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The masked cognate translation priming effect for different-script bilinguals is modulated by the phonological similarity of cognate words: Further support for the phonological account

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The effect of phonological similarity on L1–L2 cognate translation priming was examined with Japanese–English bilinguals. According to the phonological account, the cognate priming effect for different-script bilinguals consists of additive effects of phonological and conceptual facilitation. If true, then the size of the cognate priming effect would be directly influenced by the phonological similarity of cognate translation equivalents. The present experiment tested and confirmed this prediction: the cognate priming effect was significantly larger for cognate prime-target pairs with high-phonological similarity than pairs with low-phonological similarity. Implications for the nature of lexical processing in same- versus different-script bilinguals are discussed.

Keywords: Cognates; Different-script bilinguals; Masked priming; Phonology.

One important area of study for language researchers concerns the architecture of the bilingual lexicon. A topic of considerable interest is how cognates influence the organisation of this architecture (e.g., Davis et al., 2010; De Groot & Nas, 1991; Duñabeitia, Perea, & Carreiras, 2010; Gollan, Forster, & Frost, 1997; Kim & Davis, 2003; Nakayama, Sears, Hino, & Lupker, 2013; Sánchez-Casas & García-Albea, 2005; Voga & Grainger, 2007). Cognates are translation equivalents (CTEs) in two languages that are similar phonologically (e.g., レモン/remoN/–lemon, for Japanese–English words) and, for languages that employ similar writing systems (e.g., alphabets), are also similar orthographically (e.g., limón–lemon, for Spanish–English words). Noncognates are translation equivalents (NCTEs) in two languages that are not similar either

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phonologically or orthographically (e.g., リンゴ/riNgo/–apple; manzana–apple).

The experimental paradigm used in most of this research has been masked translation priming with a lexical decision task (LDT). In this paradigm, targets in one language (e.g., *LEMON*) are preceded by either their translation equivalents (e.g., *limón*) or unrelated words in the other language (e.g., *perro*). Prime words are presented briefly (40–60 ms) and are forward masked by a pattern mask (######) and backward masked by the targets themselves. Participants are typically unaware of the primes, preventing conscious strategies that may influence responding. For each target, participants respond by deciding whether the target is a real word or not. Typically, responses are significantly faster and more accurate when the targets are primed by translation equivalents than by unrelated words. Moreover, this facilitation effect is significantly larger for CTEs than for NCTEs (e.g., Davis et al., 2010; Duñabeitia et al., 2010; Gollan et al., 1997; Nakayama et al., 2013), a finding referred to as the *cognate priming advantage*. Worth noting, however, is that most of this research employed same-script bilinguals, and therefore CTEs were always orthographically, phonologically and conceptually similar (e.g., the Spanish–English words, *limón–lemon*) whereas NCTEs were only conceptually similar (e.g., *manzana–apple*).

The present study examined the representation of CTEs for Japanese–English bilinguals, bilinguals whose written scripts for their two languages have no orthographic similarity ("different-script" bilinguals). For these bilinguals, CTEs are only phonologically and conceptually similar. Despite the lack of orthographic similarity between CTEs for different-script bilinguals, there is ample evidence that these individuals also show a cognate priming advantage (e.g., Gollan et al., 1997; Nakayama et al., 2013; Voga & Grainger, 2007; but see Kim & Davis, 2003).[1]

One theoretical framework proposed to explain the cognate priming advantage is Voga and Grainger's (2007) *phonological account*. This account assumes that cognate priming is composed of two separate but additive effects: priming due to conceptual similarity and priming due to phonological similarity. Therefore, according to this view, the cognate priming advantage reflects the phonological facilitation available for CTEs but not for NCTEs. Voga and Grainger's experiments with Greek–French bilinguals provided the initial empirical support for the phonological account (their Experiments 2 and 3). Employing an L1–L2 masked priming paradigm, they found that the cognate priming effect was not larger than the noncognate priming effect when using phonologically similar (but conceptually unrelated) control primes for cognate targets. In contrast, when phonologically and conceptually unrelated control primes were used, the standard cognate priming advantage emerged. That is, when the impact of phonological similarity was taken into account, the cognate priming advantage was eliminated. These results are consistent with the view that, at least for these bilinguals, the cognate priming advantage essentially reflects additional phonological facilitation and hence the only difference between the mental representations for CTEs and NCTEs is that the former are phonologically similar whereas the latter are not.

The two languages used by Voga and Grainger (2007), Greek and French, are written in different scripts, and much of the more recent support for the phonological account also comes from studies involving different-script bilinguals. For example, Nakayama, Sears, Hino, and Lupker (2012) reported that lexical decisions to L2-English targets (e.g., SIDE) were significantly facilitated when targets were primed by phonologically similar but conceptually unrelated L1-Japanese primes (e.g. ガイド/gaido/, *guide*) compared to phonologically and conceptually unrelated L1-Japanese primes (e.g. コール/koRru/, *call*). Masked phonological priming has also been observed with Greek–French bilinguals (Dimitropoulou, Duñabeitia, & Carreiras, 2011) and Chinese–English bilinguals (Zhou, Chen, Yang, & Dunlap, 2010). The presence of cross-script masked phonological priming effects supports the phonological account by showing that phonological facilitation is available even when primes and targets are orthographically dissimilar.

Nakayama et al.'s (2012) results provide additional support for the phonological account, as they found that "pure" phonological priming effects and cognate priming effects were differentially sensitive to target frequency and L2-proficiency. Specifically, phonological priming effects were similar regardless of target frequency and L2-proficiency, whereas cognate priming effects, which are claimed to have two sources (phonological and conceptual

[1] The absence of a cognate priming advantage in Kim and Davis's (2003) experiment could be in part attributed to their use of very high-frequency targets. Nakayama et al. (2013) found that the magnitude of the cognate priming advantage was reduced when proficient bilinguals responded to high-frequency targets. When target words are very easily identified there seems to be little opportunity for phonology to have an effect.

similarity), were significantly larger for low- than high-frequency targets, and for less- than for more-proficient bilinguals.

Nakayama et al.'s (2012) findings generated several additional predictions from the phonological account: (1) if the cognate priming advantage reflects phonological facilitation, then the size of that advantage would likely *not* be affected by target frequency or by L2 proficiency, just like Nakayama et al.'s "pure" phonological priming effects, and (2) if phonological facilitation is insensitive to target frequency and L2 proficiency, then conceptual facilitation must be sensitive to those factors. Hence, cognate and noncognate priming effects would be equally affected by such factors. Nakayama et al. (2013), testing Japanese–English bilinguals, obtained results consistent with these predictions.

In Nakayama et al. (2013, Experiment 1), due to the nature of the Japanese language, cognate primes were, by necessity, always Katakana words, whereas the noncognate primes were, by necessity, always Kanji words. Although this aspect of their experiment appears to be irrelevant based on the current literature (e.g., Nakamura, Dehaene, Jobert, Le Bihan, & Kouider, 2005, 2007; a detailed discussion of this issue is contained in their General Discussion), the use of different scripts made it difficult to completely rule out the possibility that the script type differences may have affected the priming results. To alleviate this concern, Nakayama et al. (2013, Experiment 2) also evaluated the phonological account by adopting a method that does not involve the direct comparison of cognate and noncognate priming effects. Specifically, they tested the phonological account by investigating L2–L1 cognate priming. Previous masked priming studies indicated that noncognate L2 primes do not facilitate L1 target identification with different-script bilinguals in the LDT (e.g., Gollan et al., 1997; Jiang, 1999; Witzel & Forster, 2012, see Schoonbaert, Duyck, Brysbaert, & Hartsuiker, 2009, for a review), suggesting that L2 primes do not facilitate L1 targets at the lexical/conceptual level. On the other hand, previous studies have shown that phonologically similar L2 primes do significantly facilitate L1 target identification with different-script bilinguals (e.g., Dimitropoulou et al., 2011; Zhou et al., 2010, and cf. Duyck, 2005, for similar effects observed with same-script bilinguals). Nakayama et al. hypothesised that if the cognate priming effect is an additive effect of phonological and conceptual facilitation, then there should be significant L2–L1 cognate priming due to phonological similarity, even when conceptually based facilitation does not arise. The results of their Experiment 2 confirmed this prediction. Taken together, Nakayama et al.'s experiments provide strong support for Voga and Grainger's (2007) claim that cognate priming consists of the additive effects of phonological and conceptual facilitation.

The present research

The present research was another examination of the phonological account. In this experiment, we tested a clear prediction derived from the phonological account's assumptions; namely, that the cognate priming effect size will be directly related to the phonological similarity of cognate prime-target pairs. That is, everything else being equal, cognate priming will be significantly larger for phonologically more similar cognate prime-target pairs than for phonologically less similar pairs. Note that by examining only cognates, we were able to use only Katakana primes (as was done in Nakayama et al., 2013, Experiment 2), and therefore avoid any potential issues that may arise when using both Katakana primes for cognate targets and Kanji primes for noncognate targets.

The prediction that phonologically more similar cognate primes will produce larger priming effects than phonologically less similar cognate primes was also tested by Voga and Grainger (2007, Experiment 2), with Greek–French bilinguals. They found that phonologically more similar L1–L2 cognate pairs (93% overlap) produced a larger priming effect (55 ms) than phonologically less similar pairs (55% overlap—45 ms). However, this difference was not evaluated statistically. In addition, because Greek and French words have some orthographic similarity, it is possible that the phonologically more similar pairs also had greater orthographic overlap than the less similar pairs, making it difficult to attribute any priming difference solely to differential phonological similarity. In the present study, this prediction was tested using Japanese–English bilinguals. As Japanese–English CTEs do not have *any* orthographic similarity, they provide a better means for assessing the phonological account's predictions. To our knowledge, this is the first study that examined the effect of phonological similarity on masked cognate translation priming using bilinguals whose languages have completely different scripts.

TABLE 1
Lexical characteristics for high- and low-phonological similarity cognate primes, their control primes and English targets, and the mean phonological similarity ratings (phono-rating) for the two sets of cognate prime-target pairs

	High-phonological similarity cognate pairs			*Low-phonological similarity cognate pairs*			*p-values*	
	Target *LEMON*	*Translation* レモン	*Control* プラザ	*Target* *CABBAGE*	*Translation* キャベツ	*Control* フェンス	*Targets*	*Primes*
Frequency	27.1	8.0	9.4	27.7	12.9	11.3	.93	.26
Length	5.2	3.8	3.7	5.5	3.6	3.6	.31	.62
Ortho N/morae	3.1	3.4	3.5	2.7	3.5	3.4	.66	.83
Concreteness	4.4	5.8	–	4.4	5.8	–	.82	.84
Phono-rating	5.8		–	2.5		–	< .001	

P-values reported on the first four rows are the results of independent groups *t*-tests on the descriptive values for the two sets of English targets (LEMON vs. CABBAGE) and the two sets of cognate translation primes (レモン vs. キャベツ). Within each of the phonological similarity conditions, critical primes and their control primes (e.g., レモン/プラザ and キャベツ/フェンス) were also not significantly different in their word frequencies ($p = .29$ and $p = .48$), lengths ($p = .33$ and $p = 1.0$) and the numbers of morae (both ps = .33).

METHOD

Participants

Thirty-eight Japanese–English bilinguals from Waseda University (Tokyo, Japan) participated in the experiment in exchange for 1000 Yen (~US$10). All participants scored higher than 800 on the Test of English for International Communication (TOEIC; $M = 894$, range = 805–980, possible score range = 10–990). Participants reported that they had studied English for an average of 12.5 years (SD = 4.0).

Stimuli

We defined CTEs as Japanese words and English words that have the same meaning and have obvious phonological similarity to each other. Therefore, the Japanese words used were all Katakana loan words. Initially, phonological similarity ratings for 176 CTEs were collected from 29 proficient Japanese–English bilinguals with L2 proficiency equivalent to that of the participants in the masked priming experiment (all had TOEIC scores higher than 800). None of those individuals participated in the masked priming experiment. Participants were asked to silently read each of the CTE pairs and rate the degree to which they thought the words were phonologically similar, using a scale from 1 (*not at all similar*) to 7 (*extremely similar*).

Based on the phonological similarity ratings, 48 Japanese (Katakana)–English cognate pairs, each of which had a very clear L1–L2 translation correspondence, were selected. Half of the cognate pairs ($n = 24$) were phonologically highly similar (e.g. レモン /remoN/ and LEMON, $M = 5.8$; range 5.4–6.5), and the other half were phonologically less similar (e.g. キャベツ /kjabetu/ and CABBAGE, $M = 2.5$; range 1.3–3.5), $t(46) = 24.18$, $p < .001$.

The two sets of cognate prime-target pairs had similar lexical characteristics (see Table 1). For the high-phonological similarity cognate pairs, Japanese primes had a mean length of 3.8 letters (3.4 moras) and had a mean printed word frequency of 8.0 occurrences per million (Amano & Kondo, 2000). The unrelated Japanese primes selected for these English targets had a mean length of 3.6 letters (3.5 moras) and a mean frequency of 9.4. The unrelated primes were also Katakana cognates but were phonologically and conceptually dissimilar from their targets (e.g., ゴール, /goRru/, goal—LEMON).[2] English targets had a mean length of 5.2 letters and a mean frequency of 27.1

[2] Because Japanese and English words differ in their phonological properties (e.g., Japanese words have mora (CV)-based phonological patterns whereas English words have phoneme-based patterns, and because phonemes that appear to be similar in the two languages can sound differently (such as the consonants *r* and *f*), we used similarity ratings rather than the number of shared phonemes as the index of phonological similarity/dissimilarity for our cognate pairs. We did not collect similarity ratings for our unrelated pairs. However, the unrelated primes were selected to have no mora overlap with their translation primes in the same relative positions, and thus had essentially no phonological similarity with their English targets (see Appendix). That is not to say that these primes and targets never shared a similar phoneme in different positions (e.g., model-BOOM). We do report, for the interested reader, that the average percentage of absolute phoneme overlap was approximately 6.0% within the unrelated prime-target pairs.

(Kućera & Francis, 1967). The mean number of orthographic neighbours for these targets was 3.1.

For the low-phonological similarity cognate pairs, Japanese primes had a mean length of 3.6 letters (3.5 moras) and a mean frequency of 12.9 occurrences per million. The unrelated primes selected for these English targets had a mean length of 3.6 letters (3.4 moras) and a mean frequency of 11.3. The English targets had a mean length of 5.5 letters, a mean frequency of 27.7, and a mean of 2.7 orthographic neighbours.

The low-phonological similarity cognate primes and high-phonological similarity cognate primes were matched on imageability ratings, both M = 5.8 on a 7-point scale (Amano & Kondo, 2000; ratings for two high-phonological similarity cognate primes were not available, therefore the mean is based on 22 items). The English targets in the two conditions were also matched in terms of their concreteness; mean ratings for both were 4.4 on a 5-point scale (Brysbaert, Warriner, & Kuperman, 2014; based on all items). For the cognate prime-target pairs (two sets of 24 cognate pairs), two counterbalanced experimental lists were created. Within each condition, half of the targets were paired with translation primes and the other half with unrelated primes. A target paired with a translation prime in the first list was paired with an unrelated prime in the second list and vice versa.

In addition to the 48 cognate pairs, 48 Japanese Kanji noncognate prime-English-target pairs were used as fillers. These stimuli were included to decrease any focus on phonology that could be created by having a high proportion of phonologically similar prime-target pairs (the inclusion of noncognate fillers does not seem to significantly change the pattern of cognate priming effects, see Nakayama et al., 2012). Lexical characteristics of the noncognate pairs were similar to those for the cognate pairs, including primes' mean word frequency (M = 10.0), primes' number of moras (M = 3.3), targets' letter length (M = 5.4), targets' mean word frequency (M = 26.8) and targets' mean number of neighbours (M = 2.9). One difference was that due to the nature of Kanji words, the mean word length of noncognate primes (M = 1.8) was shorter than for cognate primes (Katakana words). Half of the targets were primed by translation equivalents and the other half were primed by unrelated words. Because we were not investigating noncognate translation priming in the present experiment, Prime Type (translation equivalent vs. unrelated) was not counterbalanced across the noncognate targets, and thus there was only one presentation list for noncognates.

For the "no" responses in the LDT, 96 English nonwords were selected from the English Lexicon Project database (Balota et al., 2007). The mean number of letters and mean number of neighbours for the nonwords were 5.4 and 2.9, respectively. Half of the nonword targets were preceded by Japanese cognate words (Katakana) and the other half were preceded by Japanese noncognate words (Kanji). The Japanese primes were not phonologically similar to the nonword targets. The mean number of letters and mean word frequency of the cognate primes were 3.7 and 9.3, respectively. For noncognate primes the mean number of letters was 1.8 and the mean word frequency was 9.1. There was only one presentation list for the nonword targets.

Apparatus and procedure

Participants were tested individually using the DMDX software package (Forster & Forster, 2003). Each trial began with the presentation of a forward mask (######) for 500 ms followed by a 50 ms presentation of a Japanese prime. Immediately following the prime, an upper-case English target was presented; the target remained on the CRT screen until the response. Participants were instructed to make lexical decisions to the English targets as quickly and accurately as possible by pressing the *yes* or *no* button on a response box. As some primes were longer than their targets, each target was flanked by brackets (>>>> and <<<<) so that the primes were completely masked during target presentation. Each participant completed 16 practice trials (using stimuli not used in the experimental trials) to familiarise themselves with the task prior to the experimental trials.

After the LDT, each participant was presented with a list of all of the cognate translation prime-target pairs (two sets of 24 pairs, n = 48) and the noncognate translation prime-target fillers (n = 24) used in the experiment, and was asked to rate each pair's phonological similarity using a 7-point scale (from 1 = *not at all* to 7 = *extremely similar*). The purpose of this post-experiment rating was to ensure that cognates' phonological similarity was manipulated successfully for the experimental participants (i.e., to confirm that the low-phonological similarity cognate pairs were indeed perceived to be significantly more phonologically similar than the noncognate pairs and significantly less phonologically similar than the high-phonological similarity cognate pairs). Participants were also asked to indicate whether any of the English targets were unfamiliar to them.

RESULTS

Phonological similarity ratings

The phonological similarity ratings from the initial and post-experiment phase were very highly correlated, $r(46) = .97$, $p < .001$. The post-experiment phonological ratings confirmed (see Appendix) that the high-phonological similarity cognate pairs were indeed perceived as more phonologically similar (M = 6.0, range = 5.5–6.6) than the low-phonological similarity cognate pairs (M = 3.9, range = 2.4–4.7), $t(46) = 15.77$, $p < .001$. The low-phonological similarity cognate pairs nevertheless were in turn perceived as more phonologically similar than the noncognate translation equivalent pairs (M = 1.2, range = 1.1–1.5), $t(46) = 21.7$, $p < .001$. This significant difference confirmed that the low-phonological similarity cognate pairs were regarded as cognates, according to our definition, in the present experiment. In the initial ratings of phonological similarity (by the raters who did not participate in the LDT and rated only the cognates), the low-phonological similarity pairs received a noticeably lower similarity rating than in the post-experimental ratings (M = 2.5 vs. 3.9) whereas the ratings for the high-similarity pairs were equivalent in the two situations (M = 5.8 vs. 6.0). Lastly, none of the English target words were reported as being unknown.

Lexical decision data

The data from one participant were removed due to a high error rate (> 20%); this participant was replaced by a new participant. In addition, the data from one target were excluded from all analyses due to a high error rate (>25%). Response latencies beyond the range of 300–1700 ms were replaced with the respective cut-off values (<1.1%). The data were analysed using a 2 (Phonological Similarity: high vs. low) × (Prime Type: translation vs. unrelated) factorial analyses of variance. In the subject analysis (F_s), both factors were within-subject factors; in the item analysis (F_i), Phonological Similarity was a between-item factor and Prime Type was a within-item factor. Mean response latencies and error rates from the subject analysis are shown in Table 2.

There was a significant main effect of Prime Type both for response latencies, $F_s(1, 37) = 47.38$, $p < .001$, MSE = 7248.0; $F_i(1, 45) = 71.23$, $p < .001$, MSE = 2941.5, and errors, $F_s(1, 37) = 19.18$, $p < .001$, MSE = 42.0; $F_i(1, 45) = 12.19$, $p < .001$, MSE = 43.0. Averaging over Phonological Similarity, English targets primed by Japanese cognate primes were responded to significantly faster and more accurately (662 ms vs. 3.5%) than when primed by unrelated primes (758 ms vs. 8.1%), a standard cognate priming effect. The main effect of Phonological Similarity was also significant both for response latencies, $F_s(1, 37) = 47.72$, $p < .001$, MSE = 2694.9; $F_i(1, 45) = 5.83$, $p = .020$, MSE = 13,590.7, and errors, $F_s(1, 37) = 9.58$, $p = .004$, MSE = 55.2; $F_i(1, 45) = 5.70$, $p = .021$, MSE = 68.0. Overall, high-phonological similarity targets were responded to significantly faster and more accurately (681 ms, 3.9%) than low-phonological

TABLE 2

Mean response latencies (RT) in milliseconds and percentage errors for English targets (e.g., LEMON) primed by high-phonological similarity Japanese cognates (e.g., レモン /remoN/) vs. unrelated primes (e.g., プラザ /puraza/, plaza) and for English targets (e.g., CABBAGE) primed by low-phonological similarity Japanese cognates (e.g., キャベツ /kjabetu/) vs. unrelated primes (e.g., フェンス /feNsu/, fense)

	High-phonological similarity cognates		*Low-phonological similarity cognates*	
Prime type	*RT (ms)*	*Errors (%)*	*RT (ms)*	*Errors (%)*
Translation	621	2.2	703	4.8
Unrelated	740	5.7	775	10.5
Priming	119	3.5	72	5.7

For the noncognate fillers the mean response latency was 741 ms and the mean error rate was 11.5%. For the nonword targets the mean response latency was 833 ms and the mean error rate was 8.9%.

similarity targets (739 ms, 7.7%). Critically, the interaction between Phonological Similarity and Prime Type was significant for response latencies, $F_s(1, 37) = 7.83$, $p = .008$, MSE = 2743.3; $F_i(1, 45) = 5.23$, $p = .027$, MSE = 2941.5. The high-phonological similarity pairs produced a significantly larger translation priming effect (119 ms) than the low-phonological similarity pairs (72 ms). Overall, the sizes of cognate priming effects were well within the range of the effects observed previously with Japanese–English bilinguals (Nakayama et al., 2012, 2013). Lastly, no significant interaction was observed for errors, $F_s(1, 37) = 1.49$, $p > .20$; $F_i < 1$.

DISCUSSION

According to the phonological account (Voga & Grainger, 2007), the cognate priming effect is an additive effect consisting of phonological and conceptual facilitation. The phonological account therefore predicts that the magnitude of this effect will be modulated by phonological similarity. To test this prediction, in the present experiment we compared priming effects for CTEs with high-phonological similarity to those having low-phonological similarity. We found that high-phonological similarity cognate pairs produced a 47 ms larger effect than low-phonological similarity cognate pairs, which confirms that the magnitude of the cognate priming effect is modulated by phonological similarity.

One potential counterargument could be that this large priming difference may reflect differences in conceptual relatedness of the two sets of cognate pairs (i.e., the high-similarity cognate pairs were more conceptually similar than the low-similarity cognate pairs). However, there are a number of reasons why that type of explanation is very likely unsustainable. First, the two sets of prime-target pairs had very straightforward translation correspondences, and the post-experiment ratings confirmed that bilinguals knew all of the words. Second, the English target words were matched on semantic concreteness, and the Japanese primes were matched on imageability. Therefore, the semantic richness of the words used was equivalent across the two sets of pairs. Third, there was a significant relationship between the phonological similarity ratings and the size of the facilitation effect, when considering both the initial and the post-experiment ratings ($r = .36$, $p = .014$, $r = .31$, $p = .036$, respectively). Therefore, the most reasonable explanation for the greater priming effect observed for the high-phonological similarity pairs is indeed their greater phonological overlap.

Another point to note is that the phonological account also predicts that the priming effect will be larger for low-phonological similarity cognate pairs than for noncognate pairs. That is, these cognate pairs would still benefit from some phonologically based facilitation, whereas no such facilitation is expected for noncognate pairs. Unfortunately, because we did not counterbalance the presentation of the noncognate pairs, we do not have a pure measure of the priming effect for those pairs. However, the effect size they did produce (51 ms) was quite close to that observed in the Nakayama et al. (2013) experiment (50 ms for low-frequency targets responded to by more proficient bilinguals, a condition similar to that in the present experiment). Both these values are less than the 72-ms effect size observed for the low-similarity pairs in this experiment, which is consistent with the predictions of the phonological account. Of course, what is potentially problematic for this comparison is that the primes for the cognates and noncognates were, of necessity, written in different scripts (Katakana and Kanji, respectively). A better way of examining this prediction would be to use different-script bilinguals whose scripts do not differ for words that are cognates versus noncognates (e.g., Korean–English bilinguals).

The effects of cross-language scripts and the representations of CTEs

As noted, the phonological account has been successful explaining how CTEs are represented in the mental lexicon of different-scripts bilinguals. For same-script bilinguals whose two languages are both alphabetic (e.g., Spanish–English bilinguals), a different account of the cognate priming advantage has been preferred, *the morphological account* (e.g., Davis et al., 2010; Sánchez-Casas & García-Albea, 2005). The morphological account assumes that CTEs, due to their similarity on orthographic as well as phonological and conceptual features, are represented much like within-language morphologically related words are represented, whereas NCTEs are not. That is, CTEs are represented qualitatively differently from NCTEs and it is this special representational status that produces the cognate priming advantage. Therefore, according to the morphological account, the cognate priming effect is *not* just an additive effect of phonological and conceptual facilitation.

Although the morphological account has received empirical support from masked priming studies with same-script bilinguals (e.g., Davis et al., 2010; Sánchez-Casas & García-Albea, 2005, but see Dijkstra, Miwa, Brummelhuis, Sappelli, & Baayen, 2010, who found no support using non-priming paradigms), this account has had some difficulty explaining the cognate priming advantage for different-script bilinguals. As Voga and Grainger (2007, Experiment 1) reported, morphologically related L1–L2 Greek–French primes behaved significantly differently from morphologically related L1–L1 primes. A reasonable implication of this pattern of results is that CTEs are represented differently in the mental lexicons of same-script versus different-script bilinguals.

In light of this possible conclusion, we should note the findings of Davis et al. (2010). Using Spanish–English bilinguals, Davis et al. (Experiment 3) reported that lexical decision latencies to L2 targets (e.g., *TOWER*) were almost identical when the targets were primed by L1 cognates (e.g., *torre*, 570 ms) versus L2 identity primes (e.g., *tower*, 566 ms). These results show that Spanish cognate primes, in spite of their lesser orthographic (49%) and phonological similarity (44%), facilitate English word identification as much as English identity primes (100% phonological and orthographic overlap). This result is similar to that observed in a monolingual morphological priming experiment by Voga and Grainger (2004), who showed that the sizes of within-language morphological priming (measured against form similar control primes) were equivalent for high form similarity pairs and for low form similarity pairs, indicating also that priming based on morphological relations is not sensitive to degrees of form level overlap. This insensitivity to form level similarities contrasts sharply with the results obtained in the present experiment. For Japanese–English bilinguals, a decrease in the phonological similarity of cognate pairs resulted in a smaller priming effect. Although the purpose of the present study was not to contrast the underlying representation of CTEs for same- versus different-script bilinguals, the present results, together with Davis et al.'s results and other results described earlier, have interesting implications for the architecture of the bilingual mental lexicon. That is, the presence or absence of orthographic similarity for CTEs may play a critical role in how CTEs are represented in the bilingual lexicon.

One explanation for this possible qualitative difference for same- versus different-script bilinguals would be based on how orthographic representations are created in the bilingual lexicon. According to the BIA+ model (Dijkstra & Van Heuven, 2002), bilinguals' lexical representations are integrated across languages. Although the BIA+ model does assume that representations of cognates and noncognates are quantitatively, but not qualitatively different, even for same-script bilinguals, in this architecture, CTEs for same-script bilinguals *can* be represented in much the same way as within-language morphologically related words are, because CTEs are essentially orthographically, phonologically, and conceptually analogous to within-language word pairs.[3] For different-script bilinguals, on the other hand, it is clear that the orthographies of the two languages must be represented in a language dependent way. Although previous studies have shown that phonological features are integrated across languages, even for different-script bilinguals (e.g., Nakayama et al., 2012; Zhou et al., 2010), when the orthographic representations of translation equivalents must be represented separately, fully integrated representations of CTEs cannot develop, leading to slightly different representations and, hence, a different pattern of priming effects than that for same-script bilinguals.

CONCLUSION

In the present study, the magnitude of the cognate priming effect was significantly modulated by the cognates' degree of phonological similarity: high-phonologically similar CTEs produced a significantly larger priming effect than low-phonologically similar CTEs. Our results lend support to the phonological account proposed by Voga and Grainger (2007) and add to earlier work which has directly (e.g., Nakayama et al., 2013) or indirectly (e.g., Dimitropoulou et al., 2011; Nakayama et al., 2012; Zhou et al., 2010) supported the existence of additive influences of phonological and conceptual similarity in the

[3] Currently, the BIA+ model does not implement morphological-level representations. A modified model including this representational level has been proposed by Sánchez-Casas and García-Albea (2005). Note that the authors of the BIA+ model specifically deny the idea of shared morphological representations between cognate translation equivalents (Dijkstra et al., 2010; Peeters, Dijkstra, & Grainger, 2013).

cognate priming effects for different-script bilinguals. Our findings also point to the possibility that CTEs are represented differently in the mental lexicons of same- versus different-script bilinguals, a possibility that should be investigated in future research.

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APPENDIX

Japanese cognate primes, their phonological transcriptions, unrelated primes, their phonological transcriptions, English translations and English targets, along with the phonological similarity ratings of the cognate pairs with and without the presence of noncognate (NC) fillers.

			Phonological similarity ratings (critical-target)	
Related prime	*Unrelated prime*	*Target*	*Without NC*	*With NC*
High-phonological similarity cognate pairs				
ビーチ /biRcji/	ワゴン /wagoN/, *wagon*	BEACH	6.2	6.3
ブーム /buRmu/	モデル /moderu/, *model*	BOOM	6.0	6.0
キャンパス /kjaNpasu/	チャーター /cjaRtaR/, *charter*	CAMPUS	5.7	5.9
チャリティー /cjaritiR/	フィクション /fikusjoN/, *fashion*	CHARITY	5.5	5.5
コメディ /komedi/	ニッケル /niQkeru/, *nickel*	COMEDY	5.5	5.8
ナイフ /naihu/	ゴール /goRru/, *goal*	KNIFE	5.7	5.9
ノック /noQku/	ガード /gaRdo/, *card*	KNOCK	5.5	5.8
レモン /remoN/	プラザ /puraza/, *plaza*	LEMON	5.5	5.8
マスク /masuku/	サラダ /sarada/, *salad*	MASK	5.9	5.8
ピーチ /piRcji/	リネン /rineN/, *linen*	PEACH	5.8	5.6
ピクニック /pikuniQku/	ストレッチ /sutoreQcji/, *stretch*	PICNIC	5.8	6.0
パイプ /paipu/	ボール /boRru/, *ball*	PIPE	6.0	6.1
プリンセス /purinsesu/	リサイクル /risaikuru/, *recycle*	PRINCESS	5.4	5.9
ファッション /faQsjoN/	ジェスチャー /zjesucjaR/, *gesture*	FASHION	6.5	6.5
ショック /sjoQku/	チャンス /cjaNsu/, *chance*	SHOCK	5.6	6.1
サイン /saiN/	グラフ /gurahu/, *graph*	SIGN	5.9	5.9
スキー /sukiR/	ムード /muRdo/, *mood*	SKI	5.6	5.7
スキップ /sukiQpu/	リビング /ribiNgu/, *living (room)*	SKIP	6.3	6.2
スープ /suRpu/	アート /aRto/, *art*	SOUP	6.1	6.0
スタンプ /sutaNpu/	モザイク /mozaiku/, *mosaic*	STAMP	6.4	6.6
チキン /cjikiN/	タイツ /taitu/, *tights*	CHICKEN	5.9	6.3
テニス /tenisu/	パネル /paneru/, *panel*	TENNIS	5.8	5.9
メロディー /merodiR/	シャッター /sjaQtaR/, *shutter*	MELODY	5.7	5.6
ゴルフ /goruhu/	エイズ /eizu/, *AIDS*	GOLF	6.2	6.1
Mean phonological similarity rating			5.8	6.0
Low-phonological similarity cognate pairs				
アルコール /arukoRru/	スポンサー /supoNsaR/, sponsor	ALCOHOL	1.9	4.0
アップル /aQpuru/	ブロンズ /buroNzu/, bronze	APPLE	3.3	4.3
ビール /biRru/	シフト /sihuto/, shift	BEER	2.0	3.7
バケツ /baketu/	エリア /eria/, area	BUCKET	2.1	3.8
ボタン /botaN/	スリム /surimu/, slim	BUTTON	2.5	4.1
キャベツ /kjabetu/	フェンス, /feNsu/., fence	CABBAGE	1.9	3.7
チャンネル /cjaNneru/	ギャラリー /gjarariR/, gallery	CHANNEL	2.9	4.4
カオス /kaosu/	ツリー /turiR/, tree	CHAOS	2.6	3.8
コーヒー /koRhiR/	アルバム /arubamu/, album	COFFEE	3.0	4.7
コック /koQku/	ブルー /buruR/, blue	COOK	3.2	4.7
ガラス /garasu/	マーク /maRku/, mark	GLASS	2.3	3.4
ユーモア /juRmoa/	ナンバー /naNbaR/, number	HUMOR	2.9	4.1
ラベル /raberu/	フリー /furiR/, free	LABEL	3.2	4.3
ミサイル /misairu/	スタート /sutaRto/, start	MISSILE	3.5	4.4
オルガン /orugaN/	モノクロ /monokuro/, monochrome	ORGAN	3.4	4.3
ペンキ /peNki/	カール /caRru/, curl	PAINT	1.3	2.4
シャツ /sjatu/	ウォン /woN/, Won (Korean currency)	SHIRT	2.2	3.6
シチュー /sicjuR/	ビジョン /bizjoN/, vision	STEW	2.4	3.9
スタジオ /sutazio/	キッチン /kiQtiN/, kitchen	STUDIO	2.3	3.7
セーター /seRtaR/	プレート /pureRto/, plate	SWEATER	2.5	3.2
テーマ /teRma/	コスト /kosuto/, cost	THEME	1.5	3.0
トイレ /toire/	ゲーム /geRmu/, game	TOILET	3.0	4.6
トンネル /toNneru/	ブロック /buroQku/, block	TUNNEL	2.3	4.2
ウイルス /uirusu/	アピール /apiRru/, appeal	VIRUS	1.9	4.0
Mean phonological similarity rating			2.5	3.9