglander, Kerling, & Van der Velden, 1996; Kroll & Stewart, 1994). In addition, no evidence has been found in this study for an overreliance on phonology in L2 reading, as hypothesized by Gollan et al.. On the contrary, there was a larger word-frequency effect for L2 word naming than for L1, suggesting less non-lexical grapheme-to-phoneme conversions in L2 reading.

Experiment

Method

Participants. The participants consisted of two groups of Dutch-French bilinguals. The first group were 25 students at Ghent University, who participated for course requirements. They had started to learn French in a scholastic setting around the age of 9-10. The second group were 25 balanced bilinguals who learned French from birth and who grew up in a bilingual environment (e.g. having a Dutch speaking mother and a French speaking father). Ten of them were from the same population as mentioned above. The other 15 participants participated voluntarily after responding to an e-mail announcement. All participants from the second group reported regular use of both French and Dutch in their domestic environment at the time of the experiment. All participants completed a questionnaire assessing their L1 and L2 proficiency (see further).

Stimulus Materials. The stimuli (see the Appendix) consisted of the 30 French target words matched with three types of Dutch primes collected by Brysbaert et al. (1999). Homophonic Dutch primes had the same pronunciation (according to Dutch grapheme-to-phoneme conversion rules) as the corresponding French target word (e.g. kraan – CRANE; translation tap – SKULL). Graphemic control primes had a different pronunciation, but had those letters in common with the homophonic prime that the latter shared with the target in the same letter position (e.g. graan – CRANE; translation grain – SKULL). Finally, unrelated control primes had neither letters nor sounds in common with the target (e.g. stoom – SKULL; translation steam – SKULL). This type of control prime (Berent & Perfetti, 1995) is included to check the effectiveness of the priming procedure in case differences between the first two prime conditions would be absent. There was no semantic overlap between the primes and the target, and care was also taken that no Dutch prime was also an existing French word, or was homophonic to the target word according to French grapheme-to-phoneme conversion rules. Also, the log frequency of the three Dutch primes was matched (based on the CELEX counts, Baayen, Piepenbrock, & Van Rijn, 1993). The mean printed frequency of the target words was 366 per million (*Trésor de la Langue Française,* 1971).

Procedure. The same procedure was used as in Brysbaert et al. (1999). Participants were tested in small groups. Care was taken that they were placed sufficiently far from each other. It was not possible to see the computer screen of another participant. First, the instructions were presented on the screen in French. They mentioned that five practice trials and 30 experimental trials would follow. At the beginning of each trial, two vertical lines appeared as a fixation point in the center of the screen. Participants were also instructed to press the space bar to continue with the next trial. Five hundred milliseconds after this keypress, a forward mask consisting of seven hash-marks (#######) was presented with the second sign at the place of the gap between the two vertical lines. This mask stayed on the screen for another 500 ms, and was followed by a prime for 42 ms, a target word for 42 ms and a postmask consisting of seven horizontally aligned capital Xs (*XXXXXXX*). This mask remained visible until the end of the trial. The timing of the stimulus presentation was controlled using software routines published by Bovens and Brysbaert (1990). The prime appeared in lowercase letters, unlike the target which appeared in uppercase letters (for this reason, Xs were used as a more effective postmask). Both primes and targets were presented at the optimal viewing position (i.e., the second letter always appeared between the two vertical lines, e.g. Brysbaert, Vitu, & Schroyens, 1996). Participants were warned that on each trial a French word in uppercase letters would appear on the screen, and they were instructed to identify the word and type it in. There was no mentioning of the Dutch prime words. The letters typed in by the participants were automatically converted on the screen into uppercase letters to avoid the need to type accent marks. Each participant received a random permutation of the 30 Dutch-French stimuli. Therefore, each target word was only presented once, with one type of prime stimulus (Latin-square design).

Finally, all participants also completed a questionnaire, assessing their self-reported L1 and L2 reading, speaking, writing and general proficiency level on a seven-point Likert scale ranging from ‘very bad’ to ‘very good’. In addition, the questionnaire contained some general questions regarding the participants’ history of L2 acquisition (e.g. setting, age, etc.).

Results

Balanced and unbalanced bilinguals differed significantly with respect to their reported L2 speaking proficiency (respective means were $M = 5.84$ and $M = 3.88$, $F(1, 48) = 52.39$, $MSE = .917$, $p < .001$), writing proficiency ($M = 5.56$ and $M = 3.60$, $F(1, 48) = 45.95$, $MSE = 1.045$, $p < .001$) and reading proficiency ($M = 6.12$ and $M = 4.40$, $F(1, 48) = 36.98$, $MSE = .638$, $p < .001$). Balanced bilinguals also reported significantly higher general L2 proficiency, $M = 5.95$ and $M = 3.88$, $F(1, 48) = 52.02$, $MSE = .635$, $p < .001$. Both groups did not differ with respect to L1 speaking, writing, reading and general proficiency. Accordingly, the age at which participants reported to have encountered their first L2 word was significantly lower for balanced bilinguals ($M = 1.92$) than for unbalanced bilinguals ($M = 8.96$), $F(1, 48) = 397.55$, $MSE = 1.558$, $p < .001$. Consequently, the balanced bilinguals also had significantly more years of L2 experience ($M = 21.04$ vs. $M = 11.56$ years), $F(1, 48) = 48.38$, $MSE = 9.023$, $p < .001$.

Probabilities of correct target word identification as a function of prime type and bilingual group are displayed in Table 1. ANOVAs were run with L2 proficiency (balanced versus other bilinguals), prime type (homophonic, graphemic and control) and Latin-square group as independent variables. The latter variable was included to correct for the possibly deflated power of the design due to random fluctuations between the participants or between the stimuli allocated to the different cells. This has shown to be a good solution when analyzing Latin-square designs with relatively few observations in the different cells (Pollatsek & Well, 1995).

The main effect of Prime Type was significant both in the analysis by participants and by items, $F_1(2, 88) = 14.34$, $MSE = .0094$, $p < .01$, $F_2(2, 54) = 4.89$, $MSE = .0351$, $p < .01$. Because we had precise predictions concerning the phonological priming effect at the onset of the study, we could legitimately run a planned comparisons analysis. This showed a significant difference between the homophonic and the graphemic control condition, both in the analysis by participants and items, $F_1(1, 44) = 12.57$, $MSE = .0096$, $p < .001$, $F_1(1, 27) = 5.34$, $MSE = .0287$, $p < .03$. There were no significant main effects of Latin-square group (both Fs < 1) and L2 proficiency ($F_1 < 1$, $F_2(1, 27) = 1.55$, $p > .20$).

Insert Table 1 about here

Most importantly, no significant interaction was found between L2 proficiency and primetype, Fs < 1 ($MSE_1 = .0094$, $MSE_2 = .0091$). Also, a planned comparison of the interaction between L2 proficiency and the two primetype conditions involved in the phonological priming effect was not significant, both Fs < 1 ($MSE_1 = .0096$, $MSE_2 = .0122$). To evaluate the strength of this finding, we analyzed the power of this test in our design using the procedure of the MorePower program developed by Campbell and Thompson (2002). Because of the quite large number of participants and the rather small variance in the phonological priming effect, the design had a .805 power to detect the average net phonological effect difference between balanced and unbalanced bilinguals reported by Brysbaert, Van Dyck and Van de Poel (1999) (one-tailed), which is higher than the generally accepted .80 power level. There was even a very small trend towards a larger phonological priming effect for balanced bilinguals (7.4%) compared to other bilinguals (6.9%), rather than a smaller (or absent) effect.

Finally, whereas Table 1 suggests a larger difference between the graphemic and the unrelated control condition for balanced (5.1%) than for other (1.5%) bilinguals, a planned comparison showed that this interaction was by no means significant, $F_1 < 1$, $MSE = .0088$, $F_2(1, 27) = 1.13$, $MSE = .0086$, $p > .29$.

Discussion

The results of the experiment are quite clear: although mean target recognition rate was somewhat lower than in the study of Brysbaert et al. (1999), we succeeded in replicating the Dutch-French cross-lingual phonological priming effect[1]. Moreover, the effect we found was almost of the exact same size (it was 7.1% in our study, while it was 7.0% in Brysbaert et al.). In terms of statistical reliability (especially in the analysis by materials), the effect was somewhat stronger in this study, probably because of the larger number of participants.

Most importantly, this cross-lingual phonological priming effect did not interact with L2 proficiency, contrary to our predictions based on the findings of Brysbaert et al. (1999) and Gollan et al. (1997). Hence, it seems that the (not significantly) smaller priming effect for balanced bilinguals found by Brysbaert et al. (a .10 difference averaged over experiments) was indeed due to random fluctuations within the limited sample ($n = 8$ and $n = 5$, Experiments 1 and 2) of balanced bilinguals they used. Our findings are also not completely compatible with Gollan et al.. They reported an interaction between L2 proficiency and the cross-lingual cognate effect. The phonological overlap between a L1 cognate prime and a L2 target (Hebrew-English cognates are semantically and phonologically, but not orthographically similar) was of less importance for highly proficient bilinguals than for less proficient bilinguals. This suggests a negative correlation between L2 proficiency and the importance of phonological codes in L2 word reading. This hypothesis has not been confirmed in our experiment: the cross-lingual phonological priming effect was equally large for both groups (7.4% versus 6.9%: there was even a small trend in the opposite direction of predictions based on the results of Gollan et al. with a larger effect for balanced bilinguals). This would not have been the case if phonological codes are less important for L2 word recognition in perfectly balanced bilinguals.

However, our results are in line with more recent cross-lingual priming research of Van Wijnendaele and Brysbaert (2002): they found (unlike Gollan et al., 1997; Jiang & Forster, 2001) in a Dutch-French study that it is also possible to prime L1 targets with homophonic L2 primes. This priming effect was not smaller than the cross-lingual phonological priming effect from L1 to L2 (Brysbaert et al., 1999), which is against Gollan et al.'s hypothesis of an overreliance on phonology in L2 reading, for this hypothesis implies L2 target recognition to be more influenced by homophonic primes than L1 target recognition. Most importantly, both cross-lingual priming effects were also not related to differences in word naming latencies between L1 and L2, which were used to assess L2 proficiency.

In this view, it may be plausible to attribute the priming asymmetry (i.e. forward priming from L1 to L2, but not backward from L2 to L1) observed by Gollan et al. (see also Jiang, 1999, who replicated this asymmetry in Chinese-English bilinguals), not to a greater reliance on phonology in L2 reading relative to L1 reading, but to the fact that Hebrew (their L1) and English (L2) have different alphabets and therefore share little, if any, orthographic features (Grainger, 1993; Brysbaert, 2003). This is clearly not the case for Dutch and French which are orthographically more similar, and which are also much more consistent relative to each other as grapheme to conversion rules are concerned. This has probably facilitated transfer of phonological activation between languages, although our present findings do not allow to make strong claims about this issue. However, it may be interesting to note that we recently found both forward and backward translation priming in Dutch-English bilinguals using a lexical decision task (Schoonbaert, Duyck, & Brysbaert, 2003), whereas only L1 to L2 priming was reported by Jiang and Forster (2001), again using two languages which have different alphabets (i.e. Chinese and English). Finally, one might also argue that phonological codes are more important for the L2 perceptual identification task used in this study than for the L2 lexical decision task used by Gollan et al. (1997). However, Grainger and Ferrand (1996) compared these two tasks directly with the same set of stimuli and found a robust (intra-lingual) phonological masked priming effect with both tasks. Also, Kim and Davis (2003) recently found a phonological cross-language priming effect with Korean-English bilinguals using a lexical decision task (although this 18ms effect was only significant in a one-tailed test).

The present findings offer further evidence against the existence of two independent lexical language systems, since those models are unable to explain cross-language interactions at such an early stage of visual word recognition (see also Bijeljac-Babic et al., 1997). In order to avoid between-language confusion, inhibition of an irrelevant language system is likely to occur at some point, but this and other mentioned evidence suggest that this stage occurs relatively late in visual word recognition. An example of a powerful model which does not postulate language-specific access to the mental lexicon is the Bilingual Interactive Activation (BIA) model of Dijkstra and Van Heuven (1998). This is an extension of the well-known Interactive Activation model for monolingual word recognition (e.g. McClelland & Rumelhart, 1981), in which a top-down activation flow of language nodes to word nodes is made possible to account for language inhibition and facilitation effects on the word-node level. Hence, the monolingual model has been extended by a) adding language nodes (supplementary to word, letter and feature nodes) and b) inclusion of all L2 words into a unitary word-level system. This model implies that word recognition processes are initially non-selective (though top-down language influences may exist), since word activation is affected by competing items from both languages (e.g. Van Heuven, Dijkstra, & Grainger, 1998). Note that in more recent versions of the BIA model (see Dijkstra and Van Heuven, 2002, for a description of the BIA+ model), all top-down connections have been removed. Instead, effects of language context and stimulus list composition are dealt with at the task schema level, which only receives input from the (fundamentally language non-selective) word identification system. In this architecture, decision criteria, in a lexical decision task for example, can change as a function of stimulus list composition (e.g. Dijkstra et al., 2000), without assuming that such top-down factors influence activation in the lexical representations itself. Unlike the older BIA model, the BIA+ model also contains semantic and phonological representations, although these have not been implemented yet. It will be very interesting to see whether this model will be able to cope with the cross-lingual phonological priming effect. The present study and the findings of Brysbaert et al. (1999) and Van Wijnendaele and Brysbaert (2002) strongly suggest that activation of these phonological representations will also have to be fundamentally language non-selective, just as for lexical representations. In this view, we would also like to note that the phonological priming effect was equally strong from L2 to L1 than in the other direction (Van Wijnendaele & Brysbaert, 2002). This is not entirely compatible with the temporal delay assumption of the BIA+ model, which states that L2 phonological and semantic representations are delayed in activation relative to L1 codes (the same might be true for semantic representations, e.g. see Duyck & Brysbaert, 2002). As a more detailed discussion of this issue is beyond the scope of this paper, we refer the interested reader to Brysbaert, Van Wijnendaele and Duyck (2002).

Other models of bilingual word recognition in which some degree of interconnectedness of both languages is assumed (although to a lesser extent), such as the Bilingual Model of Lexical Access (BIMOLA) of Grosjean (1988; 1997), are less compatible with the cross-lingual phonological priming effect than the BIA model. In BIMOLA, there are two independent language networks (features, phonemes, words, etc.) which are both activated to some degree, depending on higher linguistic (e.g. textual context) information. Both systems are interconnected by means of a subset of neural connections from which bilinguals are able to draw elements of both languages, supplementary to the subset of neural connections for each separate language. Hence, this model can only predict interactions between two languages at such an early stage when higher linguistic information triggers activation in and between both language networks. This is not self-evident in a French target recognition task when participants are not aware of the presence of Dutch primes (e.g. Forster & Davis, 1984). In that case, the model (operating in a monolingual language mode) would not predict much influence from the weakly activated Dutch language system on the more strongly activated French language network. It should be noted though that there has recently been some evidence (Jared & Kroll, 2001) for Grosjean's (1988; 1997; 2001) claim that the task environment becomes functionally bilingual if the participant expects the experiment in which he or she is about to participate is likely to be using both languages, even if only materials in a single language are presented. This may have been the case since our participants were recruited based on their bilingual history.

In conclusion, it can be stated that our results offer further support for a strong phonological view on word recognition (e.g. Van Orden, 1987; Frost, 1998; Dijkstra, Grainger, & Van Heuven, 1999; for a recent and more detailed discussion, see Van Wijnendaele & Brysbaert, 2002): visual input triggers automatic phonological activation, and this occurs for all grapheme-to-phoneme correspondences mastered by a bilingual (see also Doctor & Klein, 1992). Moreover, contrary to Gollan et al. (1997), this process does not interact with L2 proficiency: phonology plays a crucial role in L2 word recognition, even in perfectly balanced bilinguals, as shown by the relatively large cross-lingual phonological priming effect in this group.

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Appendix

Stimuli Collected by Brysbaert, Van Dyck and Van de Poel (1999, Appendix)

French (L2) Target	Dutch (L1) Homophonic	Dutch (L1) Graphemic Control	Dutch (L1) Unrelated Control
APTE	Abt	alt	olm
BASE	Baas	baan	rook
BATTE	Bad	bak	pil
BOUC	Boek	boot	deel
BOULE	Boel	beul	haak
CANE	Kan	dan	mug
CLOQUE	Klok	slot	smal
COULE	Koel	doel	daad
COURS	Koer	roer	fooi
CRANE	Kraan	graan	stoom
DIRE	Dier	diep	taak
DOSE	Doos	doen	haat
DURE	Duur	durf	pijn
HUILE	Wiel	zeil	boon
ILE	Iel	iep	gok
MARE	Maar	maal	veel
NEZ	Nee	nek	oud
OUI	Wie	jij	dag
PART	Paar	paal	hoog
PATTE	Pad	pak	fel
PIRE	Pier	piek	kolf
PLACE	Plas	pias	huur
POTE	Poot	poos	jurk
POULE	Poel	poen	gist
RAME	Raam	raad	punt
RAVE	Raaf	rank	tolk
ROUTE	Roet	roes	haai
TOUT	Toe	tor	dag
VOUTE	Voet	volk	hard
ZONE	Zoon	zoen	kans

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Footnotes

1. Note again that the absence of such an effect in a monolingual French control group (using the same stimuli, Brysbaert et al., 1999, Experiment 1) rules out the possibility that the origin of the phonological priming effect lies within the (unevitable) orthographic overlap of the homophonic primes with the target.

Table 1. Probabilities (%) of Correct Target Word Identification as a Function of L2 Proficiency and Prime Type

Prime Type	Example	Less Proficient Dutch-French Bilinguals	Highly Proficient Dutch-French Bilinguals	Mixed Dutch-French Bilinguals (Brysbaert et al., 1999, Experiment 1)
Homophonic	kraan – CRANE	23.3%	26.4%	30%
Graphemic Control	graan – CRANE	16.4%	19.0%	23%
Unrelated Control	stoom – CRANE	14.9%	13.9%	17%
Net Phonological Priming Effect		6.9%	7.4%	7%