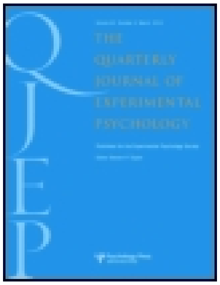

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Cognate effects in sentence context depend on word class, L2 proficiency, and task

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Cognate effects in sentence context depend on word class, L2 proficiency, and task

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Noun translation equivalents that share orthographic and semantic features, called "cognates", are generally recognized faster than translation equivalents without such overlap. This cognate effect, which has also been obtained when cognates and noncognates were embedded in a sentence context, emerges from the coactivation of representations in two languages. The present study examined whether cognate facilitation in sentences is subject to effects of word class, reading proficiency in a second language (L2), and task demands. We measured eye movements (Experiment 1) and self-paced reading times (Experiment 2) for Dutch–English bilinguals reading L2 sentences that contained either a noun or a verb cognate. Results showed that cognate effects were smaller for verbs than for nouns. Furthermore, cognate facilitation was reduced for readers with a higher proficiency in L2 as expressed by self-ratings or reading speed in L2. Additionally, the results of the eye-movement study and the self-paced reading study indicated that the likelihood of observing cognate facilitation effects also depends on task demands. The obtained pattern of results helps to identify some of the boundaries of the cognate effect.

Keywords: Bilingualism; Cognates; Sentence processing; Verbs; Proficiency.

In the last decades, numerous studies have shown that for bilinguals, language processing in one language is not restricted to representations from that one language only, but extends to those of the other language. Cross-linguistic effects on language processing were observed in many different paradigms, implying nontarget language activation of lexical semantics, orthography, and phonology (e.g., Beauvillain & Grainger, 1987; Costa, Caramazza, & Sebastián-Gallés, 2000; Dijkstra, Grainger, & van Heuven, 1999; Van Hell & De Groot, 1998; Wu & Thierry, 2010). For example, when reading a text in one language, bilinguals activate representations from both languages, especially when an input letter string is shared between those languages. This benefits the processing of words that are highly similar across two languages and has been taken as evidence that the process of lexical access is language nonspecific (see De Groot, 2011, for a review). The present study examines to what extent such effects of cross-language activation in word recognition are influenced by specific characteristics of the stimuli, participants, and task.

Research on word recognition in bilinguals has often focused on the comparison of cognate and

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noncognate processing (for reviews, see Dijkstra, 2005; Van Assche, Duyck, & Hartsuiker, 2012). Cognates are translation equivalents that are orthographically similar between a bilingual's first language (L1) and their second language (L2), such as the English–Dutch word "museum". In this example, the word is spelled identically in the two languages, but the general definition of cognates also includes English–Dutch translation pairs such as "photo"–"foto" or "music"–"muziek" (sometimes referred to as near cognates), which are similar but not identical in spelling and pronunciation. The combination of meaning and form overlap gives rise to a cognate facilitation effect, which entails that cognates are processed faster and with fewer errors than noncognate words. Cognate facilitation effects have been observed for words presented out of sentence context, in a wide variety of tasks, including lexical decision (e.g., Dijkstra et al., 1999), progressive demasking (Lemhöfer et al., 2008), semantic categorization (e.g., Dufour & Kroll, 1995), and picture naming (e.g., Costa et al., 2000; Poarch & Van Hell, 2012). The facilitation effect is largely sustained when cognates are embedded in a semantically low-constraint sentence context (e.g., Duyck, Van Assche, Drieghe, & Hartsuiker, 2007; Libben & Titone, 2009; Schwartz & Kroll, 2006; Van Hell & De Groot, 2008). In addition to behavioural evidence, event-related potentials (ERPs) also point to facilitatory processing for cognates in terms of a reduced N400 (Midgley, Holcomb, & Grainger, 2011; Yudes, Macizo, & Bajo, 2010; but see Strijkers, Costa, & Thierry, 2010, for earlier effects). The facilitation effect is taken as evidence for coactivation—that is, the activation of representations from both languages upon presentation of cognate words. The magnitude of the cognate effect appears to depend on the amount of orthography and phonology shared across languages: More coactivation is observed for cognates that have a higher degree of form overlap (Dijkstra et al., 1999; Dijkstra, Miwa, Brummelhuis, Sappelli, & Baayen, 2010; Duyck et al., 2007; Lemhöfer & Dijkstra, 2004; Lemhöfer, Dijkstra, & Michel, 2004; Schwartz, Kroll, & Diaz, 2007; Van Assche, Drieghe, Duyck, Welvaert, & Hartsuiker, 2011; Van Assche, Duyck, Hartsuiker, & Diependaele, 2009).

Despite the growing body of evidence on cognate effects and their origin, it remains unclear whether cognate effects are word class specific, as most studies conducted so far have exclusively used nouns as stimulus materials. Knowledge about cognate processing is therefore based mainly on nouns. For a full understanding of cognate processing, however, other word classes should also be studied (see Van Hell, 2002), in order to find out whether syntactic class is an important dimension to consider in bilingual processing. Given that the psychological definition of cognates relies on a pairing of words from two different languages established by an individual (Carroll, 1992), lexical items from any word category could be included, as long as a bilingual considers the two similar enough. This is particularly so for content words that overlap in both form and meaning, such as nouns and verbs. These word classes are known to differ in several respects relating to semantics and structure, which result in processing differences (see Vigliocco, Vinson, Druks, Barber, & Cappa, 2011). Such differences may also affect bilingual processing of noun and verb cognates. The first aim of the present study, therefore, is to examine whether cognate facilitation for nouns in sentence context extends to the syntactic category of verbs.

Apart from stimulus characteristics, such as word class, bilingual processing may also be influenced by characteristics of the participant, such as proficiency in the L2. Individual differences among bilinguals in terms of their L2 proficiency, as well as age of acquisition of L2, can modulate frequency effects in L2 processing (Duyck, Vanderelst, Desmet, & Hartsuiker, 2008; Whitford & Titone, 2012) and language nonspecific activation (e.g., Titone, Libben, Mercier, Whitford, & Pivneva, 2011; for a review, see Van Hell & Tanner, 2012). It is not clear, however, how L2 proficiency is best operationalized. L2 reading proficiency can be measured in different ways, reflecting reading fluency or text comprehension. This raises the question to what extent different L2 proficiency measures yield divergent or convergent data patterns on the role of L2 proficiency in language processing. The second aim of our study was therefore to determine how L2 proficiency, operationalized as self-rated proficiency and as reading speed, can modulate cognate processing in sentence context.

A third factor that can influence bilingual processing is the task used to examine the effect. Sentence reading studies employ different kinds of tasks, which more or less resemble natural reading, including self-paced reading (e.g., Binder & Rayner, 1998; Jackson & Roberts, 2010; Koornneef & Van Berkum, 2006; Traxler, Pickering, & McElree, 2002) and eye-tracking paradigms (e.g., Balling, 2012; Duyck et al., 2007; Libben & Titone, 2009; for an overview, see Rayner, 1998). Yet, self-paced reading differs from natural silent reading, given that the button press involved depends partly on the motor response rhythm of one's finger, which may influence measurements of reading speed. Furthermore, when readers are presented with one word at a time in a noncumulative fashion, there is no opportunity to look back, whereas natural reading allows readers to regress and skip freely. This means that the time to read or process a word is in part dependent on specific task demands (e.g., Rayner & Pollatsek, 1989). Different tasks engage different cognitive and behavioural processes, such that task measures may reflect differences in the time course of activation of these processes. Also, different tasks may show more or less interindividual variation in processing between participants—for example, with regard to L2 proficiency. The third aim, therefore, is to explore how task demands may influence the cognate facilitation effect in sentence context. Before we zoom in on the experiments, we review relevant empirical studies on word class differences, L2 proficiency, and task demands.

Noun and verb processing

There are several reasons why nouns and verbs may be processed differently. In general, nouns denote objects while verbs denote actions or events. This distinction between objects and actions is backed up by sensorimotor accounts of language processing that distinguish word classes in terms of semantic activation. Noun processing is associated with activation in the visual cortex, whereas verb processing more strongly involves the motor cortex (e.g., Pulvermüller, Lutzenberger, & Preissl, 1999). At a representational level, verbs are generally considered to be more abstract while nouns are considered to be more concrete (e.g., Federmeier, Segal, Lombrozo, & Kutas, 2000). Furthermore, the meaning of nouns is usually more specific and stable than that of verbs (Gentner, 1981; Reyna, 1987), whereas verb meaning is more often defined relative to context (Gentner, 1981) and more often polysemous (Miller & Fellbaum, 1991), which makes verb semantics more diffuse. This implies that verb meaning is probably only fully constructed at the sentence level rather than at the lexical level (e.g., Taylor, Lev-Ari, & Zwaan, 2008). Furthermore, verbs are considered to be structurally more complex than nouns, because they contain information on the number and kinds of arguments a verb can take (Grimshaw, 1990). These representational differences between nouns and verbs have consequences for their processing. In an extensive review of noun and verb studies, Vigliocco et al. (2011) conclude that the larger complexity of verbs relative to nouns in terms of semantics, syntax, and morphology leads to greater processing demands. There is evidence that the more complex nature of verbs results in slower processing than that for nouns (e.g., Tyler, Russell, Fadili, & Moss, 2001). The complexity associated with verbs also has consequences for language acquisition, in the sense that nouns are typically learned earlier than verbs (Gentner, 1981).

Differences between nouns and verbs have also been observed in bilingual processing. Van Hell and De Groot (1998) compared responses for between- and within-language word association tasks, in which Dutch–English bilinguals were asked to verbally associate to a target word. For example, when presented with the word "skirt", participants could respond by saying "dress" in the within-language condition, or its Dutch translation equivalent "jurk" in the between-language condition. Association responses in the within- and between-language conditions were more often translations of one another for nouns compared to verbs (and for cognates compared to noncognates, and for concrete words compared to abstract words). The authors also examined response times for the association task; response times for verbs were slower than those for nouns. This evidence suggests that semantics may not always be completely shared between translation equivalents and, of particular interest to the current study, that there may be differences in semantic overlap between nouns and verbs. Specifically, verb translations may be less similar in terms of semantics than noun translations. Interestingly, the word associations reported by Van Hell and De Groot (1998) yielded a cognate effect that was independent of word class.

Differences between nouns and verbs in bilingual processing may thus in part be due to differences between word classes in terms of similarity across languages. This also holds for orthography. Due to inherent properties of the languages relating to affixes and inflections, Dutch–English verb cognates, for example, tend to have less orthographic overlap than noun cognates across the two languages. Yet, the resemblance between an English verb such as “to start” and its Dutch translation equivalent “starten” seems enough to notice the link and build a connection between the two forms, which makes them cognates (see Carroll, 1992). This is supported by a recent study showing cognate facilitation for verbs as well as nouns. Bultena, Dijkstra, and Van Hell (2012) presented Dutch–English bilinguals with a lexical decision task that included noun and verb cognates in a minimal phrasal context (e.g., “the start” or “they start”) so as to disambiguate word class ambiguous items from their noun reading. The response times indicated a facilitatory effect for cognates irrespective of syntactic class.

Although verbs have been shown to give rise to cognate effects when presented out of sentence context, it is not known whether a similar effect would occur when verbs are embedded in a sentence context. Although the presence of a sentence context has previously been shown to not always cancel out noun cognate facilitation effects (e.g., Van Hell & De Groot, 2008), the effect of sentence context on verb processing may be different. There are several reasons why processing of verbs in sentences may be less language ambiguous. Verbs may yield more language-specific activation, because verb semantics tend to be context dependent (e.g., Gentner, 1981; Taylor et al., 2008) and more specific to a particular language than nouns (Van Hell & De Groot, 1998). The surrounding context may therefore affect semantic processing of the verb to a larger extent than is the case for nouns. Furthermore, the influence of syntactic processing in sentence context could affect verbs more than nouns. Because the main verb determines the sentence verb argument structure (see Goldberg, 1995), the syntactic framework laid out by the verb can provide an additional top-down influence that guides language-specific access. Hence, the verb cognate effect may be reduced in sentence context compared to the effect observed for nouns.

L2 proficiency

Proficiency differences in L2 can modulate effects of bilingual processing, for example pertaining to the magnitude of the cognate facilitation effect (e.g., Libben & Titone, 2009). There is evidence for an influence of L2 proficiency in cognate facilitation effects in both L1 and L2 processing (for a review, see Van Hell & Tanner, 2012). Concerning L1 processing, Van Hell and Dijkstra (2002) showed that a minimal level of foreign language fluency is required in word recognition before any weaker nontarget language effects become noticeable. They included Dutch–English (e.g., “winter”) and Dutch–French (e.g., “plafond”) cognates in a Dutch lexical decision task, which was presented to two groups of Dutch–English–French trilinguals who differed in their proficiency in third language (L3) French (moderately or highly proficient). Both groups showed a facilitatory effect for English cognates in L1 processing, but only the high L3 French proficiency trilinguals also showed a facilitatory effect for French cognates. A recent code-switching study presenting L1 cognates in sentences also showed that L1 cognates affected code switching only in proficient L2 speakers, and not in moderately proficient L2 speakers (Kootstra, Van Hell, & Dijkstra, 2012). These studies show that in unbalanced bilinguals, the weaker L2 (or L3) only influences cognate processing in L1 if proficiency in the L2 (or L3) is high enough (see also Brenders, Van Hell, & Dijkstra, 2011; Poarch & Van Hell, 2012; Titone et al., 2011).

An L2 proficiency modulation has also been observed in cognate effects in L2. While cognate facilitation in L1 processing increases with more proficiency in L2, cognate facilitation in L2 processing is attenuated by increased L2 proficiency. In an eye-tracking study, Libben and Titone (2009) showed that cognate effects for unbalanced French–English bilinguals who read in their L2 English depended on their proficiency in L2. They report correlations between L2 proficiency measures and the size of the cognate facilitation effect for both early and late reading time measures, which indicate that bilinguals who were more proficient in their L2 showed a decreased cognate facilitation effect.

The effects of L2 proficiency on cognate effects can be understood from the theoretical perspective of relative language activation in word recognition for more and less proficient bilinguals (Dijkstra & Van Hell, 2003). L1 activation during L2 processing depends on the relative activation strength of L1 and L2, which is, in turn, dependent on L2 proficiency. Lexical representations in the L1 will in general be activated more strongly and more quickly than those in an L2, because the frequency with which word forms are retrieved in a bilingual's dominant language is higher. Higher proficiency in L2, however, is likely to co-occur with increasing frequency of usage, which speeds up the activation of the L2 form. When a bilingual's relative proficiency in the L1 and L2 changes, the relative contribution of activation of L1 forms might be reduced; this can explain the smaller cognate effects. Together, the studies indicate that changes in L2 proficiency can influence the magnitude of cross-linguistic activation in both L1 and L2 processing, albeit in different directions.

Despite emerging evidence that cognate facilitation varies with L2 proficiency, the construct of L2 proficiency itself is not well established. A wide range of L2 proficiency measures have been used, including self-ratings (e.g., Marian, Blumenfeld, & Kaushanskaya, 2007), vocabulary knowledge in L2 (e.g., Lemhöfer & Broersma, 2011; Meara, 2006), as well as age of acquisition, or time spent on learning the L2. Most studies focus on an aspect of L2 proficiency that is relevant for the type of language processing under examination. In sentence reading, L2 proficiency has been linked to reading speed, which can be measured in several possible ways. Some visual sentence comprehension studies have used fixation duration in L1 and L2 as an indication of language proficiency in the two languages. For example, Libben and Titone (2009) defined relative proficiency as a difference in reading speed between L1 and L2, measured by fixation duration based on the reading of text passages in both languages (see also Altarriba, Kroll, Sholl, & Rayner, 1996). They showed that the size of the cognate facilitation effect correlated both with self-ratings of L2 proficiency, and with the difference in reading speed between L1 and L2 paragraph reading.

Alternatively, L2 reading speed in itself can be assumed to reflect L2 proficiency. Bell (2001) showed that L2 learners' reading speed increased, and reading comprehension improved with higher levels of proficiency. Both the speed and difference measures are based on the notion that for bilinguals, processing in L2 is slower than that in L1, at least at lower levels of L2 proficiency. Proficiency level in L2 is therefore assumed to affect the speed of lexical access. Yet, reading in L2 may also reflect general interindividual variation beyond L2 proficiency (e.g., Jackson & McClelland, 1979; Rayner & Pollatsek, 1989). Lee and Lemonnier Schallert (1997) showed that reading ability in L2 was in part dependent on reading ability in L1 and in part on general L2 proficiency. So although the measure of speed has often been used as an indication of L2 proficiency in reading, the validity of the measure is not completely clear. To gain more insight into the role of

L2 proficiency in reading, we examined different measures of L2 reading proficiency, comparing reading speed to self-ratings of L2 proficiency to assess which measure could best account for a proficiency modulation in cognate effects in different tasks.

Task demands

Task demands may also affect cognate effects in sentences. Duyck et al. (2007) studied the processing of identical cognates and near-cognates presented in low-constraint sentence context using two different paradigms: lexical decision and eye tracking. The lexical decision response on the sentence-final target word yielded cognate facilitation for both identical and nonidentical cognates. Reading times for the same items, presented in the middle of the sentence and measured with eye tracking (mimicking natural reading), showed a different pattern: A cognate facilitation effect was observed for identical cognates, but not for near-cognates. This suggests that the size of the cognate facilitation effect may depend on the task at hand, due to differences in processing demands and response criteria. In the lexical decision task used by Duyck et al., sentences were presented using a serial visual presentation (SVP) technique in which each word was shown for 700 ms, which may have induced relatively slow processing compared to natural reading in which reading times for words were shorter.

Furthermore, *how* reading is measured may to a larger or smaller extent be influenced by differences in L2 proficiency: Clearly, tasks may be more or less sensitive to subtle differences between readers of different proficiency levels. A very precise task measure of reading, such as eye tracking, is likely to reflect more subtle differences in reading proficiency than a task that makes reading patterns across participants more uniform, such as self-paced reading. In order to draw generalizable conclusions that are independent of task demands, it is therefore important to compare the outcomes of different tasks.

The present study

The studies reviewed above indicate that cognate effects can be modulated by the nature of the stimulus materials, the bilinguals' L2 proficiency, and task demands. In the present study, we addressed the influence of these three factors. First, we considered whether the syntactic category a word belongs to (henceforth word class) affects the size of the cognate effect in sentence context. Although verbs have less cross-linguistic semantic and orthographic overlap than nouns, cognate effects were still observed out of sentence context (e.g., Bultena et al., 2012; Van Hell & De Groot, 1998). We wanted to know to what extent verb cognate effects emerge in sentences, which provide a context that engages syntactic processing and semantic integration. Because nouns and verbs take up different roles in sentence processing, verb cognate effects may differ from noun cognate effects. In order to test this, we compared the processing of noun and verb cognates embedded in a meaningful sentence context. Specifically, we predicted that the cognate facilitation for verbs would be smaller than that for nouns, given the verb's role in the sentence and the smaller cross-linguistic form and meaning overlap of verbs than of nouns.

Second, we examined the effect of L2 proficiency on cross-linguistic activation. Bilinguals' relative proficiency in L1 and L2 can affect the magnitude of cross-linguistic activation (see Van Hell & Tanner, 2012), but the construct of L2 proficiency is not completely clear. Here we examined the extent to which cross-linguistic effects in L2 processing vary with different measures of L2 proficiency, in particular, self-ratings of L2 reading proficiency and average reading speed in L2, two measures that are frequently used in this field. We tested adult Dutch learners of English as a second language, who are generally classified as highly proficient in their L2. Cognate effects were expected to attenuate with increased proficiency in L2, because the relative activation of L2 is higher for more proficient L2 learners (Libben & Titone, 2009).

Third, we examined how task demands can influence the size of the cognate effect. More specifically, we examined cognate facilitation in sentence context in two experiments—namely, recording of eye movements during natural reading (Experiment 1) and self-paced reading (Experiment 2). These two commonly used methods to examine reading processes were assumed to be differently affected by L2 proficiency and to reflect different time windows of processing, which may, in turn, influence the size of cognate facilitation effects. Eye tracking is considered a fine-grained technique to measure reading, demonstrating subtle individual differences in reading patterns. Self-paced reading offers readers a restricted visual window, not allowing for skips and regressions, and therefore reading patterns are more likely to be similar among individuals (Rayner & Pollatsek, 1989). For that reason, subtle differences in L2 reading proficiency may be more difficult to detect in the more "classic" self-paced reading paradigm, although the latter task can still show differences between readers in terms of average reading speed.

EXPERIMENT 1: EYE TRACKING

Method

Participants

Thirty-seven Dutch–English bilinguals (5 males), students drawn from the Radboud University Nijmegen participant pool, between 18 and 30 years of age ($M = 22.27$, $SD = 3.19$), took part in the experiment. All participants were native speakers of Dutch and had learned English at school as an L2, starting around the age of 11 ($SD = 1.68$). They all had normal or corrected-to-normal vision. None of them reported any reading problems. Participants were paid a small amount of money or received course credit for their participation.

To assess L2 proficiency, participants filled out a language background questionnaire. Self-ratings for English proficiency (using a 7-point Likert scale where 7 equals native-like proficiency) were given for reading ($M = 4.7$, $SD = 1.2$), writing ($M = 4.3$, $SD = 1.3$), and speaking ($M = 4.9$, $SD = 1.3$). Several participants ($N = 14$) indicated to have lived in an English-speaking country or to have taken part in bilingual (English–Dutch) education in the Netherlands. Furthermore, each participant read a passage of English text (L2) and a passage of Dutch text (L1), which were comparable in length, difficulty, and topic. Eye movements were measured during the reading of these short pieces of text; based on the total reading times per passage, we determined the average fixation duration per word, which was used as an L2 reading speed measure (see also Altarriba et al., 1996; Libben & Titone, 2009).

Stimulus materials

A set of 53 English target sentence pairs were created; 29 sentences contained a target noun cognate or noncognate, and 24 sentences contained a target verb cognate or noncognate. Verb stimuli were drawn from the materials used in Bultena et al. (2012); verb pairs were selected based on the criterion that individual cognates should have yielded a facilitation effect in comparison to their matched control word in phrasal context. Target words were morphologically simple singular nouns or third person plural verbs (similar to the infinitival form). All sentences were declarative main clauses with a subject–verb–object construction. For each cognate target, a control target was selected that fitted in the exact same sentence context as the cognate (see Table 1).

To construct the stimulus materials for this experiment, a cloze test and two rating studies were conducted. A sentence completion study was conducted to assess cloze probabilities for the cognate and control target words. Forty-two Dutch–English bilinguals, drawn from the same population as those in the sentence-reading experiments, took part in the sentence completion study (none took part in the actual experiments). Twenty-six completed the initial study ($N = 86$ sentences), and 16 completed a follow-up study ($N = 48$ sentences). Participants were asked to complete English sentences in which the target word had been left out; the omitted word was located in the middle of the sentence in all cases. Sentences were divided in two blocks, one in

Table 1. *Example sentences of noun and verb conditions*

Word type	*Sentence with* cognate/control *target word*
Noun	The attorney consults *an expert/a lawyer* for a detailed opinion on the matter.
Verb	The bandleaders *start/change* the rehearsals for the choir after the disturbance.

Note: Target word in italics.

which nouns had been omitted, and another in which verbs had been omitted. Based on the responses, we selected stimuli that were low-constraint sentences with cloze probabilities smaller than .30, which made up the final set of 53 stimuli. Mean cloze probabilities for cognate and control words were low for both nouns ($M_{\text{cognate}} = .02$, $SD = .06$; $M_{\text{control}} = .03$, $SD = .06$) and verbs ($M_{\text{cognate}} = .04$, $SD = .06$; $M_{\text{control}} = .03$, $SD = .06$), and none of the sentences had an alternative completion with a cloze probability higher than .50. Two-level analyses of variance showed no significant differences in cloze probability between cognate and control sentences for nouns and verbs (Fs < 1).

We also conducted online rating studies to assess concreteness and semantic similarity between Dutch and English translations of cognates and noncognate controls. Concreteness ratings were obtained from a group of 52 Dutch–English bilingual participants who were asked to rate the concreteness of 199 English nouns and 235 English verbs on a scale of 1 (very abstract) to 7 (very concrete). Semantic similarity ratings were collected from a different group of 61 Dutch–English bilinguals, for 160 nouns and 160 verbs on a scale of 1 (no semantic overlap) to 5 (fully overlapping between languages). The English noun targets were rated as significantly more concrete, $t(102) = 2.83$, $p < .01$, and as having more semantic overlap with their Dutch translation equivalent, $t(102) = 2.63$, $p < .05$, than verbs (see Table 2). There were no differences between cognates and noncognates regarding these factors for both nouns and verbs (ps $> .1$).

Cognates and control target words were matched with respect to word length (between 3 and 7 characters long), English lemma log frequency, and English neighbourhood density in the CELEX database (Baayen, Piepenbrock, & Gulikers, 1995; see Table 2). Separate two-level analyses of variance (ANOVAs) for nouns and verbs indicated that cognates and controls did not differ in length, frequency, and neighbourhood density in English (all ps $> .1$). Four-level ANOVAs also showed no differences between the noun and verb cognates and controls on these criteria (ps $> .1$). Orthographic similarity of cognate translation equivalents as measured by Van Orden's similarity measure (Van Orden, 1987) was higher for nouns than for verbs, because of the fixed "–en" suffix for Dutch verbs in their infinitival form (e.g., "starten" vs. "to start"). The orthographic similarity of Dutch and English control words was low. All content words in the sentences that occurred before the target items were noncognates.

Two versions of the experiment were created; each experimental list contained both noun and verb sentences, and cognate and control targets

Table 2. *Overview of lexical characteristics for matched experimental items*

	Nouns (N = 29)		*Verbs* (N = 24)	
Lexical characteristics	*Noncognate*	*Cognate*	*Noncognate*	*Cognate*
Word length	4.90 (1.01)	4.93 (1.07)	5.21 (1.29)	5.17 (1.27)
Log frequency	1.81 (0.45)	1.85 (0.48)	1.84 (0.67)	1.81 (0.76)
Neighbourhood density	4.24 (4.12)	5.38 (5.96)	3.75 (3.37)	5.83 (5.89)
Van Orden orthographic similarity	.16 (.18)	.89 (.22)	.11 (.08)	.63 (.22)
Cross-linguistic semantic similarity	4.43 (0.37)	4.56 (0.28)	4.27 (0.33)	4.34 (0.49)
Concreteness	4.74 (1.39)	4.89 (1.36)	3.85 (1.26)	4.37 (0.78)

were counterbalanced across lists. In addition to the 53 target sentences, each list contained 75 filler sentences with different syntactic structures and tenses than the target sentences. One fourth of the sentences (16 targets and 16 fillers) were followed by a comprehension question, addressing the lexical content with respect to the first, middle, or last part of a sentence, which had to be answered with "yes" or "no". Comprehension questions occurred at random intervals in the experiment and were always succeeded by a filler sentence; feedback was only given when participants chose the wrong answer.

Procedure

Participants were tested individually on a Windows XP Intel® Pentium® 4CPU computer with a 22-inch Iiyama Vision Master Pro 510 monitor (1024 by 768 pixels, 100-Hz refresh rate) suitable for eye tracking. The experiment was designed and run with in-house developed Delphi software, which sampled *x*- and *y*-coordinates of eye positions. Eye movements were measured with an SMI I-View Eyetracker (500 Hz), a table-mounted system with forehead and chin rests. Participants were seated at 50 cm from the computer screen.

Prior to the experiment, participants were presented with a 13-point calibration grid and received English instructions on the computer screen, which instructed them to read silently at a normal pace. They were also verbally instructed to try and avoid any head movements during the experiment. The experiment started with 12 practice sentences.

Sentences were aligned to the left side of the screen in a black 16-point Courier New font to a light-grey background (this was inversed for some participants for better calibration); questions were presented in red. One letter (13 pixels wide) corresponded to a 0.5° visual angle horizontally. Between two trials, a fixation cross was presented for 1500 ms at a fixed position on the left side of the screen, indicating the position of the first word of the sentence. During presentation of a sentence, eye positions were sampled every 2 ms. Participants controlled the presentation time of a sentence by clicking a button to go to the next sentence.

Results

We analysed reading times on the target word in each sentence, as well as skipping rates for target words that were not fixated upon the first reading of a sentence. Reading times were analysed based on fixations in selected areas of interest that covered the target words. Sampled *x*- and *y*-coordinates for fixations on target words were first converted with an IDF converter and were analysed using in-house software based on an algorithm with fixed parameters for duration and dispersion to determine fixations. Fixations had a minimal duration of 100 ms (based on Rayner, 1998) and a maximal dispersion of 1° visual angle. We used four different measures of fixation duration: first-fixation duration (FFD), the length of time the eyes fixate on the target word the first time they land on it, prior to any regressions to that word; first-pass reading time (FPRT), the sum of all fixation durations during the first reading of a word, including any regressions made within the word; regression path time (RPT), the sum of fixations on a target word including all regressions to previous words until a rightward saccade past the target word has been made; and total reading time (TRT), the total sum of all fixations and refixations on the target word. These measures are commonly used in eye-tracking studies of sentence reading and are thought to reflect different stages of lexical access (see e.g., Duyck et al., 2007; Libben & Titone, 2009).

Prior to analyses, performance on the comprehension questions was analysed. Overall, accuracy was high ($M = 89\%$, $SD = 8$). The data of one participant were excluded because her mean accuracy score was at chance level. We also excluded the data of two participants whose reading time measures were more than 2.5 standard deviations above the participant group mean, and one participant whose skipping rate was more than 2.5 standard deviations above the mean. We also deleted outlier items with reading times that were more than 2.5 standard deviations above the item means (one noun and three verb items). These sentences as well as their counterparts (either cognate or control) were excluded from the dataset; one more item pair had to be discarded because of a problem in the analysis file (discarded items are marked Appendix A). Excluding these items did not affect the matching of the items (all *p*s > .1). In the end, the data of 33 participants on 48 sentences were included in the analyses. For the reading time analyses, a further 6.73% of the data was discarded due to skipping, leaving 1448 data points. All four reading time measures—that is, first-fixation duration, first-pass reading time, regression path time, and total reading time—were log transformed to correct for non-normal distributions.

Reading time measures and skipping rates were analysed using linear mixed effects models that included participant and item as random intercepts in order to control for highly variable reading patterns for individuals and items, as well as random slopes based on the predictor of L2 proficiency (Baayen, 2008). Models were fitted to the measures of first-fixation duration, first-pass reading time, regression path time, total reading time, and skipping rates, for which we considered effects of the manipulated factors of word class (noun or verb), cognate status, and two measures of L2 proficiency. The effect of cognate status was analysed based on Van Orden's (1987) orthographic similarity measure, a continuous measure ranging from 0 (no similarity) to 1 (identical), henceforth referred to as orthographic similarity. L2 proficiency was expressed by self-ratings of reading proficiency in L2 on a 7-point scale (see also Table 3). In an additional model, we replaced the self-ratings of L2 proficiency by L2 reading speed. We first considered self-ratings as a proficiency measure and then analysed the effect of reading speed.

Table 3. *Distribution of self-ratings for reading proficiency in L2*

Self-rating	*No. of participants*
3	6
4	4
5	11
6	10
7	2

Note: 7 = native-like. L2 = second language.

Analyses were performed on the overall dataset, followed by separate analyses for the noun and verb data. Reported models were trimmed by removing data points with standardized residuals exceeding 2.5 standard deviations. Fixed effects of the models are summarized in Tables 4, 5, 6, and 7. Effects of all predictors were additionally tested by means of analyses of variance over the models, which are reported in the text. An overview of the means by word class and condition is given in Table 8.

Self-rated L2 proficiency

The outcomes of the models on the combined dataset of nouns and verbs can be found in Table 4. Analyses of variance showed significant main effects of word class for first-fixation duration, $F(1, 1421) = 26.74$, $p < .001$, first-pass reading time, $F(1, 1424) = 21.03$, $p < .001$, regression path time, $F(1, 1413) = 4.28$, $p < .05$, and total reading time, $F(1, 1427) = 7.59$, $p = .01$, indicating that nouns were read faster than verbs, in terms of both early and later measures (see also Table 8). In spite of these results, the predictor "word class" made no significant contribution to the models reported in Table 4, which can result from a difference in assigning variance between the two analysis methods. The effect of self-rated L2 proficiency was significant for first-fixation duration, $F(1, 1421) = 11.45$, $p < .001$, and first-pass reading time, $F(1, 1424) = 5.04$, $p < .05$, showing that reading times decreased for more proficient L2 readers. Furthermore, the analysis of the first-pass reading times showed an interaction between word class and self-rated L2 proficiency, $F(1, 1424) = 4.66$, $p < .05$, which indicated that processing of verbs was more influenced by L2 proficiency than processing of nouns. Analyses of variance showed no effects of L2 proficiency on later reading times, indicated by nonsignificant effects of L2 proficiency for regression path time ($F < 1$) and total reading time, $F(1, 1427) = 2.46$, $p = .12$, although the model did indicate marginally

Table 4. *Fixed effects of the linear mixed effect models for reading time measures on target words*

Variable	*Estimate*	SE	t *value*
FFD			
(Intercept)	5.53	0.09	58.24
Word class	−0.03	0.11	−0.31
Orthographic similarity	−0.04	0.11	−0.37
Self-rated L2 proficiency	−0.04	0.02	−2.27
Word class × Orthographic Similarity	0.54	0.21	2.60
Word class × Self-Rated L2 Proficiency	0.02	0.02	1.14
Orthographic Similarity × Self-Rated L2 Proficiency	0.00	0.02	0.19
Word Class × Orthographic Similarity × Self-Rated L2 Proficiency	−0.11	0.04	−2.64
FPRT			
(Intercept)	5.77	0.14	41.06
Word class	0.14	0.15	0.94
Orthographic similarity	−0.24	0.15	−1.60
Self-rated L2 proficiency	−0.06	0.03	−2.02
Word Class × Orthographic Similarity	0.41	0.28	1.49
Word Class × Self-Rated L2 Proficiency	0.00	0.03	0.11
Orthographic Similarity × Self-Rated L2 Proficiency	0.05	0.03	1.66
Word Class × Orthographic Similarity × Self-Rated L2 Proficiency	−0.09	0.05	−1.75
RPT			
(Intercept)	5.97	0.17	34.55
Word class	−0.19	0.19	−0.98
Orthographic similarity	−0.50	0.19	−2.57
Self-rated L2 proficiency	−0.06	0.03	−1.80
Word Class × Orthographic Similarity	0.86	0.35	2.48
Word Class × Self-Rated L2 Proficiency	0.05	0.04	1.32
Orthographic Similarity × Self-Rated L2 Proficiency	0.09	0.04	2.37
Word Class × Orthographic Similarity × Self-Rated L2 Proficiency	−0.17	0.07	−2.49
TRT			
(Intercept)	6.19	0.22	27.86
Word class	0.05	0.20	0.24
Orthographic similarity	−0.26	0.20	−1.33
Self-rated L2 proficiency	−0.08	0.04	−1.82
Word Class × Orthographic Similarity	0.26	0.36	0.72
Word Class × L2 Proficiency	0.02	0.04	0.42
Orthographic Similarity × Self-Rated L2 Proficiency	0.05	0.04	1.40
Word Class × Orthographic Similarity × Self-Rated L2 Proficiency	−0.06	0.07	−0.90

(*Continued overleaf*)

Table 4. Continued.

Note: FFD = first-fixation duration; FPRT = first-pass reading time; RPT = regression path time; TRT = total reading time; L2 = second language. L2 proficiency refers to self-rated reading proficiency in L2.

Table 5. *Fixed effects of the linear mixed effect models for reading time measures on nouns*

Variable	*Estimate*	SE	t *value*
FFD			
(Intercept)	5.54	0.10	55.16
Orthographic similarity	−0.03	0.11	−0.26
L2 proficiency	−0.05	0.02	−2.41
Orthographic Similarity × L2 Proficiency	0.002	0.02	0.08
FPRT			
(Intercept)	5.75	0.14	40.96
Orthographic similarity	−0.25	0.15	−1.74
L2 proficiency	−0.05	0.03	−1.82
Orthographic Similarity × L2 Proficiency	0.05	0.03	1.82
RPT			
(Intercept)	5.93	0.18	33.43
Orthographic similarity	−0.43	0.19	−2.21
L2 proficiency	−0.05	0.03	−1.52
Orthographic Similarity × L2 Proficiency	0.08	0.04	2.03
TRT			
(Intercept)	6.13	0.23	27.20
Orthographic similarity	−0.19	0.19	−0.97
L2 proficiency	−0.07	0.04	−1.56
Orthographic Similarity × L2 Proficiency	0.04	0.04	1.08

Note: FFD = first-fixation duration; FPRT = first-pass reading time; RPT = regression path time; TRT = total reading time; L2 = second language. L2 proficiency refers to self-rated reading proficiency in L2.

significant effects of this predictor for both measures ($t = -1.80$ and $t = -1.82$ for regression path time and total reading time respectively). There were no main effects of orthographic

Table 6. *Fixed effects of the linear mixed effect models for reading time measures on verbs*

Variable	*Estimate*	SE	t *value*
FFD			
(Intercept)	5.52	0.13	43.24
Orthographic similarity	0.49	0.18	2.66
L2 proficiency	−0.02	0.02	−0.96
Orthographic Similarity × Self-Rated L2 Proficiency	−0.10	0.04	−2.89
FPRT			
(Intercept)	5.92	0.15	39.54
Orthographic similarity	0.15	0.23	0.62
L2 proficiency	−0.06	0.03	−1.82
Orthographic Similarity × Self-Rated L2 Proficiency	−0.04	0.04	−0.93
RPT			
(Intercept)	5.78	0.19	30.78
Orthographic similarity	0.389	0.28	1.40
L2 proficiency	−0.01	0.04	−0.32
Orthographic Similarity × Self-Rated L2 Proficiency	−0.08	0.05	−1.59
TRT			
(Intercept)	6.19	0.23	26.70
Orthographic similarity	0.06	0.30	0.20
L2 proficiency	−0.05	0.04	−1.18
Orthographic Similarity × Self-Rated L2 Proficiency	−0.03	0.06	−0.46

Note: FFD = first-fixation duration; FPRT = first-pass reading time; RPT = regression path time; TRT = total reading time; L2 = second language.

Table 7. *Fixed effects of the linear mixed effect models for skipping rates*

Variable	*Estimate*	SE	t *value*
Overall			
(Intercept)	0.21	0.08	2.73
Word class	−0.21	0.10	−2.13
Orthographic similarity	−0.15	0.10	−1.56
L2 proficiency	−0.03	0.02	−1.66
Word Class × Orthographic Similarity	0.18	0.18	0.98
Word Class × Self-Rated L2 Proficiency	0.04	0.02	2.11
Orthographic Similarity × Self-Rated L2 Proficiency	0.04	0.02	1.99
Word Class × Orthographic Similarity × Self-Rated L2 Proficiency	−0.05	0.03	−1.30
Nouns			
(Intercept)	0.22	0.09	2.56
Orthographic similarity	−0.16	0.10	−1.51
Self-rated L2 proficiency	−0.03	0.02	−1.58
Orthographic Similarity × Self-Rated L2 Proficiency	0.04	0.02	1.90
Verbs			
(Intercept)	−0.03	0.07	−0.37
Orthographic similarity	0.05	0.14	0.35
Self-rated L2 proficiency	0.02	0.01	1.36
Orthographic Similarity × Self-Rated L2 Proficiency	−0.01	0.03	−0.46

Note: L2 = second language.

similarity (see Table 4), but three-way interactions between word class, L2 proficiency, and orthographic similarity were observed for first-fixation duration, $F(1, 1421) = 6.95, p < .05$, and regression path time $F(1, 1413) = 6.22$, $p < .05$. The interaction was marginally significant for first-pass reading time, $F(1, 1424) = 3.08$, $p = .08$. The three-way interaction was followed up by separate analyses for the nouns and verbs that are reported below. In addition, the model reported in Table 4 showed significant two-way interactions between word class and orthographic similarity for first-fixation duration ($t = 2.60$) and regression path time ($t = 2.48$), as well as a main effect of orthographic similarity ($t = -2.57$) and an interaction between orthographic similarity and L2 proficiency ($t = 2.37$) for regression path time, which were not significant in the analyses of variance.

The fixed effects of the separate models regarding nouns can be found in Table 5. Analyses of variance showed a main effect of self-rated L2 proficiency for first-fixation duration, $F(1, 785) = 7.84$, $p < .05$, in the same direction as the overall results. There were no significant effects of self-rated L2 proficiency on the other measures, but the model indicated a trend towards significance for first-pass reading time ($t = -1.82$). Cognate facilitation effects were only observed in interaction with self-rated L2 proficiency. First-pass reading times revealed a marginally significant interaction between orthographic similarity and reading speed, $F(1, 783) = 3.33$, $p = .07$, which was significant for regression path time, $F(1, 778) = 4.11$, $p < .05$. This indicated that cognate facilitation was reduced for participants who gave higher self-ratings for their reading proficiency in L2 (see Figure 1). Although the model on

Table 8. *Means across word classes and cognate status and cognate facilitation for all reading time measures*

	Nouns			*Verbs*		
Reading time measure	*Noncognate*	*Cognate*	*Facilitation*	*Noncognate*	*Cognate*	*Facilitation*
FFD	214 (72)	211 (66)	3	236 (87)	237 (90)	−1
FPRT	273 (136)	265 (122)	8	308 (143)	307 (143)	1
RPT	372 (316)	348 (262)	24	365 (257)	367 (248)	−2
TRT	417 (279)	379 (216)	38	446 (286)	440 (272)	6

Note: Standard deviations in parentheses. Reading time measures in ms. FFD = first-fixation duration; FPRT = first-pass reading time; RPT = regression path time; TRT = total reading time.

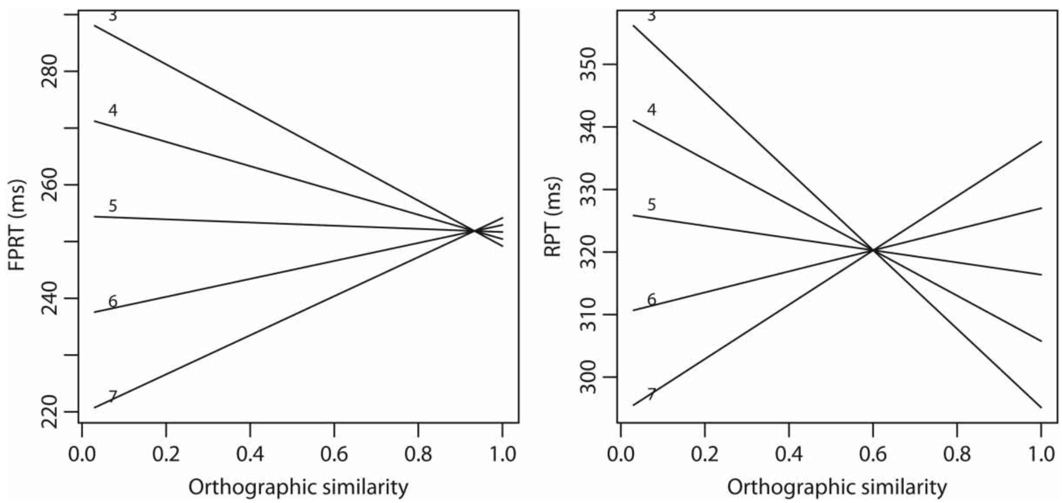

Figure 1. *Effect of orthographic similarity for first-pass reading times (FPRTs) and regression path times (RPTs) of nouns according to self-rated reading proficiency in second language (L2; 7 = native-like proficiency).*

regression path times also indicated a main effect of orthographic similarity ($t = -2.21$), this was not significant in the analyses of variance. In spite of substantial numeric differences between cognates and noncognates, there was no effect of orthographic similarity for total reading times, which can be explained by a substantial amount of variance in the data (see Table 8).

Fixed effects for the separate verb analyses are reported in Table 6.] Analyses of variance showed an effect of self-rated L2 proficiency for first-fixation duration, $F(1, 638) = 9.91$, $p < .01$, and first-pass reading time, $F(1, 636) = 7.85$, $p = .01$, indicating faster reading times for more proficient L2 readers. Neither of these effects was significant as fixed effects in the model (see Table 6). There were also no significant main effects of L2 proficiency for regression path time, $F(1, 634) = 2.16$, $p = .14$, and total reading time, $F(1, 636) = 2.67$, $p = .10$. An interaction between orthographic similarity and L2 proficiency was present only for first-fixation duration, $F(1, 638) = 8.37$, $p < .01$. This effect went in the opposite direction to the noun effect and showed that more cross-linguistic overlap induced faster reading times only when participants were more proficient in L2 (see Figure 2).

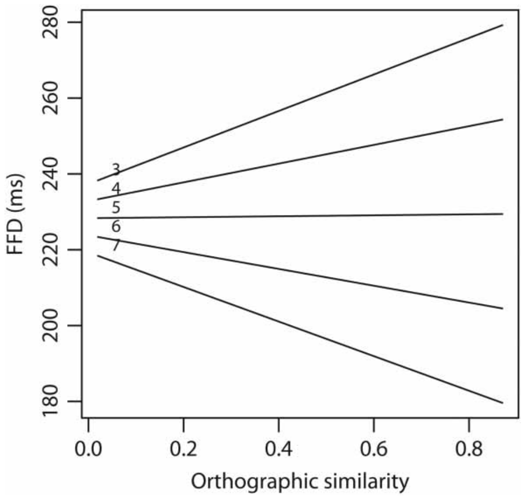

Figure 2. *Effect of orthographic similarity for first-fixation duration (FFD) of verbs according to self-rated reading proficiency in second language (L2; 7 = native-like proficiency).*

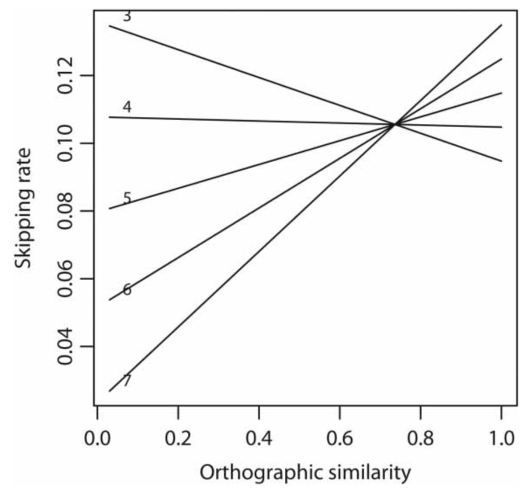

Figure 3. *Effect of orthographic similarity for skipping rates according to self-rated reading proficiency in second language (L2) for noun targets. Skipping rate is given as a value between 0 and 1.*

The main effect of orthographic similarity for first-fixation duration was not significant in the analyses of variance ($F < 1$).

Skipping rate analyses

The overall analysis on the proportion of skipped target words showed an effect of word class, $F(1, 1572) = 4.02$, $p = .05$. Nouns ($M = 9.80\%$, $SD = 29.76$) were more often skipped than verbs ($M = 6.49\%$, $SD = 24.66$). The model (see Table 7) also showed an interaction between word class and self-rated L2 proficiency ($t = 2.11$), showing higher skipping rates for more proficient readers for verbs, but the opposite pattern for nouns, and a marginally significant interaction between orthographic similarity and self-rated L2 proficiency ($t = 1.99$), none of which were significant in the analyses of variance. Analyses of variance over the separate analyses for the nouns and verbs (see also Table 7) showed a marginally significant interaction between self-rated L2 proficiency and orthographic similarity, $F(1, 833) = 3.61$, $p = .06$ for nouns, which was not present for verbs ($F < 1$). Overall, cognate nouns ($M = 10.76\%$, $SD = 31.01$) were skipped more often than noncognate nouns ($M = 8.89$, $SD = 28.49$). The interaction effect for nouns reflected that more proficient L2 readers skipped nouns more often in case of more cross-linguistic orthographic similarity, whereas less proficient L2 readers had high skipping rates for words with high and low orthographic similarity (see Figure 3).

L2 reading speed

In the other model, we examined the effect of L2 reading speed as an expression of L2 reading proficiency. Only the analyses of variance are reported here. The model including word class, orthographic similarity, and L2 reading speed showed significant effects of word class for first-fixation duration, $F(1, 1421) = 26.75$, $p < .001$, first-pass reading time, $F(1, 1423) = 20.79$, $p < .001$, regression path time, $F(1, 1409) = 4.04$, $p < .05$, and total reading time, $F(1, 1426) = 7.57$, $p < .05$, in the same direction as the model with self-rated L2 proficiency. Similarly, a main effect of L2 reading speed was observed for first-fixation duration, $F(1, 1421) = 3.63$, $p = .06$, first-pass reading time, $F(1, 1423) = 23.26$, $p < .001$, regression path time, $F(1, 1409) = 14.22$, $p < .001$, and total reading time, $F(1, 1426) = 44.94$, $p < .001$. For all reading time measures, fixation durations were shorter when average reading speed was faster. The model showed no interactions with word class, and no cognate effects, although a trend towards an interaction between L2 reading speed and Van Orden's (1987) orthographic similarity was present at first-pass reading times, $F(1, 1423) = 2.84$, $p = .09$, suggesting a cognate facilitation effect for slower readers. Skipping data showed a significant main effect of word class, $F(1, 1572) = 4.12$, $p < .05$, with more skips for nouns than for verbs, as well as an interaction between word class and reading speed, $F(1, 1572) = 4.51$, $p < .05$, indicating that differences in reading speed only affected reading times of nouns, but not those of verbs. Because there were no interactions between word class and cognate status, the noun and verb data were not analysed separately.

Discussion

The eye-tracking data of Experiment 1 revealed an effect of word class on reading: Nouns were read faster than verbs and were skipped more often, which replicates earlier findings in the monolingual (Gentner, 1981; Tyler et al., 2001) and bilingual (e.g., Baayen, McQueen, Dijkstra, & Schreuder, 2003; Bultena et al., 2012; Van Hell & De Groot, 1998) domains, suggesting that noun processing is easier than verb processing. The word class effect was present in both early and late measures of reading times. This supports the view that nouns and verbs are processed differently in a sentence, implying that the recognition of a word's syntactic properties occurs at an early stage in word recognition. It should be noted that, in spite of matching, part of the effect may be due to the (inevitably) slightly longer length of the verbs than of the nouns (see Table 2).

Furthermore, the data suggested differences between nouns and verbs with regard to cognate effects. The reading times for verbs showed little cognate facilitation. Only first-fixation durations showed a proficiency-dependent effect, indicating facilitation for more proficient L2 readers. Other reading time measures and skipping rates indicated that cognate and noncognate verbs were processed equally fast by the Dutch–English bilinguals, suggesting that verb processing is more language specific. The noun data yielded proficiency-dependent cognate facilitation effects for first-pass reading time and regression path time. These noun facilitation effects were shown to be smaller for bilinguals who were more proficient in L2. A proficiency modulation in the opposite direction was observed in skipping rates, showing more facilitation for more overlapping noun cognates for more proficient L2 readers. Although more and less proficient readers differed in reading speed, they did not differ in the proportion of skipped target words. This result indicates that reading patterns of more proficient readers are still subject to cognate manipulation, but at a different level. Whereas less proficient, slower, readers showed an effect in reading times, more proficient, faster, readers showed an effect in skipping rates.

These data provide limited evidence for verb cognate effects. The effect observed for more proficient readers at first-fixation duration was not present in any of the other measures, and, moreover, no cognate effect was found for nouns at this measure. The lack of a robust cognate facilitation effect for verbs is similar to recent findings by Van Assche, Duyck, and Brysbaert (2013). In an eye-tracking study with a similar set-up to that of the present study, they examined processing of verb cognates in sentence context. Reading times in this study showed a small cognate facilitation effect only at go past times, a later measure, which the authors related to processing of shared semantics. In the present study, however, we could not replicate this later measure effect.

The finding that form overlap with an L1 translation equivalent speeded up lexical access for noun cognates is comparable to other eye-tracking studies with similar set-up and stimulus materials (e.g., Duyck et al., 2007; Van Assche et al., 2009, 2011). The present findings extend previous data by showing that cognate facilitation effects in sentence context were modulated by L2 reading proficiency. The results showed that noun cognate facilitation is reduced when reading proficiency is higher. This is in agreement with findings by Libben and Titone (2009), who reported smaller cognate facilitation for bilinguals who were more proficient in their L2. Similar to the Libben and Titone study in which L2 proficiency ratings and the difference between L1 and L2 reading speed were shown to be correlated, analyses showed that L2 reading speed correlated with self-rated reading proficiency in our study, $r(32) = -.45$, $p < .05$, indicating that faster readers rated themselves as being more proficient. This indicates that the two measures reflected a common aspect related to L2 proficiency.

We note that noun cognate effects were not obtained for all reading time measures. The data showed no effects of cognate facilitation in terms of first-fixation duration and total reading time. The latter measure was subject to large individual variations in our dataset (see Table 8), which can explain why the effect was not significant. The difference between cognates and noncognates for the first-fixation durations (3 ms) was too small to become significant. Furthermore, it may well be that the reading times of this measure are at ceiling. In comparison to previous eye-tracking studies testing noun cognates in sentence context (see Appendix B), the reading times in our eye-tracking data are quite fast. The overview of fixation durations and effects sizes (see Appendix A) indicates that reading times for both early and late measures are substantially faster than those of studies that are otherwise very similar regarding stimulus materials, including the study by Van Assche et al. (2011) that also included nonidentical cognates in low-constraint sentences. Reading speed determines how much information is encoded in each fixation (e.g., Jackson & McClelland, 1975), and it has been shown previously that processing times can become too fast to show facilitation effects (Dell & O'Seaghdha, 1992). The reason for the fast reading times cannot easily be ascribed to methodological or analytical differences across studies. Similar to other studies, reading times below 100 ms were not included in the analyses of our study, and items across studies were comparable in terms of frequency and length. It must be noted that numeric effects in both our study and that by Van Assche et al. (2011), who did find a general cognate facilitation effect, were rather small, implying that the effect may be dependent on sample size.

The eye-tracking data pointed to a large degree of variation in the data as a consequence of individual differences in reading proficiency in L2. In order to examine the role of task demands in proficiency-modulated cognate effects, we tested the same materials using a self-paced reading paradigm. By comparing the findings of two reading paradigms, we tested whether task demands influenced effects of L2 proficiency and cross-linguistic activation. In the second experiment, we also included an additional proficiency measure, vocabulary size, to further validate the L2 proficiency measures.

EXPERIMENT 2: SELF-PACED READING

Method

Participants

Thirty-eight Dutch–English bilinguals (7 males), students drawn from the same Radboud University Nijmegen participant pool as that used in Experiment 1, took part in the experiment. The participants were between 18 and 29 years of age ($M = 22.11$, $SD = 2.59$), and all were native speakers of Dutch who had learned English at school as an L2, starting around the age of 10 ($SD = 2.81$). Their mean score on the English version of LexTALE (Lemhöfer & Broersma, 2011) was 77.88 ($SD = 11.30$), which indicates that they were highly proficient learners of English. This validated task assesses a learner's proficiency in English based on vocabulary knowledge and is specifically aimed at advanced learners such as the participants used in this experiment. Participants self-rated their English proficiency on a 7-point Likert scale (7 = native-like) on reading ($M = 4.8$, $SD = 1.0$), writing ($M = 4.3$, $SD = 1.3$), and speaking ($M = 4.6$, $SD = 1.5$). Thirteen participants indicated to have lived in an English-speaking country, to have taken part in bilingual education, or to have studied English. None of the participants reported any reading problems. Participants were paid a small amount of money or received course credit for their participation.

Stimulus materials

The materials were identical to those used in the eye-tracking experiment.

Procedure

Participants were tested individually on a Windows XP Intel® Pentium® 4CPU computer with a 17-inch Philips 107MB monitor (1280 × 1024 pixels, 60-Hz refresh rate). The experiment was designed and run with Presentation® software (www.neurobs.com), which measured reaction times (RTs) via a button box. Participants were seated at approximately 50 cm from the computer screen.

Prior to the start of the self-paced reading task, participants performed the LexTALE task and received English instructions on the computer screen, which encouraged them to read silently at a normal pace that allowed them to answer comprehension questions. The instructions emphasized using the index finger of their dominant hand to push the button to initiate presentation of the next word. The experiment started with 12 practice sentences.

Sentences were aligned to the middle of the screen in a white 16-point Courier New font to a black background. Sentences were presented using a noncumulative self-paced reading variant of the moving window paradigm (Just, Carpenter, & Woolley, 1982), meaning that each sentence was presented word by word controlled by the participant. Sentences were initially dashed, with each dash corresponding to a letter on the screen (e.g., ___ _______ for "the parents"). By indicating the number of words, letters, and spaces, the actual reading pattern was preserved as much as possible. When a participant clicked a button, a dashed word changed into the first word of the sentence; upon the next click, the next word was revealed while the first word changed back into its dashed form. Reading times for each word were measured from the moment a word was displayed until the participant pushed the button.

Results

Reading times of the target word in each sentence were analysed. Prior to the analyses, performance on comprehension questions was examined. Overall, accuracy rates were high ($M = 91.32\%$, $SD = 5.95$). The data of three participants were excluded because they made more than 20% errors on the comprehension questions. We excluded the data of one other participant whose reading times were more than 2.5 standard deviations above the participant group mean. Furthermore, we considered outliers among the items and excluded one noncognate control item and its matched cognate (marked Appendix A), because the mean reading time for the control item was more than 2.5 standard deviations above the item mean. Excluding this item pair did not affect the matching (all ps $> .1$). In the end, we analysed the data of 34 participants for 52 sentences (1768 data points). Reading times of the target word were log-transformed to correct for non-normal distributions. All results reported below are the outcomes of the best fitting models, which were trimmed by removing data points with standardized residuals exceeding 2.5 standard deviations.

Reading times were again analysed using linear mixed effects models including participant and item as random intercepts and L2 proficiency predictors as random slopes. Similar to Experiment 1, we tested for effects of word class, orthographic similarity, and two measures of L2 proficiency. Cognate effects were assessed based on the Van Orden (1987) measure of orthographic similarity, and self-ratings of L2 reading proficiency were used as an indication of L2 proficiency. We also examined the effect of L2 reading speed in a separate model. We first considered the combined data set including both nouns and verbs, followed by separate analyses of the noun and verb data. Analysis procedures were similar to those in Experiment 1.

Correlations of L2 proficiency

To validate the measures of L2 proficiency, we looked at correlations between self-ratings, reading speed, and the vocabulary measure. A person's average reading speed was based on their reading times for all lexical items in the sentences. Significant correlations between the mean reading speed per participant and the LexTALE proficiency measure, $r(34) = -.51$, $p < .01$, indicated that participants with a higher reading speed scored higher on the vocabulary task. The LexTALE score also correlated with the measure of self-rated L2 reading proficiency as assessed by the language background questionnaire, $r(34) = .42$, $p < .05$, showing higher self-ratings for those with a larger vocabulary knowledge. Furthermore, mean reading speed showed a marginally significant correlation with self-rated reading proficiency, $r(34) = -.32$, $p = .069$. This showed that faster readers tended to rate themselves as having a higher reading proficiency in their L2. For reasons of consistency between Experiments 1 and 2, we only included self-ratings and reading speed as proficiency measures and did not consider the vocabulary size measure any further.

Self-rated L2 proficiency

A model was fitted to the target word RTs including factors of word class, cognate status, and self-rated L2 proficiency. Analyses of variance on the target indicated that reading times for nouns ($M = 407$ ms, $SD = 229$) were shorter than those for verbs ($M = 434$ ms, $SD = 199$), and that this difference was significant, $F(1, 1717) = 25.47$, $p < .001$. Furthermore, the main effect of self-rated L2 proficiency was significant, $F(1, 1717) = 4.01$, $p = .05$, showing that target word RTs decreased as proficiency increased. The model showed no cognate effect and no significant interactions between factors. Because no word class modulations were observed, no effort was made to analyse the noun and verb data separately. Given the limited effects in this model, effects are not reported in more detail here.

L2 reading speed

A new model was fitted to the target word RTs, including factors of word class, orthographic similarity, and L2 reading speed. The analyses yielded a main effect of word class, $F(1, 1719) = 26.35$, $p < .001$, similar to the model reported above, and a main effect of L2 reading speed, $F(1, 1719) = 493.97$, $p < .001$, indicating faster reading times on the target word when average reading speed in L2 was faster. Moreover, the model showed an interaction between L2 reading speed and orthographic similarity, $F(1, 1719) = 6.57$, $p < .05$, indicating an effect of cognate facilitation when reading speed was slower.

Separate analyses for the noun and verb data yielded effects that were of a similar nature. The noun model showed a main effect of L2 reading speed, $F(1, 922) = 318.16$, $p < .001$, and a trend towards an interaction between L2 reading speed and orthographic similarity, $F(1, 922) = 3.31$, $p = .07$. Likewise, the verb model showed an effect of L2 reading speed, $F(1, 793) = 235.25$, $p < .001$, as well as an interaction between reading speed and orthographic similarity, $F(1, 793) = 4.49$, $p < .05$. The trend for a main effect of orthographic similarity present in the model was not observed in the analyses of variance, nor in the numeric data (see Tables 9 and 10). All effects went in the same direction as those reported for the nouns and verbs combined, showing more cognate facilitation for the slower readers.

Discussion

Similar to Experiment 1, the self-paced reading data demonstrated that nouns were read faster than verbs. Furthermore, cognate facilitation effects were dependent on L2 proficiency as expressed by reading speed, but not when L2 proficiency was measured by self-ratings. Other than in the first experiment, the proficiency-dependent cognate effect was present for both nouns and verbs.

These data thus indicate that a verb cognate facilitation effect can also be observed in sentence context, which to some extent resembles the findings of other studies (Balling, 2012; Van Assche et al., 2013). The extent to which this effect emerges seems to depend on the task and the measure of L2 reading proficiency. A trend towards a proficiency-dependent cognate facilitation effect was also present for nouns, similar to

Table 9. *Fixed effects of the linear mixed effect models for reading times in the self-paced reading task on the target word*

Variable	*Estimate*	SE	t *value*
Overall			
(Intercept)	4.69	0.08	57.07
Word class	−0.03	0.10	−0.25
Orthographic similarity	.17	.10	1.59
L2 reading speed	0.00	0.00	15.27
Word Class × Orthographic Similarity	0.11	0.19	0.62
Word Class × L2 Reading Speed	0.00	0.00	1.23
Orthographic Similarity × L2 Reading Speed	−0.00	0.00	−1.72
Word Class × Orthographic Similarity × L2 Reading Speed	−0.00	0.00	−0.70
Nouns			
(Intercept)	4.67	0.08	57.12
Orthographic similarity	.17	.10	1.69
L2 reading speed	0.00	0.00	15.10
Orthographic Similarity × L2 Reading Speed	−0.00	0.00	−1.82
Verbs			
(Intercept)	4.64	0.10	46.93
Orthographic similarity	.29	.15	1.90
L2 reading speed	0.00	0.00	13.75
Orthographic Similarity × L2 Reading Speed	−0.00	0.00	−2.12

Note: L2 = second language.

Table 10. *Mean reading times for noun and verb cognates and controls*

Word class	*Noncognate*	*Cognate*	*Facilitation*
Nouns	425 (274)	389 (171)	36
Verbs	436 (200)	432 (198)	4

Note: Reading times in ms.

findings of Experiment 1 and other studies (Duyck et al., 2007; Libben & Titone, 2009; Schwartz & Kroll, 2006; Van Assche et al., 2011; Van Hell & De Groot, 2008).

The main differences between Experiments 1 and 2 pertain to the cognate effect for verbs and the proficiency measure. The self-paced reading task did not replicate the opposite proficiency-modulated cognate effect for verbs, as observed at first-fixation duration in the eye-tracking experiment. In combination with the fact that nouns showed no significant effects of cognate facilitation at first-fixation duration and the pattern observed at later reading time measures for verbs, this finding in the eye-tracking experiment can be considered highly remarkable and possibly spurious.

Although the two proficiency models did not lead to similar outcomes, the self-paced reading experiment replicated the proficiency modulation of noun cognate effects in the eye-tracking experiment. In combination with the observed correlations between the different L2 proficiency measures, this suggests that reading speed is an appropriate measure of reading proficiency in this kind of task. This suggests that reading proficiency is best established in a task-dependent manner. The importance of reading speed in this task can be related to participants' behaviour in performing the task. Self-paced reading may induce a rhythmic pattern in presses, meaning that participants tended to adopt an almost steady pace of clicking through the sentences. This may explain why reading speed had a major influence on the data.

GENERAL DISCUSSION

In recent years, several studies have shown cognate facilitation effects in sentence context irrespective of language (e.g., Van Assche et al., 2009; Van Hell & De Groot, 2008) or even semantic constraint (Van Assche et al., 2011). In doing so, researchers have pushed the limits of the effect, showing that cognate effects arise under a large variety of experimental conditions. The present study shows that there are boundaries to cognate facilitation: Differences in the syntactic class of items and in the bilinguals' L2 reading proficiency modulated cognate facilitation effects. Furthermore, we predicted that task demands would influence the size of cognate facilitation. Two different research techniques, eye-tracking and self-paced reading, showed that cognate facilitation effects were differently modulated by L2 proficiency and task demands for the two word classes. Eye-tracking data showed a proficiency-dependent cognate facilitation effect in early and late reading time measures and skipping rates for nouns, indicating that cognate facilitation was reduced as bilinguals had a higher proficiency in L2, while no clear cognate effects were observed for verbs in sentence context. In self-paced reading times, an effect of cognate facilitation was present for both nouns and verbs for slower readers. In sum, the data indicate that coactivation in sentence context depends on several factors that may reduce cognate facilitation effects. Below we further discuss the role of word class, L2 proficiency, and task demands.

Verb cognate effects

The present results showed that the cognate facilitation effect commonly reported for nouns embedded in a low-constraint sentence context is less strong for verbs. Although the same verb items yielded a cognate effect when presented in a minimally disambiguating phrasal context in a lexical decision task (Bultena et al., 2012), an effect in sentence context only emerged in the less sensitive self-paced reading task, but not in the eye-tracking experiment. This suggests that when reading times were prolonged by the use of a moving window paradigm, there was more room for cognate effects to occur. The reading times in the self-paced reading times most resembled first-pass reading times in nature, but the self-paced reading times were considerably longer and may therefore have provided a larger time window for effects to occur.

Because verb cognate facilitation was not observed as a general effect across both tasks, we can say that the presence of a sentence context did seem to reduce facilitatory processing of verb cognates. This could be explained in terms of semantic integration or syntactic processing associated with verbs embedded in sentences. If the construction of verb semantics is based on the surrounding sentence (see e.g., Taylor et al., 2008), then a context consisting of noncognate content words may exert a more language-specific influence on meaning processing of the verb. Such language-specific information may influence the bilingual processing of verbs. Furthermore, verbs involve syntactic processing, which may be more or less language specific, for example in relation to verb argument structure.

However, as of yet, few studies provide evidence for a language-specific influence of syntactic processing. A recent study by Van Assche, Duyck, and Brysbaert (2013) examining processing of present and past tense verb cognates embedded in an L2 sentence context, showed no influence of verb conjugation on cognate effects. Reading times showed a small facilitatory effect in one eye-tracking measure for verb cognates, the size of which did not differ between present tense and cross-linguistically less overlapping past tenses (Van Assche et al., 2013). Another recent study did point to the influence of syntax as a possibly modulating factor of cross-linguistic activation (Gullifer, Kroll, & Dussias, 2011).

Alternatively, the reduced cognate effect for verbs may be driven by their smaller cross-linguistic orthographic and semantic overlap relative to nouns. Previous studies examining noun cognates have shown that cross-linguistic facilitation, in sentence context in particular, depends on the amount of shared orthography (see Duyck et al., 2007; Van Assche et al., 2009). Although verbs are characterized by less cross-linguistic orthographic similarity (see also Van Assche et al., 2013), verbs may also share fewer semantic features across languages (Van Hell & De Groot, 1998), which could also account for reduced coactivation. It must be noted that the degree of semantic similarity may be strongly related to orthographic similarity, given that a minimal degree of form overlap is required for a semantic effect to occur (see Dijkstra et al., 2010). More form overlap can thus aid the degree to which translation equivalents are considered semantically similar, which suggests that the degree to which cognate representations are shared is influenced by a combination of lexical and semantic connections in the mental lexicon (see Dijkstra et al., 1999). The present data indicate that the degree of form and meaning overlap for verb cognates is smaller than that for noun cognates, such that reading verb cognates embedded in an L2 sentence context does not always yield convergent L1 activation for target words.

L2 proficiency modulation

The reading patterns observed for nouns and verbs indicate more cross-linguistic activation for less proficient L2 readers. These findings extend the correlations observed by Libben and Titone (2009), which showed that noun cognate facilitation effects in L2 sentences decreased with increasing proficiency in L2. This implies that cognate facilitation is in part a result of a difference in relative activation strength of L1 and L2.

The proficiency modulation is further evidence that the cognate facilitation effect is dependent on the relative activation of L1 and L2 representations (Dijkstra & Van Hell, 2003). In localist connectionist models, such as the BIA+ (Bilingual Interactive Activation) model (Dijkstra & van Heuven, 2002), this effect is explained by coactivation of L1 and L2. Upon seeing an L2 cognate, the L1 lexical representation speeds up the activation of the presumably shared semantic representation, which causes cognates to be processed faster than noncognates. Coactivation of cognates depends on the relative resting state activation of lexical items, which determines the speed of lexical access. The relative activation of L2 and L1 representations varies with proficiency in the L2. The less proficient L2 users in the present study benefited more from cross-linguistic overlap, suggesting that the relative activation of L1 representations is higher for these bilinguals. When unbalanced bilinguals process cognates in their weaker L2, lexical access mostly benefits from activation of the stronger L1 representation, meaning that the effect of L1 activation is larger when L2 activation is relatively small. As a bilingual gains more proficiency in the L2, the activation of L2 word forms is speeded up due to more exposure to lexical items in L2, leading to more L2 activation. This means that L1 and L2 representational strength and activation become more similar, and both cognate and noncognate words in L2 are activated faster.

The study also aimed to examine which is an appropriate measure of L2 proficiency in reading. The results of the two tasks suggest that this measure is task dependent. Cognate effects in the eye-tracking study were sensitive to self-rated L2 reading proficiency but not to L2 reading speed, whereas the opposite pattern held for cognate effects in the self-paced reading times. This is discussed in more detail below.

Task dependency

The magnitude of cognate facilitation was sensitive to task demands. The extent to which cognate facilitation effects arise was shown to be task dependent, as indicated by the different findings regarding verb cognate effects in the eye-tracking and self-paced reading experiments. A larger time window due to slower processing seems to give more room for a small (or late) cognate effect to occur. Other studies also suggest that the size of cognate facilitation depends on task-related aspects. A comparison of the average reading times across similar eye-tracking studies shows that the numerical size of the cognate effect is variable (see Appendix A); it partly depends on reading times. As indicated in the overview, the largest numerical effects are found in the studies by Duyck et al. (2007) and by Libben and Titone (2009). These studies also showed the slowest reading times overall, suggesting that longer processing times provide a longer time window for cognate facilitation to arise.

Task demands also determine how precise the measurement is, as reflected by the different influences of L2 proficiency measures between the two tasks. Differences in reading strategies across self-paced reading and eye tracking may explain why different proficiency measures influence lexical processing in the two tasks. Self-ratings of reading proficiency were shown to be a better predictor of reading measured by eye tracking, while reading speed was a better predictor in a task sensitive to pace of responding. Although explanations in this respect are highly speculative, it may be assumed that self-ratings of reading proficiency index the ease of lexical access in natural reading (for a related argument, see Mitchell & Green, 1978), while self-paced reading times are highly sensitive to reading speed. Furthermore, as an anonymous reviewer pointed out, rereadings of the text passages in the eye-tracking paradigm may have influenced the reading speed measure in Experiment 1, which could explain why reading speed had no influence on cognate effects in the eye-tracking measures. This reasoning leads to two conclusions. First, one should be careful in evaluating results involving L2 proficiency differences. Secondly, exploring how proficiency should be defined and measured (at the lexical and/or at other levels of language processing) should be a topic to focus on in future studies.

In conclusion, the present study indicates that coactivation of representations in the target and nontarget languages for cognates in L2 sentence context depends not only on the similarity between lexical representations, but also on syntactic category, proficiency in the L2, and task demands. The presence of a sentence context can restrict cross-linguistic activation for verbs. Also, cognate facilitation in L2 processing decreases with more reading proficiency in L2, but in a way that is sensitive to the task at hand. Furthermore, the size of the effect may be enhanced in particular tasks relative to others. On a methodological level, the present results show that it is important to be careful and cautious when measuring L2 proficiency in different tasks, because different measures may induce different results. On a theoretical level, the present results emphasize the role of individual differences and context in language processing and with respect to cross-linguistic effects.

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APPENDIX A

Stimulus materials (target words are capitalized)

Noun manipulation

1. He convinces her to buy the ART / BED at the department store in town. [kunst / bed]
2. He does not like to talk about the ERROR / DRAMA out of a sense of guilt. [fout / drama]
3. I barely recognized the WITCH/ TITLE on the black and white cover of the magazine. [heks / title]
4. Mary hesitates to show the MOVIE / PHOTO because she is afraid to be laughed at. [film / foto]
5. My uncle calls the EDITOR / MUSEUM to get the announcement on the exhibition. [redacteur / museum]
6. The attorney consults a LAWYER / EXPERT for a detailed opinion on the matter. [advocaat / expert]
7. The boys ask permission to use the SPOON / MOTOR and then suddenly turn around. [lepel / motor]
8. The brothers notice the AUNT / TEXT in the old picture of their grandmother. [tante / tekst]
9.* The builders demolish the WALL / BANK in the old mall that will be renovated. [muur / bank]
10. The buyers accept the RULE / COST imposed by the town's local government. [regel / kosten]
11. The campaigners halt before the WINDOW / STUDENT and do not dare to move further. [raam / student]
12. The children visit the FARM / RACE on their annual outing to Germany. [boerderij / race]
13.* The critics bash the NOVEL / MEDIA for misinterpreting the subject entirely. [roman / media]
14.** The flyers contact their AIRPORT / PARTNER before taking off on a six-hour flight. [vliegveld / partner]
15. The fortune-tellers know the DESTINY / DILEMMA of the wealthy gentleman's fiancée. [lot / dilemma]
16. The governor worries about the SAFETY / STATUS of the big aircraft after the crash. [veiligheid / status]
17. The hostess discovers the LIAR / MENU in the kitchen behind the wall. [leugenaar / menu]
18. The inspectors review the CASE / WEEK thoroughly to pinpoint their mistakes. [zaak / week]
19. The ladies watch the BOTTLE / DETAIL in the cupboard with great interest. [fles / detail]
20. The officers catch the FEAR / HAND of the burglar as he reaches for his knife. [angst / hand]
21. The painting depicts the CITY / BABY from above in a beautiful manner. [stad / baby]
22. The parents are surprised by the FAIRY / CHAOS in their children's bedroom. [fee / chaos]
23. The participants submit the VOTE / FILM for the contest at the festival. [stem / film]
24. The researchers look at the TRIBE / CLOCK from a distance through their glasses. [stam / klok]
25. The residents dislike the PRISON / WINTER for the trouble experienced in the past. [gevangenis / winter]
26. The servant adds the MEAT / WINE to the vegetable mixture and leaves it to simmer. [vlees / wijn]
27. The spectators like the DRESS / STYLE of the young model on the runway. [jurk / stijl]
28. The superiors invite the UNIT / TEAM for a short briefing in the office. [eenheid / team]
29. The wives send a REPLY / PLANT to their sick husbands in the nursery home. [antwoord / plant]

Verb manipulation

1. The bandleaders CHANGE / START the rehearsals for the choir after the disturbance. [veranderen / starten]
2. The blunt shopkeepers TERRIFY / ANALYSE the new customers as they enter the shop. [beangstigen / analyseren]
3.* The brave guards BETRAY / ASSIST the cruel queen of the poor country. [verraden / assisteren]
4. The brown foxes HUNT / BITE the new born chicken in the forest. [jagen / bijten]
5. The careful attendants SHUT / WASH the large office windows in the evening. [dichtdoen / wassen]
6. The courageous knights DESTROY / RESPECT the written commands of the ruler. [vernietigen / respecteren]
7. The determined pupils KNOW / MAKE the extensive recipe for the dish. [weten / maken]
8. The elderly people INJURE / INFECT the grumpy nurse in the hospital. [verwonden / infecteren]
9. The experienced businessmen BORROW / INVEST the required money at the agency. [lenen / investeren]
10. The famous musicians RUSH / SING the loud encore at the venue. [haasten / zingen]
11. The fast neighbours CYCLE / SPRINT from the summit down to the village. [fietsen / sprinten]
12. The fearless boys want to SEDUCE / HINDER the pretty women in the contest. [verleiden / hinderen]
13. The foreign guests CATCH / BREAK the empty plates in the dining hall. [vangen / breken]
14.* The fortunate kids TRY / WIN the delicious pie on the wooden display. [proberen / winnen]
15. The frightened servants BRUSH / ALARM the black horses in the stable. [borstelen /alarmeren]
16. The girls cannot RESIST / SELECT a single fragrance in the drugstore. [weerstaan / selecteren]
17. The girls do nothing but SMILE / DRINK all night while sitting in the corner. [glimlachen / drinken]
18. The hasty waiters CARRY / SERVE the spicy food on a tray. [dragen / serveren]
19. The hikers decided to REMAIN / BEGIN close to home when the weather was bad. [blijven / beginnen]
20. The intelligence agencies TORTURE / SPONSOR the foreign traitor in secret. [martelen / sponsoren]
21. The smart cleaners SOLVE / STEAL the hidden number combination to the locker. [oplossen / stelen]

22. The tidy housekeepers ADD / EAT the healthy vegetables in a hurry. [toevoegen / eten]
23. The tired officers CONFUSE / INSPECT the similar looking cars at the crime scene. [verwarren / inspecteren]
24.* The unemployed parents BUY / SEE the expensive watch at the jewellery store. [kopen / zien]

* = excluded in analyses Experiment 1; ** = excluded in analyses Experiment 2.

APPENDIX B

Table A1. *Comparison of noun cognate effects in eye-tracking studies*

Present study (L2; $N = 37$)										
Measure	Control	Cognate	Facilitation	Items	Control	Cognate				
FFD	214 (72)	211 (66)	3	length	4.9	4.93				
FPRT	273 (136)	265 (122)	8	frequency	1.81	1.85				
RPT	372 (316)	348 (262)	24	NHD	4.24	5.38				
TRT	417 (279)	379 (216)	38	cloze *p*	.02	.03				
Duyck et al., 2007 (L2; $N = 34$)										
Measure	Control	Identical cognate	Facilitation	Control	Near cognate	Facilitation	Items	Control	Identical cognate	Near cognate
FFD	278	249	29	249	252	−3	length	4.67	4	4.9
GD	305	262	43	287	283	4	frequency	1.76	1.88	1.76
CRRT	346	292	54	355	345	10	NHD	7.17	9.8	6.4
							cloze *p*	.005/ .043	.005	.047
Libben and Titone, 2009 (L2; $N = 30$)										
Measure	LC control	LC cognate	Facilitation	HC control	HC cognate	Facilitation	Items	Control	Identical cognate	
FFD	326	307	19	263	229	34	length	6.39	6.39	
FPGD	365	329	36	300	261	39	frequency	1.43	1.49	
GPT	474	388	86	392	385	7	NHD	1.42	1.34	
TRT	600	505	95	464	458	6	cloze *p*	.04/.49	.04/.48	
Van Assche et al., 2011 (L2; $N = 62$)										
Measure	LC control	LC cognate	Facilitation	HC control	HC cognate	Facilitation	Items	Control	Cognate	
FFD	239 (82)	230 (72)	9	228 (72)	219 (70)	9	length	5.22	5.22	
GD	275 (115)	263 (109)	12	253 (101)	240 (96)	13	frequency	1.87	1.85	
GPT	321 (188)	298 (162)	23	287 (157)	270 (143)	17	NHD	4.69	4.41	
							cloze *p*	/.86	/.89	
Van Assche et al., 2009 (L1; $N = 45$)										
Measure	Control	Cognate	Facilitation					Control	Cognate	
FFD	201 (53)	196 (49)	5							
GD	213 (66)	205 (63)	8							
RPT	249 (111)	239 (108)	10				cloze *p*	.029	.024	

Note: L1 = first language; L2 = second language; FFD = first-fixation duration; FPRT = first-pass reading time; GD = Gaze Duration; FPGD = First Pass Gaze Duration; CRRT = Cumulative Region Reading Time; GPT = Go Past Time; NHD = NeighbourHood Density; RPT = regression path time; TRT = total reading time; LC = low-constraint; HC = high-constraint. Reading time measures in ms.