The Influence of Sentence Context Constraint on Cognate Effects in Lexical Decision and Translation

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1. Cross-language activation, cognate effects and linguistic context

A central question in bilingual research on language and cognition is how bilinguals activate and process words in their two languages, and how they control their two language systems. Two main theoretical views have been proposed in the literature. According to the language-selective activation view, bilinguals activate only word candidates from the language that is contextually relevant. In contrast, the language-nonselective activation view holds that words from both languages are activated in response to incoming information.

An increasing number of studies indicate that the activation of words in bilingual memory operates in a parallel, language-nonselective way (e.g., Altenberg & Cairns, 1983; Brysbaert, Van Dyck, & Van de Poel, 1999; Colomé, 2001; Costa, Caramazza, & Sebastian-Galles, 2000; Costa, Miozzo, & Caramazza, 1999; De Groot, Delmaar, and Lupker, 2000; Dijkstra, Grainger, & Van Heuven, 1999; Dijkstra, Van Jaarsveld, & Ten Brinke, 1998; Gollan, Forster & Frost, 1997; Hermans, Bongaerts, De Bot, & Schreuder, 1998; Jared & Kroll, 2001; Nas, 1983; Van Hell & De Groot, 1998a; Van Hell & Dijkstra, 2002; Van Heuven, Dijkstra, & Grainger, 1998; but see Rodriquez-Fornells, Rotte, Heinze, Nösselt, & Münte, 2002). Evidence for language-nonselective activation comes from studies using a wide variety of bilinguals who together performed various tasks, including recognition and production tasks. In the majority of these studies bilinguals processed a word or a picture in isolation, without a surrounding linguistic context that might inform the lexical activation process of the word or picture.

For example, Dijkstra, Van Jaarsveld & Ten Brinke (1998) had Dutch-English bilinguals perform a lexical decision task in their second language (L2; English) on a set of identical cognates (words with identical meanings and spellings across languages, such as the Dutch-English translation pair 'lip-lip'), a set of identical interlexical homographs (i.e., words with an identical spelling but different meanings across languages, such as 'room', meaning 'cream' in Dutch), and matched controls, all noncognates. Dijkstra et al. observed that lexical decision times on the cognates were shorter than those on the matched controls. The difference in lexical decision times between the interlexical homographs and their controls, however, varied across experiments: Depending on task demands and stimulus list composition, interlexical homographs were recognized faster than, slower than, or as fast as noncognate control words.

The cognate effect as found by Dijkstra et al. (1998) was replicated in a subsequent lexical decision study by Dijkstra, Grainger, & Van Heuven (1999). Similar cognate effects have been observed in a wide range of recognition and production tasks performed by bilinguals, including progressive demasking (Dijkstra et al., 1999), picture naming (Costa, Caramazza, & Sebastian-Galles, 2000), foreign language vocabulary learning (De Groot & Lotto, 1998), within-language and cross-language word association (Van Hell & De Groot, 1998a; Van Hell & Dijkstra, 2002), and word translation (e.g., De Groot, Dannenburg, & Van Hell, 1994). Cognate facilitation effects were obtained even when multilinguals, situated in an exclusive L1 communicative setting, performed a lexical decision or word association task in their native, and dominant, language (Van Hell & Dijkstra, 2002). Using multilinguals with Dutch as their native language (L1) English as their second language (L2),

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and French as their third language (L3), we obtained a facilitation effect on L1 words (e.g., the Dutch word ‘appel’) that were cognates with their L2 translation (here, ‘apple’) or with their L3 translation (e.g., the Dutch word ‘meubel’, meaning ‘meuble’ in French, and ‘piece of furniture’ in English; the latter effect was obtained only in speakers that were relatively fluent in their L3).

In the experiments reported in this paper, I studied the processing of cognates and noncognates in lexical decision and translation. The cognates and noncognates were preceded by a sentence context in order to examine whether a meaningful context modulates the cognate advantage. Before discussing the central research questions in more detail, I will first elaborate on theoretical explanations on the advantage of cognates over noncognates when presented in isolation.

In the literature, the processing advantage of cognates over noncognates presented in isolation is typically described by assuming a language-nonselective activation process in which word candidates from both languages are activated in parallel (see, e.g., Van Hell & Dijkstra, 2002; Dijkstra & Van Hell, 2003). The presentation of a word in one language co-activates words in the other language, most likely words that are highly similar in orthography, semantics, and phonology. Since cognate translations share orthographic, semantic, and phonological information, whereas noncognate translations share only semantic information, the convergent activation of these three codes in cognate translations benefits the activation of cognates compared to that of noncognates. This leads to faster recognition and production times for cognates than for noncognates.

This explanation of the cognate effect fits in with recent models of isolated-word processing in bilingual memory, like distributed models of bilingual memory (e.g., Thomas & Allport, 2000; Van Hell & De Groot, 1998a), the Inhibitory Control model (Green, 1986), or interactive accounts of bilingual word recognition (i.e., the Bilingual Interactive Activation (BIA) Model, and its successor BIA+; Dijkstra & Van Heuven, 2002). For example, a main assumption of the BIA+ model is that the bilingual lexicon is integrated across languages and is accessed in a language nonselective way. The BIA+ model assumes that word recognition is affected by cross-linguistic orthographic, phonological and semantic overlap. Since cognates not only share semantic but also orthographic and phonological information, activation in the word recognition system reaches a stable state earlier in case of cognates than in case of noncognates, resulting in faster recognition times for the cognates.

The studies discussed so far all studied the processing of single words. These words were presented in isolation, out of a meaningful linguistic context. Clearly, recognizing or processing isolated words is not a common task in the everyday life of bilinguals who normally function in contextually rich situations. Moreover, the linguistic context surrounding the target word may influence the lexical activation process of this word. Specifically, the sentence context in which a target word is embedded may modulate the degree of co-activation of related words in bilingual memory. How words are recognized in natural sentence contexts may thus form a critical test of the validity and plausibility of bilingual isolated word recognition and production models (cf. Van Hell, 2002).

In the three experiments reported in this paper, I studied if, and how, sentence context modulates lexical decision and translation performance on isolated words, i.e., cognates and noncognates. Is language nonselectivity and the co-activation of information in the non-target language, as typically observed in isolated word processing, modulated when the target word is embedded in a meaningful sentence context?

Studies investigating the processing of target words presented in a linguistic context in bilingual speakers are scarce (but see Altarriba, Kroll, Sholl, and Rayner, 1996). More work has been done with monolingual speakers. These studies found that contextual information influences word processing. Generally speaking, words (e.g., ‘apple’) that are preceded by a semantically constraining context (like ‘She took a bite of the fresh green ….’) are recognized faster than words preceded by a neutral sentence context (like ‘The final word in this sentence is ….’; see, e.g., Stanovich & West, 1983).

Studies with monolingual speakers also showed that effects of word type, like concreteness, frequency or ambiguity, are modulated by sentence context. For example, when presented in isolation, performance on concrete words (that have a direct sensory referent) is typically better than on abstract words (which lack such a sensory referent; e.g., Van Hell & De Groot, 1998b). Differences in the processing of concrete and abstract words disappeared when these word were embedded in a high constraint sentence context that was highly predictive with respect to the target word (e.g., Schwanenflugel, Harnishfeger, & Stowe, 1989). Likewise, when presented in isolation, high frequency words are recognized faster than low frequency words. Such frequency effects are modulated when the words are embedded in a high constraint sentence context (e.g., Van Petten & Kutas, 1990). Interestingly, in one of the few studies with bilingual speakers, Altarriba et al. (1996) observed an interaction between sentence context and frequency when the language of the target words was different from that of the sentence context. Finally, studies on semantic ambiguity, studying the recognition of intralexical homographs (like ‘bank’ for money and ‘bank’ to sit on) found that a sentence context modulates the processing of ambiguous words (Simpson & Krueger, 1991).

In the majority of studies investigating how sentence context may modulate differences in the processing of concrete vs. abstract words, high vs. low frequency words, or intralexical homographs vs. control words, the sentence contexts were (strongly) predictive with regard to the target words. However, words in natural language use cannot usually be predicted from the surrounding context. Aborn, Rubenstein, and Sterling (1959) showed that only 25% of the omitted nouns could be guessed correctly on the basis of contextual information (see also Gough, Alford, and Holley-Wilcox, 1981). This implies that not every sentence context is highly predictive with regard to the target word. In fact, many sentences occurring in natural language situations may be mildly predictive. We therefore manipulated the semantic constraint of the sentences and included high constraint sentences that were highly predictive with regard to the target word, and less predictive, low constraint sentence contexts.

In sum, in three studies I studied whether sentence context modulates cognate effects, and the role of semantic constraint of the sentence context. Target words were presented in isolation, or were preceded by a predictive, high constraint sentence context of by a congruent, low constraint sentence context. Dutch-English bilinguals performed lexical decision in their L2, or translated words in forward direction (from L1 to L2) or in backward direction (from L2 to L1).

Before introducing the experiments and the concomitant norming studies, I will briefly describe the proficiency level of the bilinguals participating in the study. They were all unbalanced bilinguals with Dutch as their native language and English as their second, and all were first-year students of the University of Amsterdam, the Netherlands. After preparatory English lessons at elementary school (starting at around age 10), they had all attended English classes at secondary school for about 3-4 hours a week, starting at around age 12 and continuing until their enrollment in the university. Their schooling at the university required them to read mainly in English. So, the participants were fairly proficient in their second language; nevertheless they had less experience with their second language than with their native language. As a result, their second language lexicon is presumably smaller than their native language lexicon, and second language words probably have weaker connections to their meanings than first language words (e.g., De Groot et al., 1994; Kroll & Stewart, 1994; La Heij, Hooglander, Kerling, & Van der Velden, 1996).

2. Sentence context norming studies

Prior to the actual experiments, two norming studies were performed to determine the degree of contextual constraint and the plausibility of the sentence contexts to be used.

2.1 Sentence completion study

In order to qualify sentences as high or low constraint, 240 participants, drawn from the same population as those of the actual experiments, took part in a sentence completion study. They were presented with sentences in which one word was omitted, and were asked to write down the first three reasonable completions that came into their mind. The instructions given to the participants were those used by Schwanenflugel and Shoben (1985) and Schwanenflugel, Harnishfeger, & Stowe (1988), but translated into Dutch. For each of the 60 Dutch words and their English translations to be used in the experiments (see below), 8 sentence contexts were constructed: two Dutch sentence contexts expected to provide high constraint contexts and two Dutch sentence contexts expected to provide low constraint contexts, as well as the corresponding translations in English (all English sentences had been checked by a native English speaker). In half of the sentence contexts, for both constraint conditions, the omitted target was the final word of the sentence, whereas in the other half the target's place was located somewhere in the middle of the sentence. (The reason for also including the latter type of contexts was that it was not always possible to construct a satisfactory, and syntactically regular, Dutch sentence context in which the target word was the final word of the sentence). These 480 sentence fragments were presented in 8 different booklets, all containing one sentence for each of the 60 translation pairs. In each booklet, half the sentence fragments had their omitted word somewhere in the middle, whereas in the other half the omission appeared at the end of the sentence. All sentences within a booklet were in the same language (either Dutch or English), and had the same (presumed) level of constraint (high or low). All booklets contained five sentence contexts per page, and the pages were reshuffled in every new booklet. Each type of booklet was rated by 30 participants.

After data collection, the production probability of each completed word, given that particular sentence context, was calculated across participants.

2.2 Sentence plausibility ratings

Some sentences are more plausible than others, and performance on sentences describing plausible events is better than on sentences describing less plausible events (e.g., Forster, 1979). Moreover, in the present experiments, a difference in the plausibility of sentence contexts would possibly interfere with the influence of sentence constraint on the upcoming words. Therefore, we performed a second norming study in which the plausibility of the sentence contexts was assessed.

A new group of 240 participants, drawn from the same population as the previous norming study and the actual experiments, took part in this study. They were presented with the complete sentences (including the intended target word), and were asked to assess the plausibility. The instructions were based on Noble's (1953) word familiarity instructions, but it was stressed that the plausibility of the situation as described by the sentence had to be judged, and not the plausibility of the exact wording of the sentence. The 8 types of booklets of the sentence completion norming study, each containing 60 sentences, were adapted for use in the plausibility norming study. Each type of booklet was rated by 30 participants. In order to assess the inter-group reliability of the plausibility ratings, a set of 20 sentences was added to (and reshuffled within) each booklet. The inter-group reliability of participants who rated these sentences turned out to be quite high (*r*s ranging from .91 to .95 for the Dutch sentences, and from .81 to .88 for the English sentences).

3. Experiment 1: lexical decision in the second language

3.1 Method

Design. A 2 (cognate status: cognate vs. noncognate) by 3 (sentence context: high constraint, low constraint, or no context) factorial design was used.

Participants. Sixty new fairly fluent bilinguals, drawn from the population described in the Introduction, participated. They were randomly allocated to one of the three context conditions. After finishing the experiment they were asked to rate their comprehension and production abilities in English on a 7-point scale (1 = very low; 7 = same as in Dutch). The mean comprehension ratings were 5.40 (*SD*: .75), 5.10 (*SD*: .79), and 5.50 (*SD*: .51) for participants in the high constraint, low constraint and no context conditions, respectively. Similarly, their mean production ratings were 4.85 (*SD*: .88), 4.75 (*SD*: .91), and 4.80 (*SD*: .77), in the above order. All participants received course credit for participation.

Materials: words and pseudowords. Sixty English words, 30 cognates and 30 noncognates, were selected for the experiment. These words were selected from a set of 440 words rated for word characteristics relevant to this study (De Groot et al., 1994). Each English word (and its Dutch translation) had been rated in separate norming studies by groups of Dutch-English bilinguals, drawn from the same population as the bilinguals of the present experiment. The cognate status of the English word and its Dutch translation was rated by asking bilinguals to indicate on a 7-point scale how similar they regarded the words within each translation pair (1 = very low similarity; 7 = very high similarity).

Participants had been told that their rating should reflect a combined assessment of the spelling and sound of each word pair under consideration. The mean ratings of the cognates and noncognates selected for the experiment were 5.89 (*SD*: .62), and 1.23 (*SD*: .08), respectively.

Half the cognates and half the noncognates were concrete words, and the remaining halves were abstract words. The cognates and noncognates were further matched on three word characteristics known to influence monolingual and bilingual processing: context availability, length, and log word frequency. These word characteristics, as well as concreteness, were derived from the 440-words corpus of De Groot et al. (1994) and from the CELEX word frequency counts (Baayen, Piepenbrock, & Van Rijn, 1993).

Furthermore, 40 pseudowords (i.e., nonwords that obey the phonological and orthographic rules of the critical language, here English) were constructed by changing one letter of English words; absence of an entry in Dutch-English and English-Dutch dictionaries (Martin & Tops, 1984; 1986) was used as the criterion for pseudoword status. The pseudowords did not differ in length from the word stimuli. Similarly, the frequencies of the words the pseudowords were derived from did not differ from those of the word stimuli.

In addition to the test stimuli, 10 cognates and 10 noncognates were selected as practice stimuli. They were all different from any of the test stimuli. Of these 20 words, 10 were converted into pseudowords by changing one letter.

Materials: sentence contexts. In the selected high constraint sentence contexts, the mean production probabilities of the cognates (.67) and noncognates (.68) were similar ($p > .10$). In the selected low constraint sentence contexts, the mean production probabilities of the cognates and noncognates were .09 and .10, respectively; $p > .10$. (Care was taken that these latter sentence contexts did not have an alternative completion with a high production probability.)

The high and low constraint sentence contexts for the cognates and the noncognates were controlled for plausibility, length, and for target position (i.e., whether the target appeared at the end or somewhere in the middle of the sentence).

In addition, 20 high and 20 low constraint sentence contexts were constructed to precede the pseudowords. Across all conditions, the sentence contexts for the pseudowords were comparable to those for the word stimuli in terms of length and of target position. Finally, 10 high and 10 low constraint sentence contexts were constructed for the practice stimuli. In all respects, these sentence contexts were comparable to those of the test stimuli, words and pseudowords.

Apparatus and procedure. The experiment was run on an Apple Macintosh computer in a normally lit room. All participants were tested individually. Stimuli were presented in black lower-case letters on a light-gray background. A two-button keyboard registered the responses of the participants.

The procedure for stimulus presentation was as follows. For participants in the high and low constraint conditions, each trial began with a fixation stimulus (an asterisk) presented on the left-side of the screen for 1 s, at the position where the first letter of the sentence was to appear. Then, the sentence context was presented and remained on the screen for 4 seconds. The location of the target word in the sentence (either at the end or somewhere in the middle) was marked with three dashes (the target word itself was not included). Immediately after the sentence context disappeared from the screen, the target word appeared. This target remained on the screen until the participant responded by pressing one of two buttons. Response time (RT) was measured from the onset of the target word. One second after the participant pushed either response key, the fixation stimulus of the next trial appeared. Participants received no feedback regarding the speed and accuracy of their responses, for we wanted to uniform the procedure of the lexical decision task and that of the translation tasks (to be used in Experiments 2 and 3) as much as possible. To participants in the control condition, the target words were presented in isolation. So, in the control condition, a fixation stimulus (an asterisk) appeared on the screen for 1 s, slightly to the left and above of where the target was to appear. Then, the target word was presented; the remainder of the procedure was identical to that of the sentence context conditions.

The participants in the high and low constraint conditions were instructed to read the sentences attentively. To ensure that participants followed this instruction, they were told that the program would occasionally ask them, immediately after their response on the target word, to write down the sentence context they had just seen. This request was made 6 times. It appeared that all participants read the sentence contexts sufficiently well: The sentence frames noted down covered at least 75% of the information actually presented. After the participants had written down the sentence, the experimenter initiated the next trial.

With regard to the target word, participants were instructed that on each trial a letter string would appear on the screen and they were asked to determine as quickly and as accurately as possible, whether or not this letter string was an English word. In case of a word, participants should push the right-hand one of two push buttons with their right forefinger. In case of a nonword, they were to push the left-hand button with their left forefinger.

For all conditions, trials were divided in 5 blocks of 20 stimuli each. After each block, the participant was allowed a brief rest of minimally 10 seconds, after which the first trial of the next block was called. All trials were presented in random order with a different order for each participant.

3.2 Results and discussion

For each participant, mean RTs were calculated for the cognates and noncognates. Furthermore, mean RTs for the cognates and noncognates, collapsed across the participants within each context condition, were calculated. RTs of incorrect responses and those shorter than 100 ms or longer than 2.5 *SD* above the participant's mean were eliminated (2.72% all data). Data on the pseudowords, requiring a 'no' response, were regarded as fillers and are not reported here. Next, a 3 (sentence context) by 2 (cognate status) ANOVA was performed on the mean subject RTs, treating sentence context as a between-subjects variable and cognate status as a within-subject variable. In addition, the corresponding 3 x 2 ANOVA was performed on the mean item RTs, treating sentence context as a within-item variable and cognate status as a between-items variables. (In these ANOVAs data were collapsed across the factor target position (omitted target word in middle vs. end of the sentence) as this factor appeared to play no role of importance; see also, e.g., Sharkey & Sharkey, 1992).

The mean subject RTs and error rates are presented in Table 1.

Table 1
Mean Reaction Times (in ms) and Error Rates (in Percentages) for Lexical Decision in the Second Language (English). Standard Deviations are in Parentheses. (Experiment 1)

Cognate status	RT	Error
	High constraint	
Noncognates	675 (109)	3.0 (4.2)
Cognates	653 (104)	2.0 (2.3)
Effect	22	1.0
	Low constraint	
Noncognates	804 (140)	3.5 (4.8)
Cognates	757 (121)	2.0 (2.9)
Effect	47	1.5
	No context	
Noncognates	703 (155)	5.5 (3.6)
Cognates	637 (123)	1.7 (2.0)
Effect	66	3.8

Note. All means presented are based on participants' scores.

The main effect of cognate status was significant, $F_1(1,57) = 30.11$, $p < .0001$, and $F_2(1,58) = 8.26$, $p < .01$. The effect of sentence context was also significant, $F_1(2,57) = 5.72$, $p < .01$, and $F_2(2,116) = 74.61$, $p < .0001$; mean overall lexical decision times were 664 ms, 781 ms, and 670 ms for the high constraint, low constraint, and no context conditions, respectively. A Tukey HSD procedure confirmed that overall lexical decision performance was faster in the high constraint than in the low constraint condition (*p*s < .05 or better), and that performance in the low constraint condition was slower than in the no context condition (ps < .05 or better); RTs in the high constraint and the no context conditions did not differ significantly from one another.

The interaction between cognate status and sentence context was marginally significant, $F_1(2,57) = 2.39$, $p = .10$, and $F_2(2,116) = 2.70$, $p = .07$. A priori planned simple effects analyses indicated that the 66 ms effect of cognate status in the no context condition was significant, $F_1(1,57) = 21.43$, $p < .001$, and $F_2(1,58) = 12.39$, $p < .001$. The effect of cognate status was also significant in the low constraint condition (47 ms), $F_1(1,57) = 11.04$, $p < .01$, and $F_2(1,58) = 5.57$, $p < .05$, but was not significant in the high constraint condition (both ps > .10).

Analyses on the error data will not be reported, since, as can be seen in Table 1, no speed/accuracy trade-off occurred.

In sum, the cognate effect that was present when cognates and noncognates were presented in isolation was no longer significant when the words were preceded by a high constraint sentence context. However, the cognate effect remained significant in the low constraint condition. Furthermore, words preceded by a high constraint sentence context were processed faster than words preceded by a low constraint sentence context, which replicates previous findings in the monolingual literature (e.g., Fischler & Bloom, 1979; Schwanenflugel & LaCount, 1988; Schwanenflugel & Shoben, 1985).

In Experiment 2, a possible effect of sentence context constraint on the cognate effect will be tested once more, but now in a cross-language processing task, namely, word translation. Dutch-English bilinguals were asked to translate words in forward direction (from L1 to L2), which were preceded by a L1 high constraint or low constraint sentence context, or were presented in isolation.

4. Experiment 2: forward translation

4.1 Method

Design. The design was similar to that of Experiment 1.

Participants. Sixty participants, drawn from the same population as those of Experiment 1, took part. They were randomly allocated to one of the three context conditions. None of them participated in Experiment 1. After finishing the experiment they were asked to rate their comprehension and production abilities in English (see Experiment 1). Their mean comprehension ratings were 5.35 (*SD*: .88), 5.60 (*SD*: .75), and 5.60 (*SD*: .60) for participants in the high constraint, low constraint and no context conditions, respectively. Their mean production ratings were 4.65 (*SD*: .93), 4.75 (*SD*: .91), and 4.75 (*SD*: .55), in the above order. Participants received course credit or money for participation.

Materials: words. The Dutch translations of the 60 target words of Experiment 1 constituted the test materials of the forward translation experiment. Half the cognates and half the noncognates were concrete words, and the remaining halves were abstract words. The stimuli were further matched on context availability, length, and log word frequency. As in Experiment 1, the scores on the relevant characteristics were derived from the 440-word corpus of De Groot et al. (1994) or from the CELEX word frequency counts (Baayen et al., 1993). The instructions and procedures underlying the Dutch word ratings in this corpus were similar to those of the corresponding English word ratings.

Materials: sentence contexts. The sentence contexts were the translations of the contexts used in Experiment 1. The language of the sentence contexts was the same as the language of the target words, so the Dutch target words were preceded by Dutch sentence contexts. In the selected set of high constraint sentences, the mean production probabilities of cognates (.80) and noncognates (.81) were similar (p > .10). In the low constraint sentences, the mean production probabilities of the cognates (.09) and noncognates (.10) were also similar (p > .10). The high and low constraint sentence contexts for the cognate and noncognates were controlled for plausibility, length, and for target position.

The 20 practice words and the corresponding sentence contexts of Experiment 1 were used. Of the 10 words converted to pseudowords in Experiments 1, the original word stimuli were used.

Apparatus and procedure. The apparatus was identical to that of the foregoing experiments, with the exception that the responses were registered by a microphone that activated a voice-operated switch. The experimenter typed in the participant's response on the computer keyboard (what was being typed in was not echoed on the screen) and monitored the workings of the voice switch. Failures of the voice-key to register the participant's response or triggering due to faltering of the participant's voice or ambient sounds were noted down.

The instructions for reading the sentence contexts were similar to that of Experiment 1, although in this experiment the request for writing down the sentence was made four times throughout the task. It appeared that all participants read the sentence contexts sufficiently well; the sentence frames noted down covered at least 75% of the information. With regard to the target word, participants were asked to speak out loud the English translation of the Dutch stimulus word. They were instructed to respond as fast as they could while maintaining high accuracy. They were asked to remain silent when they could not come up with the translation of the stimulus.

The procedure in the translation condition was similar to that of Experiment 1, up until response registration of the target word. The onset of the participant's response (or of any other sound) was registered by the voice-switch. RT was measured from the onset of the target word. Then the experimenter typed in the participant's response and hit the RETURN-key, effectuating the presentation of the next stimulus one second afterwards. The maximum presentation duration for the target word was 5 seconds. Whenever this period expired, the experimenter typed the word 'none' and the next trial was called by pressing the RETURN-key.

Participants completed 60 test trials that were preceded by 20 practice trials. The test trials were divided in 3 blocks of 20 stimuli each. After each block, the participant was permitted a brief rest of minimally 10 seconds, after which the experimenter initiated the presentation of the first trial of the next block.

4.2 Results and discussion

Following the procedures described in Experiment 1, mean subject and mean item RTs were calculated. RTs associated with translation errors or voice-switch registration failures were excluded. Failures of the voice-switch (including false starts of the participants) made up 6.30% of all data. A response was considered an error when it was not listed as a possible translation of the stimulus in a set of Dutch-English and English-Dutch dictionaries (Martin & Tops, 1984; 1986). An omission was scored if the participant had not initiated a response within 5 seconds after stimulus onset. For each participant and for each item, the mean proportions of errors and omissions were calculated for each condition. The data were subsequently analyzed conform the analyses described in Experiment 1.

The mean subject RTs and the error and omission rates are presented in Table 2.

Table 2
Mean Reaction Times (in ms) and Error-Omission Rates (in Percentages) for the Forward Translation Task. Standard Deviations are in Parentheses. (Experiment 2)

Cognate status	RT	Error-Omission
	High constraint	
Noncognates	892 (199)	12.2 (7.8)
Cognates	784 (122)	4.0 (4.0)
Effect	108	8.2
	Low constraint	
Noncognates	1389 (378)	15.0 (9.5)
Cognates	1101 (225)	4.3 (5.4)
Effect	288	10.7
	No context	
Noncognates	1276 (327)	11.7 (9.7)
Cognates	930 (160)	2.3 (2.9)
Effect	346	9.4

Note. All means presented are based on participants' scores.

The RT analyses revealed a significant main effect of cognate status, $F_1(1,57) = 80.50$, $p < .0001$, and $F_2(1,58) = 11.87$, $p < .01$. The main effect of sentence context was also significant, $F_1(2,57) = 16.38$, $p < .0001$, and $F_2(2,116) = 96.26$, $p < .0001$; mean overall RTs were 838 ms, 1245 ms, and 1103 ms for the high constraint, low constraint, and no context conditions, respectively. A Tukey HSD procedure showed that translation times were shorter in the high than in the low constraint condition (both *p*s < .01), and were also shorter in the high constraint than in the no context condition (both *p*s < .01); RTs in the low constraint and the no context conditions differed significantly only in the item analysis ($p < .01$).

More interestingly, these main effects were qualified by a significant interaction between cognate status and sentence context, $F_1(2,57) = 6.76$, $p < .005$, and $F_2(2,116) = 9.72$, $p < .001$. As can be seen in Table 2, and as is substantiated by simple effects analyses, a strong effect of cognate status was obtained when cognates and noncognates were presented in isolation (346 ms), $F_1(1,57) = 52.52$, $p < .001$, and $F_2(1,58) = 21.343$, $p < .0001$, and when they were preceded by a low constraint sentence context (288 ms), $F_1(1,57) = 36.38$, $p < .001$, and $F_2(1,58) = 10.30$, $p < .005$. When cognates and noncognates were preceded by a high constraint sentence context, however, the effect of cognate status was strongly reduced (108 ms), $F_1(1,57) = 5.12$, $p < .05$, and $F_2(1,58) = 1.61$, $p > .20$.

Summarizing, in forward translation the cognate effect was considerably larger in the no context condition than in the condition with a highly constraining context. The cognate effect remained substantial, however, in the low constraint context condition.

5. Experiment 3: backward translation

5.1 Method

Design. The design was similar to that of Experiments 1 and 2.

Participants. Sixty participants, drawn from the same population as those of Experiments 1 and 2, took part. They were randomly allocated to one of the three context conditions. None of them participated in Experiments 1 or 2. After finishing the experiment they were asked to rate their comprehension and production abilities in English (See Experiments 1 and 2). Their mean comprehension ratings were 5.20 (*SD*: .70), 5.75 (*SD*: .44), and 5.10 (*SD*: .97) for bilinguals in the high constraint, low constraint and no context conditions, respectively. Their mean production ratings were 4.60 (*SD*: .88), 5.20 (*SD*: .52), and 4.90 (*SD*: .72), in the same order. Participants received course credit or money for participation.

Materials. The English word stimuli and sentence contexts were the same as those of Experiment 1 (i.e., the translations of the stimulus materials used in the forward translation task). As in the forward translation task, the language of the sentence contexts was the same as the language of the target word).

Apparatus and procedure. The apparatus was identical to that of Experiment 2. The instructions for reading the sentences and for translating the target word were identical to those of Experiment 2, with the exception that the bilinguals were now asked to translate the word in backward direction. As in the previous experiments, all participants read the sentence contexts sufficiently well; the sentence frames noted down covered at least 75% of the information.

5.2 Results and discussion

Following the procedures described in Experiment 2, mean subject and mean item RTs were calculated. Failures of the voice-switch made up 6.89% of all data. The data were subsequently analyzed conform the analyses described in Experiments 1 and 2. The mean subject RTs and the error and omission rates of the backward translation study are presented in Table 3.

The RT data yielded a strong main effects of cognate status, $F_1(1,57) = 133.50$, $p < .0001$, and $F_2(1,58) = 21.53$, $p < .0001$. The main effect of sentence context was also significant, $F_1(2,57) = 16.55$, $p < .0001$, and $F_2(2,116) = 49.81$, $p < .0001$; mean overall translation times were 880 ms, 1142 ms, and 1056 ms for the high constraint, low constraint, and no context conditions, respectively. A Tukey HSD procedure confirmed that bilinguals were faster in the high than in the low constraint condition (both *p*s < .01), and were also faster in the high constraint than in the no context condition (both *p*s < .01); the low constraint and the no context conditions differed significantly only in the item analysis ($p < .01$).

Table 3
Mean Reaction Times (in ms) and Error-Omission Rates (in Percentages) for the Backward Translation Task. Standard Deviations are in Parentheses. (Experiment 3)

Cognate status	RT	Error-Omission
	High constraint	
Noncognates	950 (168)	8.0 (5.3)
Cognates	811 (142)	0.8 (1.5)
Effect	139	7.2
	Low constraint	
Noncognates	1243 (216)	7.7 (5.4)
Cognates	1042 (126)	1.7 (2.0)
Effect	201	6.0
	No context	
Noncognates	1193 (175)	14.5 (8.9)
Cognates	918 (127)	1.3 (1.7)
Effect	275	13.2

Note. All means presented are based on participants' scores.

The interaction between cognate status and sentence context was also significant, $F_1(2,57) = 4.87$, $p < .05$, and $F_2(2,116) = 4.23$, $p < .05$. Similar to the pattern of results obtained in the forward translation task, a strong cognate effect was obtained in the no context condition (275 ms), $F_1(1,57) = 79.70$, $p < .001$, and $F_2(1,58) = 26.27$, $p < .0001$, and in the low constraint condition (201 ms), $F_1(1,57) = 43.11$, $p < .001$, and $F_2(1,58) = 13.26$, $p < .001$. However, in the high constraint condition, the cognate effect (139 ms) was notably smaller, yet remained significant, $F_1(1,57) = 20.42$, $p < .001$, and $F_2(1,58) = 7.64$, $p < .01$.

In short, the backward translation data resembled those of forward translation: In the high constraint condition, the cognate effect was, as compared to words presented in isolation, considerably reduced. In the low constraint condition the cognate effect remained substantial.

6. General discussion

In three experiments the influence of sentence context constraint on subsequent processing of cognates and noncognates was examined. The results were similar across the experiments: In the high constraint context condition, the cognate effect was eliminated in lexical decision in the second language, and was strongly reduced in forward and backward translation. In contrast, in all three tasks, prior reading of a congruent, low constraint sentence context did not markedly influence the cognate effect.

The pattern of results of the experiments can be explained by assuming that the basic activation process of words in bilingual memory is language-nonselective: words from two languages are activated in parallel, and orthographic, semantic and phonological information is interconnected and integrated across languages. Do to their higher overlap of orthographic, semantic, and phonological information, cognates are processed faster than noncognates.

We also found that contextual information may modulate the degree of co-activation of related words in bilingual memory: Prior reading of a high constraint (but not low constraint) sentence context eliminated or decreased the cognate effect. This suggests that the activation of words can thus become more or less language selective on the basis of contextual information.

One of the few models on bilingual memory organization that takes linguistic context effects into account is the BIA+ model (Dijkstra & Van Heuven, 2002). In the BIA+ architecture, Dijkstra and Van Heuven make a distinction between a word identification system and a task/decision system. They further distinguish between effects of non-linguistic and linguistic context on performance. Nonlinguistic context effects that can arise from instruction, task demands or participant strategies are assumed to affect the task/decision system (see Dijkstra & Van Heuven, 2002, for more details). Linguistic context effects, and these effects are particularly relevant for the experiments reported in this paper, arise from lexical, syntactic, and semantic sources. Linguistic context effects are assumed to directly affect the activity in the word identification system. So, the word identification system is interactive not only with respect to orthographic, semantic, and phonological information, but also relative to the sentence parsing system. BIA+ thus predicts that the recognition of words embedded in a sentence context is sensitive to syntactic and semantic information, and that sentence context interacts with target word recognition, as was indeed found in the experiments reported in this paper.

Importantly, the co-activation of related words in memory was not only influenced by sentence context, but it was also qualified by semantic constraints of the sentence context. The differential effects obtained with high and low constraint sentences can be understood by assuming that a high constraint context, but not a low constraint context, delineates the semantic and lexical information of a word that is activated on the basis of feature restrictions imposed by the sentence context. According to this feature restrictions hypothesis, proposed by, e.g., Schwanenflugel and LaCount (1988) and Kellas, Paul, Martin, and Simpson (1991) in the monolingual literature, semantic constraint influences the generation of feature restrictions for upcoming words: Readers will generate more feature restrictions for high constraint sentences than for low constraint sentences. These feature restrictions are compared to the conceptual features of upcoming words. For example, in case of the high constraint sentence context 'She took a bite of the fresh green …' for the target word 'apple', readers may generate the feature restrictions [can be bitten], [fresh], and [green]. In the low constraint sentence context 'My sister was hungry and took the last … ' for the target word 'apple', readers may generate the single feature restriction [taken when hungry]. Many upcoming words will accommodate this single feature restriction [taken when hungry], whereas a few words will accommodate all three feature restrictions in the high constraint example. High, but not low, constraint sentence contexts thus delineate the activation of semantic, orthographic and phonological elements of words in bilingual memory (I assume here, as in the BIA+ model, that semantic, orthographic and phonological information is highly interconnected).

How does this affect the processing of cognates and noncognates in sentence contexts? If high constraint sentence contexts activate a specific set of elements, they may do so in both cognates and noncognates alike. This reduces, of may even eliminate, the cognate effect due to the higher overlap of orthographic, phonological, and semantic information across languages. The elements activated by a low constraint sentence context, however, are not specific enough to overcome the cognate advantage.

In conclusion, the cognate effect in lexical decision in L2 and in forward and backward word translation disappeared or decreased after prior reading of a high constraint sentence context, but not after reading a low constraint sentence context. This suggests that the activation of words in bilingual memory can be influenced by the surrounding linguistic context: the sentence context in which a target word is embedded modulates the degree of co-activation of related words in bilingual memory. Specifically, it was found that the contextual effect depended on the semantic constraint of the sentence context, which suggests that high constraint, predictive sentence contexts, but not low constraint sentence contexts, delineate the (co)activation of semantic, orthographic and phonological elements of words in bilingual memory.

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