

# Interlingual lexical competition in a spoken sentence context: Evidence from the visual world paradigm

Evelyne Lagrou · Robert J. Hartsuiker · Wouter Duyck

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**Abstract** We used the visual world paradigm to examine interlingual lexical competition when Dutch–English bilinguals listened to low-constraining sentences in their nonnative (L2; Experiment 1) and native (L1; Experiment 2) languages. Additionally, we investigated the influence of the degree of cross-lingual phonological similarity. When listening in L2, participants fixated more on competitor pictures of which the onset of the name was phonologically related to the onset of the name of the target in the nontarget language (e.g., *fles*, “bottle”, given target *flower*) than on phonologically unrelated distractor pictures. Even when they listened in L1, this effect was also observed when the onsets of the names of the target picture (in L1) and the competitor picture (in L2) were phonologically very similar. These findings provide evidence for interlingual competition during the comprehension of spoken sentences, both in L2 and in L1.

**Keywords** Language comprehension · Phonology · Psycholinguistics · Spoken word recognition

Many studies on visual word recognition by bilinguals have pointed out that a bilingual is not merely the sum of two monolinguals. Instead, learning a second language (L2) changes the cognitive system in several ways. For instance, bilinguals are not able to “turn off” the irrelevant language when reading, and so a bilingual’s native language (L1) and L2 constantly compete with each other for recognition, both when reading in L2 and when reading in L1 (e.g., Dijkstra & Van Heuven, 1998; Duyck, 2005; Duyck, Van Assche, Drieghe, & Hartsuiker, 2007; Van Assche, Duyck, Hartsuiker, & Diependaele, 2009). However, the story may be different for auditory word recognition: In contrast to written language, speech contains

subsegmental and suprasegmental cues that are highly indicative of the (target) language in use. Even monolingual word recognition is highly sensitive to fine-grained phonetic details (Andruski, Blumstein, & Burton, 1994; McMurray, Tanenhaus, & Aslin, 2002; Salverda, Dahan, & McQueen, 2003), which is predicted by models of monolingual spoken word recognition (e.g., exemplar models; Goldinger, 1998). Hence, these approaches would predict that bilinguals are also able to use such fine-grained detail to constrain lexical access.

Accordingly, evidence for nontarget language activation in the auditory domain is more mixed. There is consistent evidence in favor of language nonselectivity when isolated words are listened to in L2 (e.g., Marian & Spivey, 2003; Schulpen, Dijkstra, Schriefers, & Hasper, 2003). But in isolated L1 auditory word recognition, evidence for cross-lingual lexical interactions is inconsistent, without a clear explanation. Moreover, although some data exist for L2 word recognition in meaningful sentence contexts, such data are lacking for L1, so that it also remains unclear whether top-down factors may modulate such influences. The present study addressed both issues. We tested whether lexical items from L1 and L2 compete with each other for activation when semantically coherent (but low-constraining) sentences are listened to in L2 (Experiment 1) and in L1 (Experiment 2), even though such sentences constitute strong and reliable cues for the language of words appearing in those sentences. Additionally, we investigated the role of cross-lingual phonological similarity and asked whether this might explain the divergent L1 findings reported in earlier studies on isolated word recognition.

A good method for examining lexical competitor activation in auditory word recognition is the visual world paradigm (e.g., Altmann, 2004; Tanenhaus, Spivey-Knowlton, Eberhard, & Sedivy, 1995). In this paradigm, eye movements to objects in a scene are continuously recorded, so that target word recognition may be monitored as speech unfolds over time. In a seminal study, Tanenhaus et al. investigated within-language lexical competition using this paradigm. Each critical display contained four objects, two of

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which had phonologically similar beginnings (e.g., *candy* and *candle*). Tanenhaus et al. found that it took longer to initiate eye movements to the correct object when an object with a phonologically similar name was presented.

Visual world studies on isolated L2 word recognition have yielded consistent cross-lingual lexical competition effects. In the studies of Marian and Spivey (2003) and Weber and Cutler (2004), bilinguals fixated more on competitor pictures with a name that was phonologically related to the onset of the name of the target in the nontarget language (e.g., *marka*, “stamp,” given target *marker*) than on unrelated distractor pictures. Importantly, studies that embedded target words in spoken sentences found that such cross-lingual interactions are influenced by sentence context (Chambers & Cooke, 2009; FitzPatrick & Indefrey, 2010). When the semantic information in a sentence was compatible with both the target (e.g., *poule*) and the interlingual competitor (e.g., *pool*), Chambers and Cooke found that competitors were fixated more often during L2 recognition than controls (e.g., *Marie va decrire la poule* [Marie will describe the chicken/pool]). This was not the case when the prior semantic information in the sentence was incompatible with the competitor meaning (e.g., *Marie va nourrir la poule* [Marie will feed the chicken/pool]). In an EEG study by FitzPatrick and Indefrey, sentences could be (1) congruent (e.g., “The goods from Ikea arrived in a large cardboard *box*”), (2) incongruent (e.g., “He unpacked the computer, but the printer is still in the *towel*”), (3) initially congruent within L2 (e.g., “When we moved house, I had to put all my books in a bottle”), or (4) initially overlapping with a congruent L1 translation equivalent (e.g., “My Christmas present came in a bright-orange doughnut,” which shares phonemes with the Dutch *doos*, “box”). The EEG results demonstrated an N400 component on all incongruent sentences that was delayed for L2 words, but not for L1 translation equivalents. This indicates that those L1 competitors that were initially congruent with the sentence context were not activated when bilinguals listened to sentences in L2. Hence, these studies seem to suggest that sentence context influences cross-lingual lexical interactions, even for L2 recognition, which shows consistent interference effects from L1 in isolated word recognition.

For L1 word recognition, the evidence for language nonselectivity is mixed, and the question of whether this nonselectivity can be affected by top-down factors remains unaddressed. Whereas Spivey and Marian (1999) observed lexical competition from L2 during L1 recognition, Weber and Cutler (2004) did not replicate this finding. Because bilinguals in the former study were immersed in an L2-dominant setting, whereas the latter bilinguals were not, this suggests that between-language lexical competition may depend on language profile factors. When it comes to L1 auditory word recognition in a meaningful sentence context, there are currently even *no* studies investigating cross-lingual interactions. Table 1 summarizes the different studies on isolated L2 and L1 word recognition and those using sentence context.

**Table 1** Overview of the different studies on auditory L2 and L1 word recognition in isolation and in a sentence context

	Isolation	Sentence
L2	Marian and Spivey (2003)	Chambers and Cooke (2009)
	Schulpen et al. (2003)	FitzPatrick and Indefrey (2010)
	Weber and Culter (2004)	
L1	Ju and Luce (2004)	The present study
	Spivey and Marian (1999)	
	Weber and Culter (2004)	

These results raise the question of which factors may constrain lexical access. For L2 word recognition, the studies above suggest that sentence context may be a constraining factor, whereas for isolated L1 word recognition, cross-lingual interactions seem to require sufficient language proficiency/dominance. A further factor may be phonology. In a study of isolated L2 word recognition by Schulpen et al. (2003), the influence of subphonemic cues on lexical access was investigated. In this study, Dutch–English bilinguals completed a cross-modal priming task with auditory primes and visual targets. Reaction times were longer for interlingual homophone pairs (e.g., /li:s/–LEASE; /li:s/ is the Dutch translation of *groin*) than for monolingual controls (e.g., /freIm/–FRAME), which suggests that bilinguals activated both meanings of the homophones. Crucially, the English pronunciation of the homophone led to shorter decision times on the related English target word than did the Dutch version of the homophone, which indicates that cross-lingual interactions are affected by subphonemic differences between homophones. For isolated L1 word recognition in a visual world paradigm, Ju and Luce (2004) found that Spanish–English bilinguals fixated interlingual distractors (nontarget pictures whose English names shared a phonological similarity with the Spanish targets) more frequently than control distractors, but only when the Spanish target words were altered to contain English-appropriate voice onset times.

In the present study, we investigated whether a meaningful, but low-constraining sentence context may restrict cross-lingual interactions in L1 auditory word recognition. We also tested whether differences with respect to the phonological similarity between phonemes influence cross-lingual lexical activation transfer. In contrast with Schulpen et al. (2003) and Ju and Luce (2004), we used existing natural variation in phonological similarity between L1 and L2 representations, instead of experimentally manipulating pronunciations. In order to confirm previous results on L2 word recognition and extend them with the results on the influence of subphonemic cues, we first investigated these questions when participants listened in L2. In Experiment 1, unbalanced Dutch–English bilinguals, immersed in an L1-dominant environment, listened to low-constraining sentences in L2. We investigated whether they fixated

competitor pictures with a name in the irrelevant L1 that was phonologically related to the target name (e.g., *fles*, “bottle”, given target *flower*) more than distractor pictures with an L1 name that was unrelated to the L2 target name. In Experiment 2, we investigated whether we could also observe between-language competition when these bilinguals were listening to L1 sentences. Additionally, we also analyzed effects of cross-lingual phoneme similarity. Typically, high-similarity items shared a consonant cluster such as /fl/, /sl/, or /sp/; low-similarity items tended to have a vowel as the second phoneme or had a consonant cluster involving /r/; vowel space is different between Dutch and English, and these languages realize /r/ with different phones. Even if phonological cues are not used as a strict cue to limit lexical activation to only one lexicon, between-language competition may still be stronger when the target and the competitor are perceived as sounding more similar.

## Experiment 1: L2

### Method

#### Participants

Twenty-two Ghent University students participated. All were unbalanced Dutch–English bilinguals. They started to learn English (L2) around age 14 at secondary school. Although they use their L1 (Dutch) most of the time, they were regularly exposed to their L2 through popular media and English university textbooks.

#### Stimulus materials

Twenty target nouns were embedded in low-constraining L2 sentences (see Appendix 1). All sentences were semantically compatible with both the competitor and distractor and were pronounced by a native speaker of British English. The names of targets, competitors, and distractors were plausible but not predictable from the sentence context. This was assessed in a

sentence completion study with 20 further participants. Production probabilities for targets, competitors, and distractors were low (targets: .007; competitors: .005; distractors: .002). Each target was paired with a competitor picture, where the onset of the name of the L1 translation overlapped phonologically with the onset of the target name. Target names were up to three syllables long, and all target–competitor pairs shared two or three phonemes. Names of targets and competitors did not differ (dependent samples *t*-tests yielded  $ps > .23$ ) with respect to number of phonemes, number of syllables, word frequency, neighborhood size, and age of acquisition (see Table 2).

To calculate a phonological similarity score for each target–competitor pair, 15 other participants from the same population listened to the phonemes that were shared between target and competitor names (i.e., the onset in the pair), once when listening to these phonemes extracted from the target, and once extracted from the competitor. Next, they judged phonological similarity on a scale ranging from 1 (*very different*) to 9 (*very similar*). Using a median-split procedure, target–competitor pairs were classified either as very similar ( $M=7.47$ ,  $SD=0.69$ ) (e.g., *flower* /fla 3/–*fles* /flɛs/ [bottle]) or less similar ( $M=4.90$ ,  $SD=0.76$ ) (e.g., *comb* /k m/–*koffer* /k f/ [suitcase]).

In addition to the target and competitor, each display (for an example, see Fig. 1) contained two phonologically unrelated distractors (e.g., *dog*, *orange*). Thirty new filler displays that were semantically and phonologically unrelated were included in the experiment. Pictures were selected from Severens, Van Lommel, Ratinckx, and Hartsuiker (2005). All pictures were black-and-white drawings, arranged in a two-by-two grid.

#### Apparatus

Using WaveLab software, sentences were recorded in a sound-attenuated booth by means of an SE Electronics USB1000A microphone with a sampling rate of 44.1 kHz (16-bit). Eye movements were recorded from the right eye with an Eyelink 1000 eye-tracking device (SR Research). Viewing was

**Table 2** Mean lexical characteristics of target and competitor names in Experiments 1 and 2 (in Experiment 2, targets were competitors, and vice versa) (with standard deviations indicated in parentheses)

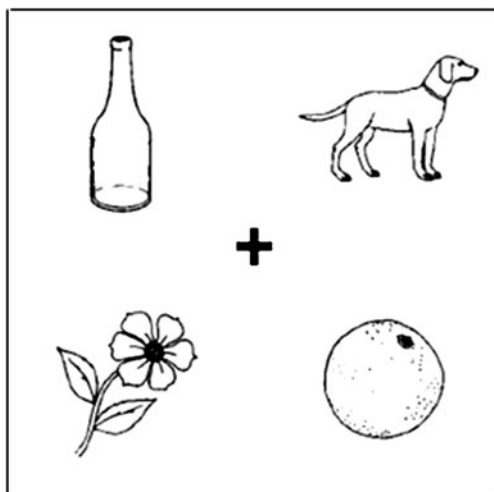
Condition	Number of phonemes	Number of syllables	Word frequency <sup>a</sup>	Neighborhoodsize <sup>b</sup>	Age-of-acquisition <sup>c</sup>
targets	4.80 (1.47)	1.45 (0.60)	1.48 (0.50)	4.40 (4.20)	5.20 (0.91)
competitors	5.25 (1.62)	1.65 (0.67)	1.34 (0.69)	4.20 (4.14)	5.15 (0.78)
<i>p</i>	> .40	> .30	> .46	> .89	> .59

Reported *p*-values indicate significance levels of dependent samples *t*-tests between targets and competitors

<sup>a</sup> Mean log frequency per million words, according to the CELEX lemma database (Baayen et al. 1993)

<sup>b</sup> Neighborhood size calculated using WordGen (Duyck et al. 2004)

<sup>c</sup> Age-of-acquisition ratings by Ghyselink, Custers, and Brysbaert (2003)



**Fig. 1** Example of a visual display. In this example, the picture of the flower is the L2 target, the picture of the bottle is the L1 competitor (the Dutch translation equivalent of *bottle* is *fles*), and the other pictures are unrelated distractors

binocular. Participants' fixations were sampled every millisecond. Calibration occurred through a 9-point grid.

### Procedure

Participants were instructed to listen carefully to the L2 sentences and were not required to perform any explicit task. We chose a look-and-listen paradigm because we were interested in the question of whether between-language competition is a general feature of language–vision interactions (see Altmann, 2004), although we acknowledge that task-based experiments may also sometimes have advantages (see Salverda, Brown, & Tanenhaus, 2011, for a discussion). Display presentation was synchronized with the auditory presentation of the sentences. On average, the onset of the target started 1,219 ms after sentence onset. A new trial started 1,000 ms after sentence offset.

### Results

#### Time window 0–300 ms after target onset

To investigate whether there are baseline effects during this time window, an ANOVA with picture (competitor vs. distractor) and phonological overlap (high vs. low) as within-participants variables and proportion of fixations as the dependent variable was conducted. The main effect of picture was not significant,  $F_1(1, 21)=2.05, p=.17$ ;  $F_2(1, 18)=1.51, p=.23$ , nor was the main effect of phonological overlap,  $F_1(1, 21)=1.08, p=.31$ ;  $F_2<1$ . The interaction between picture and phonological overlap was also not significant,  $F_1<1$ ;  $F_2<1$ . This ensures that competitor and distractor pictures did not differ in their intrinsic capture of visual attention.

#### Time window 300–800 ms after target onset<sup>1</sup>

We carried out an ANOVA on fixations in the time window between 300 and 800 ms after target onset (for a graphical presentation of the fixations in this interval, see Fig. 2), with picture (competitor vs. distractor) and phonological overlap (high vs. low) as within-participants variables and proportion of fixations as the dependent variable. This showed a main effect of picture,  $F_1(1, 21)=8.01, p<.01$ ;  $F_2(1, 18)=7.04, p<.05$ . Participants fixated significantly more on competitor pictures with Dutch names phonologically related to English target names ( $M=19.83\%$ ) than to unrelated distractors ( $M=16.43\%$ ). The main effect of phonological overlap was not significant,  $F_1(1, 21)=1.56, p=.25$ ;  $F_2(1, 18)=0.34, p=.57$ , nor was the interaction between picture and phonological overlap,  $F_1<1$ ;  $F_2<1$ .

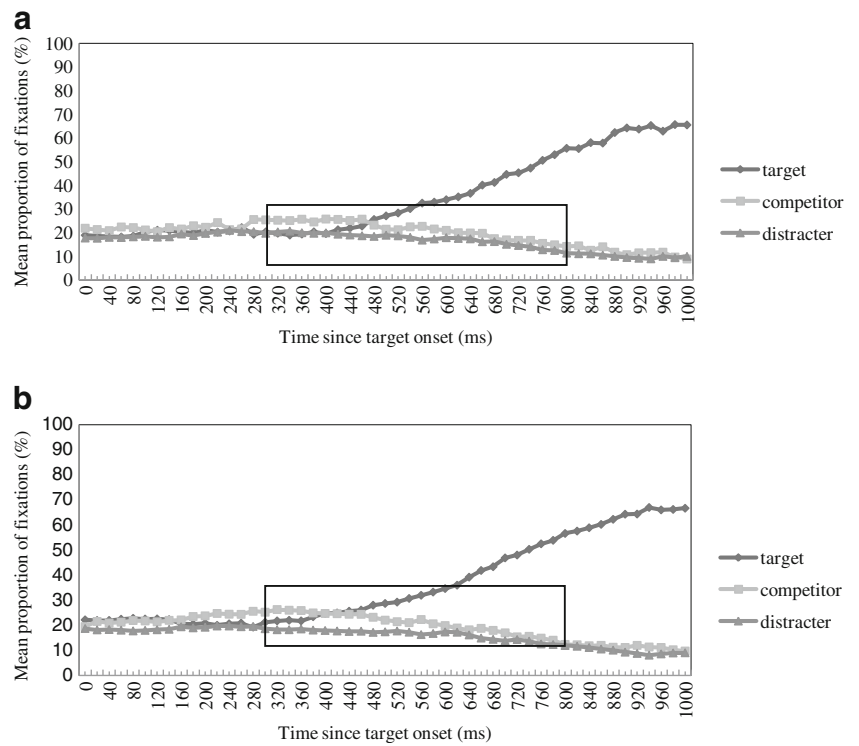
To investigate the effect of phonological similarity further, we ran three different linear regression analyses. First, we investigated whether the subjective phonological onset similarity ratings of pairs predicted the lexical competition effect for that pair. This was not the case,  $F<1$ ;  $R^2=.01$ ;  $\beta=-.007, r=-.11$  (see Fig. 3a). Second, we calculated the proportion of overlapping phonemes for each target–competitor pair (i.e., for the pair *broom–broek* (pants), three out of four phonemes of “broom” overlap with the competitor “broek”). Again, this variable did not predict the lexical competition effect,  $F(1, 19)=2.46, p=.14$ ;  $R^2=.12$ ;  $\beta=-.22, r=.24$  (see Fig. 3b). Third, we also calculated the duration (in milliseconds) of onset overlap. For example, for the pair *flower–fles* (bottle), the duration of the overlapping part /fl/ is 185 ms, whereas the total duration of the target “flower” is 546 ms. This implies that the proportion of overlap here is 34.08%. Again, the regression analysis revealed that this measure did not predict the lexical competition effect,  $F<1$ ;  $R^2=.0001$ ;  $\beta=-.01, r=-.02$  (see Fig. 3c). This implies that nonnative listeners experience competition from L1 competitors when listening to low-constraining sentences in L2 (even though L1 is irrelevant), independently of the degree of phonological similarity between the target and the competitor.

### Experiment 2: L1

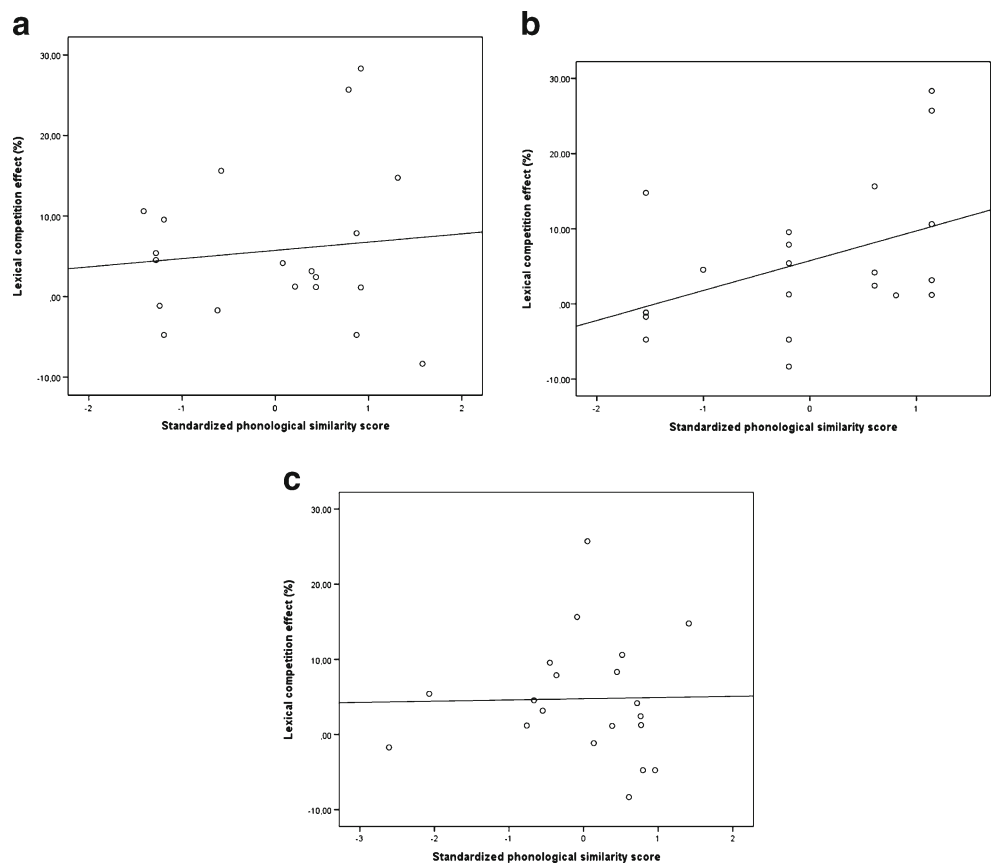
In Experiment 2, we tested for between-language competition when semantically coherent sentences were listened to in L1. Again, we also investigated whether this effect is influenced by the degree of phonological similarity between languages.

<sup>1</sup> To increase comparability between our study and the work of Weber and Cutler (2004), we chose the time window between 300 and 800 ms after target onset to analyze the proportion of fixations, because it is estimated that an eye movement is programmed about 200 ms before it is launched (e.g., Fischer, 1992; Matin et al. 1993; Saslow, 1967). As a consequence, 300 ms after target onset is approximately the point at which fixations driven by the first 100 ms of acoustic information from the target word can be seen.

**Fig. 2** Fixation proportions for English targets, competitors, and averaged distractors in Experiment 1 for high (a) and low (b) phonological overlap with the Dutch competitor name



**Fig. 3** Scatterplots representing the lexical competition effect (in percentages) in L2 (Experiment 1) as a function of three different measures of phonological similarity between items—namely, self-ratings (a), overlap in phonemes (b), and overlap in time (c)



## Method

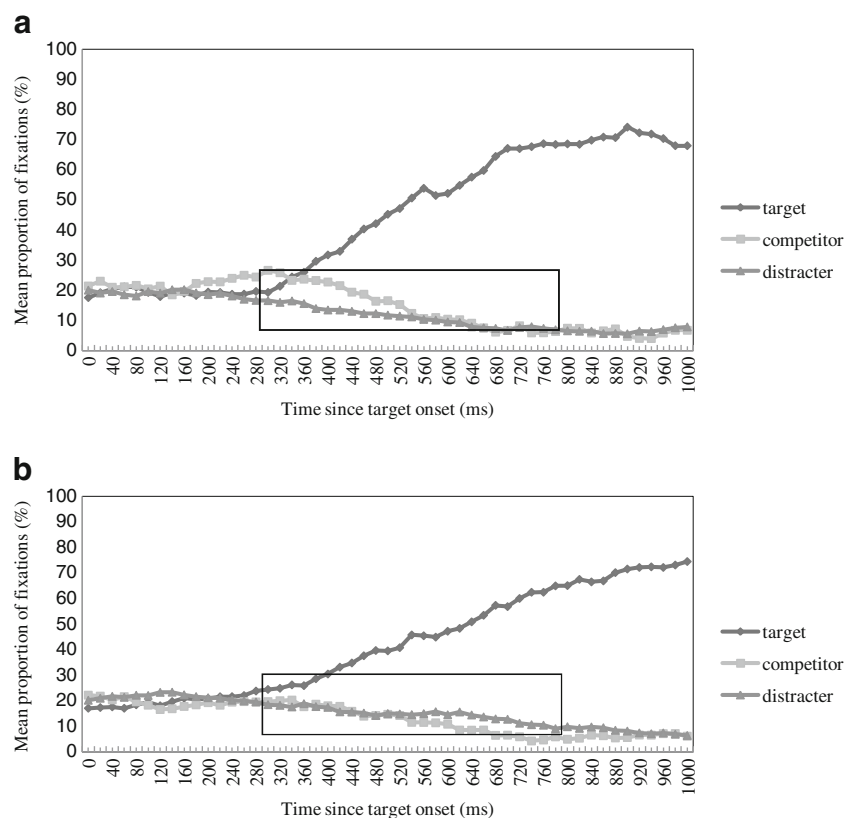
Twenty-two students from the same bilingual population participated. Stimulus materials, apparatus, and procedure were identical to Experiment 1, except that targets were now competitors (and vice versa), and sentences were translated into Dutch (see Appendix 2). This ensures comparability of L1 and L2 experiments. On average, the onset of the name of the target started 1,388 ms after sentence onset. Sentences were now pronounced by a native Dutch speaker. Targets, competitors, and distractors were again plausible but not predictable from the sentence context. This was assessed in a sentence completion study with 17 further participants. In this completion study, participants were asked to complete the 30 critical sentences with a Dutch target. Production probabilities for targets, competitors, and distractors were again low (targets: .00; competitors: .01; distractors: .00).

## Results

*Time window 0–300 ms after target onset*

Baseline picture effects in the time window between 0 and 300 ms after target onset were assessed as in Experiment 1. The main effect of picture was not significant,  $F_1 < 1$ ;  $F_2 < 1$ , as was the main effect of phonological overlap,  $F_1 < 1$ ;  $F_2 < 1$ . The interaction between picture and phonological overlap was also not significant,  $F_1(1, 21) = 1.16$ ,  $p = .29$ ;  $F_2 < 1$ .

**Fig. 4** Fixation proportions for Dutch targets, competitors, and averaged distractors in Experiment 2 for high (a) and low (b) phonological overlap with the English competitor name

*Time window 300–800 ms after target onset*

We ran an ANOVA on fixations in the time window between 300 and 800 ms after target onset (for a graphical presentation of the fixations in this interval, see Fig. 4), with picture (competitor vs. distractor) and phonological overlap (high vs. low) as within-participants variables and proportion of fixations as the dependent variable. This showed that the main effect of picture was not significant,  $F_1 < 1$ ;  $F_2 < 1$ , nor was the main effect of phonological overlap,  $F_1(1, 21) = 2.85$ ,  $p = .11$ ;  $F_2(1, 18) = 2.14$ ,  $p = .16$ . However, the interaction between picture and phonological overlap was significant,  $F_1(1, 21) = 5.71$ ,  $p < .05$ ;  $F_2(1, 18) = 7.47$ ,  $p < .05$ . Closer inspection revealed that participants fixated more on competitors than on unrelated distractors only when the phonological overlap between the English competitor name and the Dutch target name was very high,  $F_1(1, 21) = 6.37$ ,  $p < .05$ ;  $F_2(1, 18) = 6.78$ ,  $p < .05$ . When the English competitor name and the Dutch target name were phonologically less similar, fixation proportions on competitors and unrelated distractors did not differ,  $F_1 < 1$ ;  $F_2 < 1$ .

To investigate the effect of phonological similarity further, we ran the same three different linear regression analyses. First, subjective phonological onset similarity ratings predicted lexical competitions effect for that pair (see Fig. 5a),  $F(1, 19) = 5.58$ ,  $p < .05$ ;  $R^2 = .24$ ;  $\beta = .49$ ,  $r = .49$ . Second, the proportion of overlapping phonemes (see

**Fig. 5** Scatterplots representing the lexical competition effect (in percentages) in L2 (Experiment 1) as a function of three different measures of phonological similarity between items—namely, self-ratings (a), overlap in phonemes (b), and overlap in time (c)

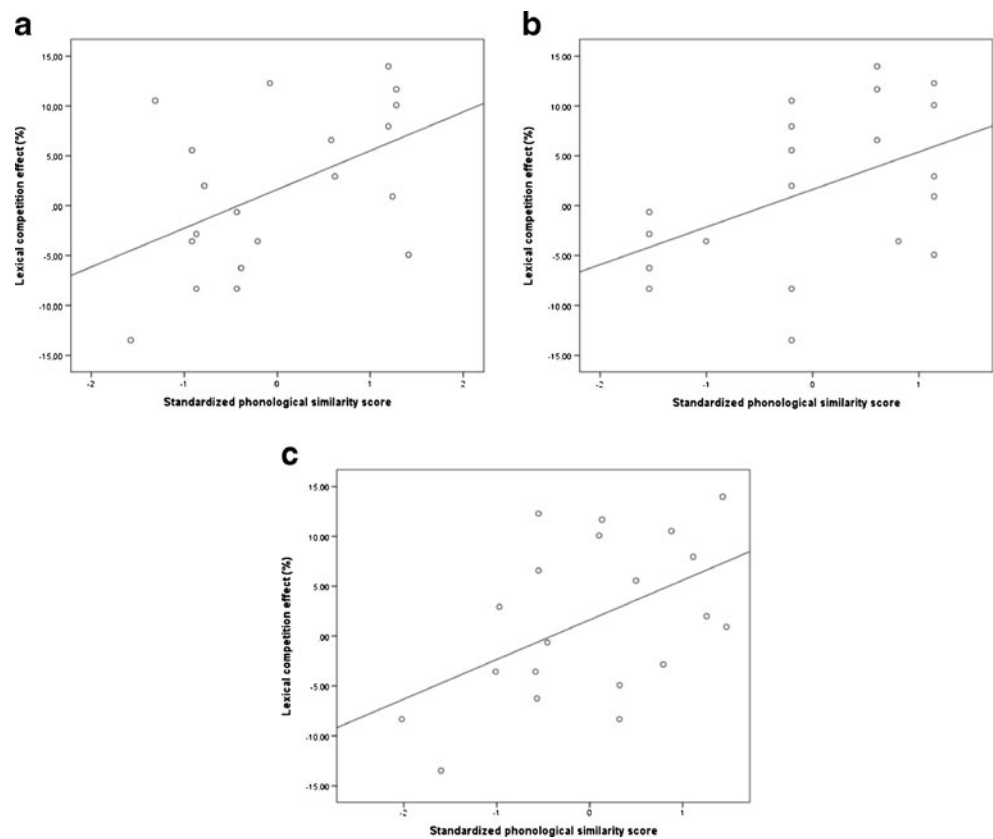


Fig. 5b) also predicted the lexical competition effect,  $F(1, 19)=5.16$ ,  $p<.05$ ;  $R^2=.22$ ;  $\beta=-.30$ ,  $r=.47$ . Third, also the duration of onset overlap (see Fig. 5c) correlated strongly with the lexical competition effect,  $F(1, 19)=5.93$ ,  $p<.05$ ;  $R^2=.25$ ;  $\beta=-.42$ ,  $r=.49$ . This provides evidence for language nonselectivity when sentences are listened to in L1, but with the constraint that the L2 representations appear to influence L1 recognition only when the phonological overlap between the relevant L1 and L2 representations is relatively large.

## Discussion

The present study provides evidence for cross-lingual lexical interactions in bilingual auditory word recognition. When listening to sentences in L2, participants fixated more on competitor pictures with names that were phonologically similar in L1 than on phonologically unrelated distractor pictures. This effect was independent of the degree of cross-lingual onset overlap. This is consistent with the results of isolation studies by Marian and Spivey (2003) and Weber and Cutler (2004) but contrasts with sentence studies by Chambers and Cooke (2009) and FitzPatrick and Indefrey (2010). Hence, cross-lingual interactions are not necessarily eliminated, even though sentences provide a strong language cue for lexical search, not present in isolated word recognition.

Crucially, we also showed for the first time that cross-lingual lexical interactions are not annulled by a sentence context when

people listen in the native language. Participants fixated significantly more on pictures with a name with an overlapping L2 onset than on phonologically unrelated distractors, but only when the phonological similarity was relatively large (e.g., flower–files [*bottle*]). If the onset overlap of the Dutch target and the English competitor was smaller (e.g., comb–koffer [*suitcase*]), distractor pictures did not interfere with L1 target recognition.

In addition to testing for cross-linguistic competition in an L1 spoken sentence context, this study is also important in explaining the inconsistent findings on the influence of L2 knowledge on L1 recognition in isolation. Because cross-lingual competition in L1 processing is heavily influenced by even a small variation in the phonological overlap between the lexical representations of both languages, this could explain why Weber and Cutler (2004) did not find an L1 effect, unlike Marian and colleagues (in addition to language profile factors). Indeed, the Weber and Cutler stimuli would correspond to the stimuli with partial overlap in the present study, also showing no effect. It is plausible that such an effect emerges especially in L1 processing: Overall activation is much weaker in L2 representations, so that cross-lingual competition arising from them is more susceptible to variations in the degree of activation transfer.

At a theoretical level, the between-language competition effect is consistent with monolingual models of auditory word recognition such as the distributed model of speech perception (Gaskell & Marslen-Wilson, 1997), the neighborhood activation model (Luce & Pisoni, 1998), Shortlist (Norris, 1994), and

exemplar models (Goldinger, 1998) if they are extended with the assumption that L2 representations are part of the same system as, and interact with, L1 representations. Moreover, the fact that L2 knowledge competes with L1 recognition only when the phonological similarity between languages is sufficiently strong may be explained if these models assume that language-specific subphonemic cues result in (bottom-up) higher activation in the lexical representations of the target language. However, this subphonemic information could also be working through top-down competition if it is the case that language-specific phonemes and variations activate specific language nodes before lexical representations are activated. The latter would be predicted by interactive activation models

such as TRACE (Elman & McClelland, 1988; McClelland & Elman, 1986).

To conclude, the present study reports lexical competition effects between languages, when unilingual sentences are listened to in both L2 and L1. This suggests that bilingual listeners do not use the cues that are inherent to the speech or the language of a sentence to restrict activation to a single lexicon. The resulting cross-lingual competition effects are highly sensitive to phonological similarity, especially in L1 processing, when competitive L2 activation is weak.

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## Appendix 1

Experimental stimuli used in Experiment 1 (overlapping onsets of target–competitor pairs are underlined)

### *Very similar phonological overlap*

English target	Dutch competitor	Translation competitor	Unrelated distractor	Unrelated distractor	
<u>box</u>	<u>b</u> okaal	goblet	skirt	tail	The shot of the man hit a <b>box</b> and missed the target.
<u>curtain</u>	<u>k</u> ussen	pillow	pig	shirt	My friend Hannah was looking at a <b>curtain</b> in that neighborhood.
<u>duck</u>	<u>du</u> im	thumb	cloud	tape	Her little brother has drawn a <b>duck</b> and is now playing outside.
<u>flower</u>	<u>f</u> les	bottle	dog	orange	That man finally got a <b>flower</b> , and that's why he is happy
<u>slide</u>	<u>s</u> leutel	key	king	lobster	One day she found a <b>slide</b> in the garden.
<u>speaker</u>	<u>s</u> poek	ghost	mouse	seal	I had a dream about a <b>speaker</b> during my sleep.
<u>spoon</u>	<u>s</u> piegel	mirror	floor	truck	For his design of the the <b>spoon</b> the designer won the first prize.
<u>stairs</u>	<u>s</u> toel	chair	neck	cell	To have a better look at the <b>stairs</b> she walked to the other side.
<u>stamp</u>	<u>s</u> teen	rock	feather	peanut	When Josh showed up with a <b>stamp</b> , everybody laughed.
<u>strawberry</u>	<u>s</u> trik	bow	toe	flashlight	She discovered a <b>strawberry</b> when she opened the box.

### *Less similar phonological overlap*

English target	Dutch competitor	Translation competitor	Unrelated distractor	Unrelated distractor	
<u>broom</u>	<u>br</u> oek	pants	peach	record	During a walk in the city, he saw a <b>broom</b> in the store.
<u>carpet</u>	<u>ka</u> st	cupboard	hammer	button	They almost found everything, but were still looking for a <b>carpet</b> in that house.
<u>carrot</u>	<u>ke</u> rk	church	spider	dentist	The stranger could not believe his eyes when he saw a <b>carrot</b> in that village.
<u>comb</u>	<u>ko</u> ffer	suitcase	shoe	nail	The woman made a painting of the <b>comb</b> with the red paint.
<u>drill</u>	<u>dra</u> aimolen	carrousel	house	bird	Lucie took her bike and bought a <b>drill</b> at the market.
<u>farm</u>	<u>fa</u> kkel	torch	basket	brush	She received a <b>farm</b> as a birthday present.
<u>road</u>	<u>ro</u> lstoel	wheelchair	cheese	boy	Because I wanted to see the <b>road</b> I looked outside.
<u>scissors</u>	<u>ci</u> troen	lemon	chicken	trash	The only thing she wanted were <b>scissors</b> to throw with.
<u>tree</u>	<u>tr</u> ommel	drum	necklace	bucket	She saw a <b>tree</b> at the corner of the street.
<u>wallet</u>	<u>wa</u> sknijper	clothespin	canopener	train	He says that a <b>wallet</b> is the most stupid invention.



## Appendix 2

Experimental stimuli used in Experiment 2 (overlapping onsets of target—competitor pairs are underlined)

### Very similar phonological overlap

Dutch target	Translation target	English competitor	Unrelated distractor	Unrelated distractor	
<u>b</u> okaal	goblet	<u>b</u> ox	skirt	tail	Het schot van de man raakte een <b>bokaal</b> en miste het doel.
<u>k</u> ussen	pillow	<u>c</u> urtain	pig	shirt	Mijn vriendin Hannah bekeek een <b>kussen</b> in die buurt.
<u>d</u> uim	thumb	<u>d</u> uck	cloud	tape	Haar kleine broer maakte een tekening van een <b>duim</b> , en speelt nu buiten.
<u>f</u> les	bottle	<u>f</u> lower	dog	orange	Die man kreeg eindelijk een <b>fles</b> , en was daarom gelukkig.
<u>s</u> leutel	key	<u>s</u> lide	king	lobster	Op een dag vond ze een <b>sleutel</b> in de tuin.
<u>s</u> pook	ghost	<u>s</u> peaker	mouse	seal	1 k had een droom over een <b>spook</b> tijdens mijn slaap.
<u>s</u> piegel	mirror	<u>s</u> poon	floor	truck	Voor zijn ontwerp van een <b>spiegel</b> won de ontwerper de eerste prijs.
<u>s</u> toel	chair	<u>s</u> tairs	neck	cell	Opdat ze beter kon kijken naar een <b>stoel</b> wandelde ze naar de andere kant.
<u>s</u> teen	rock	<u>s</u> tamp	feather	peanut	Toen Jos aankwam met een <b>steen</b> , lachte iedereen.
<u>s</u> trik	bow	<u>s</u> trawberry	toe	flashlight	Ze ontdekte een <b>strik</b> toen ze de doos opende.

### Less similar phonological overlap

Dutch target	Translation target	English competitor	Unrelated distractor	Unrelated distractor	
<u>b</u> roek	pants	<u>b</u> room	peach	record	Tijdens een wandeling in de stad zag hij een <b>broek</b> in de winkel.
<u>k</u> ast	cupboard	<u>c</u> arpet	hammer	button	Ze vonden bijna alles, maar waren nog op zoek naar een <b>kast</b> in dat huis.
<u>k</u> erk	church	<u>c</u> arrot	spider	dentist	De vreemde kon zijn ogen niet geloven bij het zien van een <b>kerk</b> in dat dorp.
<u>k</u> offer	suitcase	<u>c</u> omb	shoe	nail	De kunstenaar schilderde een <b>koffer</b> met de rode verf.
<u>d</u> raaimolen	carrousel	<u>d</u> rill	house	bird	Lucie nam haar fiets en zag een <b>draaimolen</b> op de markt.
<u>f</u> akkkel	torch	<u>f</u> arm	basket	brush	Ze kreeg een <b>fakkkel</b> als geschenk voor haar verjaardag.
<u>r</u> olstoel	wheelchair	<u>r</u> oad	cheese	boy	Omdat ik wou kijken naar een <b>rolstoel</b> keek ik naar buiten.
<u>c</u> itroen	lemon	<u>s</u> ciissors	chicken	trash	Ze wilde niets anders dan <b>citroen</b> om mee te gooien.
<u>t</u> rommel	drum	<u>t</u> ree	necklace	bucket	Ze zag een <b>trommel</b> op de hoek van de straat.
<u>w</u> asknijper	clothespin	<u>w</u> allet	canopener	train	Volgens hem is een <b>wasknijper</b> de stomste uitvinding.

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