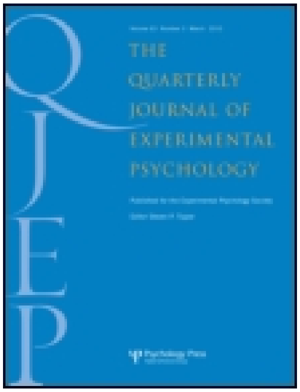

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Homophonic context effects when naming Japanese kanji: evidence for processing costs?

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Homophonic context effects when naming Japanese kanji: evidence for processing costs

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The current study investigated the effects of phonologically related context pictures on the naming latencies of target words in Japanese and Chinese. Reading bare words in alphabetic languages has been shown to be rather immune to effects of context stimuli, even when these stimuli are presented in advance of the target word (e.g., Glaser & Düngelhoff, 1984; Roelofs, 2003). However, recently, semantic context effects of distractor pictures on the naming latencies of Japanese kanji (but not Chinese hànzì) words have been observed (Verdonschot, La Heij, & Schiller, 2010). In the present study, we further investigated this issue using phonologically related (i.e., homophonic) context pictures when naming target words in either Chinese or Japanese. We found that pronouncing bare nouns in Japanese is sensitive to phonologically related context pictures, whereas this is not the case in Chinese. The difference between these two languages is attributed to processing costs caused by multiple pronunciations for Japanese kanji.

Keywords: Phonological context effects; Reading aloud; Language production; Japanese kanji; Chinese hànzì.

Word naming (i.e., reading aloud words) has been intensively studied in recent years, and several models have emerged to explain how word naming is accomplished. The influential dual-route cascading (DRC) model (Colheart, Rastle, Perry, Langdon, & Ziegler, 2001) assumes that

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there are two routes through which a word can be read aloud: the *lexical* and *nonlexical* route. The lexical route can be further divided into two parts: The *lexical nonsemantic* route entails the involvement of the components of the mental lexicon that contains the correct pronunciation of a specific word. The *lexical semantic* route within the DRC involves accessing the word's semantic representation. The *nonlexical* route converts orthographic information ("graphemes") into pronounceable output by means of orthography-to-phonology conversion (OPC) rules. The existence of the OPC route is evidenced by the fact that we can name nonwords such as "DELK", which, by definition, do not have an entry in the mental lexicon. In contrast, words with an "irregular" pronunciation, such as "TWO" /tu/, would have to be looked up in the mental lexicon, as simple conversion would produce overgeneralization errors—that is, /two/.

An influential word-production model that also simulates word naming is WEAVER++ (Indefrey & Levelt, 2004; Levelt, Roelofs, & Meyer, 1999; Roeloefs, 1992, 2006; Roelofs, Meyer, & Levelt, 1996). Regarding the naming of objects, this model distinguishes a number of processing levels including conceptualization, retrieval of syntactic features, phonological word-form encoding, and ultimately articulation. As can be seen from Figure 1, there are three routes to overtly produce a word: (a) the lexical–syntactic route; (b) the lexical–phonological or *direct* route; and (c) the OPC route.

The WEAVER++ model (e.g., Roelofs, 1992, 2006) assumes that to-be-named words automatically activate the lexical–syntactic (Route 1) and lexical–phonological (Route 2) routes in parallel. If the task does not require information at the lexical–syntactic level, the fastest route will determine the reading latencies—that is, Route 2. This entails phonological word form retrieval, syllabification, and ultimately turning syllables into motor action instructions (e.g., overt articulation). However, Route 1 determines reading latencies if the task requires information stored at the lexical–syntactic level. Support for the usage of a direct Route 2 without involvement of Route 1 comes from an observation by Glaser and Düngelhoff (1984). These authors found that semantically related distractor words slowed down picture naming compared to unrelated distractor words, but that the reverse effect was not found: Semantically related distractor pictures did not affect the naming of single words. A simple horse-race explanation for this asymmetry was rejected on the basis of the finding that context pictures did not even affect word naming when presented 400 ms before the target word. This finding suggests that words can be named via a fast route that bypasses the lexical semantic/syntactic level.

Recently, Verdonschot, La Heij, and Schiller (2010) investigated semantic context effects of pictures on naming Japanese kanji and Chinese hànzì words. Japanese kanji form a unique set of words in that over 60% are homographic heterophones, meaning that most kanji have at least two different pronunciations (or readings). This contrasts with most alphabetic languages (and Chinese hànzì) in which the majority of words only have a single pronunciation. The etymology of these multiple readings of Japanese kanji lies in the fact that they were originally imported from China. In those days, not only was the script itself imported but also the Chinese pronunciation of the characters. For instance, the original name for "water" in Japanese is /mizu/ (called the KUN-reading), and the Chinese name for "water" is /shui3/. Over time the Chinese-derived ON-reading in Japanese changed to some extent (e.g., /sui/), but the character for "water" 水 still has two potential readings in modern Japanese —that is, /mizu_{kun}/ and /sui_{on}/, depending on the character it combines with (e.g., 海水 /kai_{on}.sui_{on}/ "seawater" and 雨水 /ama_{kun}.mizu_{kun}/ "rainwater").

In their study, Verdonschot et al. (2010) combined kanji targets with semantically related and unrelated context pictures and found that at two stimulus-onset asynchronies (SOAs) of 0 ms (simultaneous presentation) and –150 ms (context picture first), semantically related distractor pictures shortened word-naming latencies. This result is at variance with both the lack of a picture-context effect in reading Chinese characters and the lack of picture-context effects in naming words in alphabetic languages discussed above (Glaser & Düngelhoff, 1984; Roelofs, 2003, 2006). Verdonschot et al.

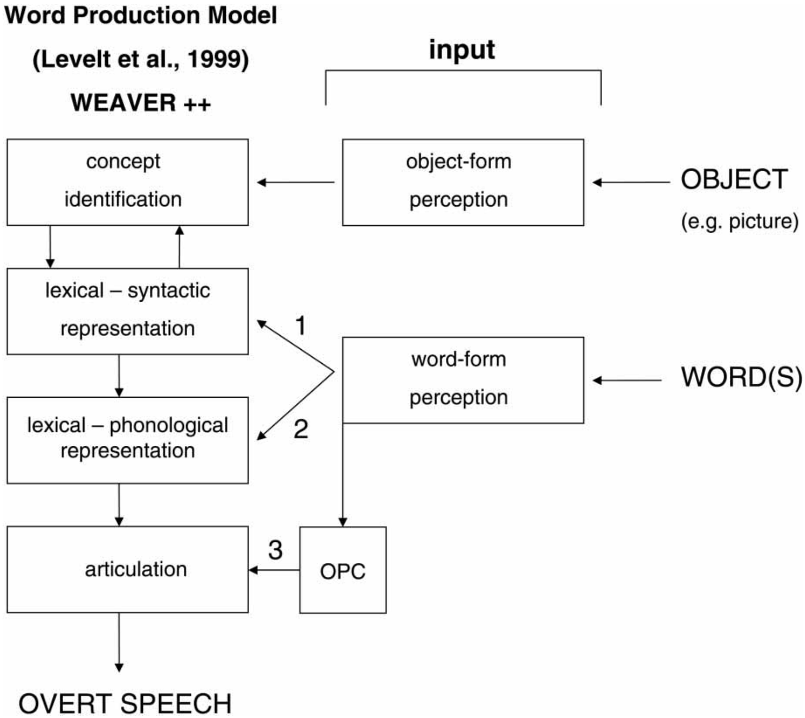

Figure 1. *Input to the WEAVER ++ word production model of Levelt et al. (1999). From "Context Effects of Pictures and Words in Naming Objects, Reading Words, and Generating Simple Phrases", by A. Roelofs, 2006,* Quarterly Journal of Experimental Psychology, 59, *pp. 1764–1784. Adapted with permission.*

suggested two possible accounts of their finding with Japanese kanji: (a) Naming kanji requires lexical–syntactic information to determine which pronunciation is the correct one (Route 1), and (b) naming kanji faces a processing cost at the lexical–phonological level (due to the necessity of pronunciation selection), which provides the opportunity for context pictures to exert an effect on naming latencies. Although the data did not completely exclude the possibility that the observed facilitation effect could have originated at the lexical–syntactic level, the authors opted for the latter, more parsimonious, alternative (which is supported by neuropsychological evidence indicating the use of a direct orthography-to-phonology route in reading kanji, e.g., Fushimi et al., 2003; Nakamura et al., 1998; Sasanuma, Sakuma, & Kitano, 1992).

As noted above, kanji are unique because over 60% are homographic heterophones. Although much smaller in number, homographic heterophones are also present in alphabetic languages, like the word "read" in English—that is, "I'll read (/rid/) this book" versus "I've read (/rɛd/) this book". There is evidence that such words show longer naming latencies than matched controls (Folk & Morris, 1995; Gottlob, Goldinger, Stone, & Van Orden, 1999; Kawamoto & Zemblidge, 1992; Seidenberg, Waters, Barnes, & Tanenhaus, 1984). It has been proposed that this is due to the time necessary to select between two or more simultaneously activated pronunciations.

In WEAVER ++ there are at least two ways for a word such as "read" to activate one of its pronunciations (/rid/ or /rɛd/). One option is that a single orthographic unit—that is, "read"—activates both pronunciations and that one of these pronunciations is ultimately selected. The second option is that such a word is read via the lexical–syntactic route, resulting in the selection of a representation (for instance, on the basis of syntactic or semantic context) subsequently leading to the activation of the corresponding phonological representation(s).

It seems plausible to assume that in Japanese, a heterophonic kanji could follow the same two routes: The kanji for "water" 水, for example, could either be read via its lexical–syntactic representation or via the direct route from orthography to phonology (see Figure 2).

Within the basic model depicted in Figure 2, the kanji symbol for water 水 will activate its representation in the orthographic lexicon, and activation will spread to the phonological word form /mizu$_{kun}$/ as this character, when standing alone, is typically pronounced in this way. However, as argued before, it could also activate the alternative word form /sui$_{on}$/. Evidence for the activation of /sui$_{on}$/, although this pronunciation is not used when standing alone, comes from a study by Kayamoto, Yamada, and Takashima (1998). They reported that single kanji that have a frequent alternative reading when part of a compound are named slower than their matched controls (but see Wydell, Butterworth, and Patterson, 1995, Experiment 5). Furthermore, Fushimi, Ijuin, Patterson, and Tatsumi (1999) found significant consistency effects when naming compound kanji and nonwords in Japanese when typicality was introduced as a factor. Pure consistent kanji were kanji compounds for which its constituents have the same pronunciation in all words containing that constituent in that position (e.g., 医 and 学 in target word 医学 /i$_{on}$.gaku$_{on}$/ "medical science"; other words are e.g., 医者 /i$_{on}$.sha$_{on}$/ "doctor" and 科学 /ka$_{on}$.gaku$_{on}$/ "science"). Inconsistent but typical kanji are target compounds for which the constituents can take more than one pronunciation but there is a statistically common pronunciation (e.g., compounds using that kanji at that position usually take that reading). Inconsistent but atypical kanji are target words for which its constituents can have alternative pronunciations, and the current reading is not typical amongst words in that same position (e.g., 人 and 間 in target 人間 /nin$_{on}$.gen$_{on}$/ "mankind"; other words are, e.g., 人手 /hito$_{kun}$.de$_{kun}$/ "crowd" and 時間 /ji$_{on}$.kan$_{on}$/ "time"). Consistent words typically took less time to name than inconsistent words, especially when they were of low frequency. Furthermore, consistency effects between inconsistent atypical and typical words were also observed. This shows that at a constituent level (individual kanji), character–sound correspondences exerted an effect, which suggests involvement of multiple pronunciations (e.g., /hito$_{kun}$/ for 人 in 人間).

Finally, a study by Verdonschot, La Heij, Poppe, Tamaoka, and Schiller (2011) reported that a single kanji prime could facilitate its multiple readings when those readings were both transcribed in Japanese katakana script (e.g., 町 "town", which can be pronounced /machi$_{kun}$/ or /chou$_{on}$/; i.e., マチ "machi" and チョウ "chou"), compared to an unrelated prime. This indicates that multiple readings were activated during the short time span in which the prime was presented.

As mentioned earlier, Verdonschot et al. (2010) obtained facilitation effects from semantically related pictures compared to unrelated pictures when naming Japanese kanji but not when naming Chinese hànzì. If this effect originates from the fact that Japanese kanji is read through the direct

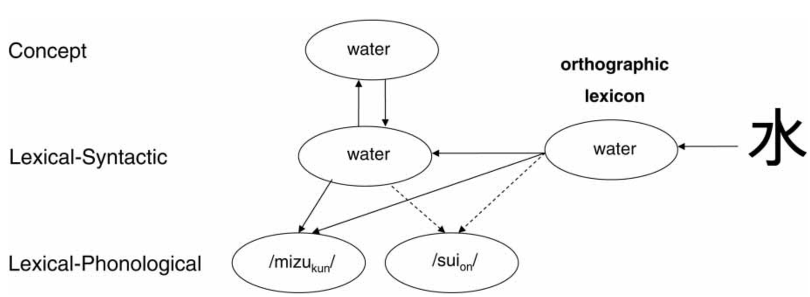

Figure 2. *Activation spreading from orthographic kanji input to its pronunciations.*

route (Route 2 in Figure 1), and this route is susceptible to context effects when a processing cost is incurred, then also phonologically related context pictures are expected to speed up naming latencies in Japanese (but not Chinese). The current study further examines this issue by means of two experiments involving phonological (homophonic) effects of context pictures on word naming. The experiments employ to-be-named Japanese/Chinese logographic characters, which are superimposed on context pictures. The names of these pictures are either homophones of the correct kanji/hànzì reading, or phonologically unrelated to the correct reading.

First of all, for Chinese the predictions are straightforward—that is, Chinese hànzì naming proceeds via the fast direct route from orthography (Route 2 in Figure 1) in line with the interpretation by Verdonschot et al. (2010). Therefore, distractor pictures with homophonic names will not facilitate Chinese hànzì naming as the fast direct route and the lack of multiple pronunciations prevent any influence from picture processing. However, for Japanese the story becomes different. In this case, we propose that naming Japanese kanji also proceeds via the direct lexical–phonological level; however, the fact that multiple pronunciations are activated (due to kanji heterophony) causes a processing cost, which in turn leads to the same susceptibility to context effects as observed (for semantic context) in Verdonschot et al. (2010). Therefore, we hypothesize that introducing homophonic context pictures in our experiments should give rise to different effects for Japanese (Experiment 1) and Chinese (Experiment 2).

EXPERIMENT 1: NAMING JAPANESE KANJI WITH HOMOPHONIC DISTRACTOR PICTURES

In this study, kanji target words are presented with distractor pictures whose names are homophonic with the dominant reading of the (standing alone) kanji character. For instance, the kanji for "white" 白 (/$\text{shiro}_{\text{kun}}$/ or /$\text{haku}_{\text{on}}$/) was superimposed on a picture of a "castle", which is also named /$\text{shiro}_{\text{kun}}$/ (note: the kanji for "castle" is 城 /$\text{shiro}_{\text{kun}}$/ or /$\text{jyou}_{\text{on}}$/) compared to an unrelated picture. As any semantic or orthographic relationship between picture distractor and target word is absent in our stimuli, a possible facilitation effect of homophonic pictures is presumably localized at the lexical–phonological level. Note that phonological facilitation by picture names has been observed in word production tasks (picture naming and colour naming; Kuipers & La Heij, 2009; Morsella & Miozzo, 2002; Navarrete & Costa, 2005), indicating that, at least under some circumstances, context pictures are processed up to the level of phonological word forms (but see Bloem & La Heij, 2003; Bloem, van den Boogaard, & La Heij, 2004; Jescheniak et al., 2009).

Method

Participants

Twenty-one undergraduate students from Yamaguchi University, Japan (15 female, average age: 20.3 years; $SD = 1.3$) took part in the experiment in exchange for financial compensation. All participants were native speakers (and fluent readers) of Japanese and had normal or corrected-to-normal vision.

Stimuli

We selected 22 kanji characters for which we could also select an appropriate picture bearing the same pronunciation. For instance, the kanji 造 for "construction", which is pronounced /zou/, was superimposed on a picture of an elephant (which carries the same pronunciation, /zou/). The control picture of a tree (pronounced /ki/) does not bear any phonological relationship with the target kanji.

To avoid effects due to the nature (e.g., visual properties) of the pictures, we balanced the distractor pictures so they made so-called *equal pairs* with the targets—for example, for the target 器 ("bowl", /ki/) the same two pictures were used as those for 造 ("construction", /zou/), only their roles were reversed in this case. Figure 3 provides examples of kanji–picture pairs, and Appendix A lists all Japanese stimuli. We also selected 30 kanji characters that were paired with two unrelated pictures to

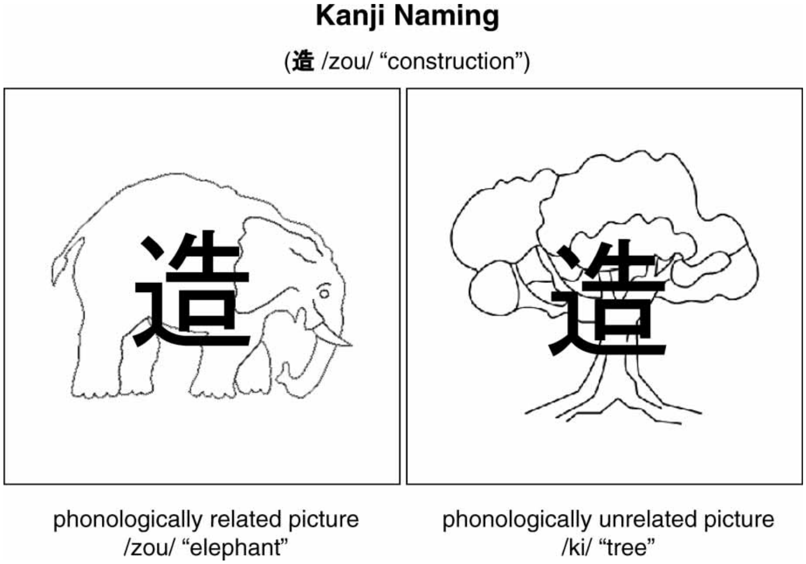

Figure 3. *Examples of Japanese experimental stimuli.*

act as filler items (thereby reducing the homophonic proportion to 26.8%) to reduce the likelihood that participants became aware of the homophonic relation between some of the target–picture pairs. Kanji target characters had summed average kanji-to-sound correspondence (ranging from 1, not adequate, to 7, very adequate) for the KUN-reading of 5.58 ($SD = 1.4$) and for the ON-reading of 5.9 ($SD = 0.8$; Amano & Kondo, 2000).

Design

A 2×2 within-subjects factorial design was implemented, with the factors SOA (0 ms, i.e., picture and word presented simultaneously, or –150 ms, i.e., picture first) and phonological relatedness (homophonic or unrelated context picture). Each participant was subjected to 208 kanji naming (88 experimental + 120 filler) trials presented in four blocks (two blocks per SOA). For each participant, pseudorandom lists were constructed per block such that there were minimally two intervening trials between phonologically or semantically related characters or pictures. Across participants, the order of blocks was counterbalanced. Each block started with three warm-up trials (all filler trials).

Procedure

Participants were seated approximately 60 cm from a 17-inch LCD computer screen (Eizo Flexscan P1700 at 60 Hz) in a quiet room at Yamaguchi University. The E-prime 2.0 software package was used to present the stimuli and record the responses. Trials consisted of a fixation point presented for 750 ms, followed and replaced by the picture–kanji pair (using the appropriate SOA for that block), which disappeared when participants responded or after maximally 2,000 ms. Following a response, the experimenter recorded whether or not the response was accurate before the next trial started. Naming latencies were measured from target onset using a voice-key. Participants were instructed to respond as fast as possible while avoiding errors.

Results

Reaction time results

Naming latencies below 300 ms and above 1,500 ms and voice-key errors were counted as outliers (comprising 1.5% of the data). Other errors (i.e., incorrect target names) accounted for 4.3% of the data. Table 1 shows the mean reaction times and percentages of errors in the various

Table 1. *Mean naming latencies and error rates in the kanji naming task as a function of SOA and phonological relatedness*

	SOA = −150 ms		*SOA = 0 ms*	
	M	*%E*	*M*	*%E*
Homophonic relation	552 (54)	3.6 (0.1)	587 (79)	4.2 (0.1)
Phonologically unrelated	589 (64)	4.9 (0.1)	595 (93)	4.5 (0.1)
Homophonic context effect	−37 (29)	−1.3 (0.0)	−8 (38)	−0.3 (0.0)

Note: Naming latencies in milliseconds; standard deviations in parentheses. %E = percentage error rates; percentage standard deviations in parentheses. SOA = stimulus onset asynchrony.

conditions. An analysis of variance (ANOVA) with SOA (0 ms and −150 ms) and phonological relatedness (homophonic vs. unrelated) as within-subject variables showed a marginal effect of SOA in the items (but not the subjects) analysis, $F_1(1, 20) = 1.66$, *ns*; $F_2(1, 21) = 4.32$, $MSE = 1{,}329.3$, $p = .05$, and a main effect of phonological relatedness in the subjects (but not the items) analysis, $F_1(1, 20) = 17.15$, $MSE = 611.6$, $p < .001$; $F_2(1, 21) = 1.42$, *ns*, reflecting in the subject analysis that overall homophonic target–distractor pairs were named faster. More importantly, there was a significant interaction between SOA and phonological relatedness in the subjects (not the items) analysis, $F_1(1, 20) = 8.18$, $MSE = 549.7$, $p = .01$; $F_2(1, 21) = 2.81$, $MSE = 3{,}717.6$, $p = .11$. Planned *t* tests show that at SOA = 0, the 8-ms facilitation effect of homophonic pictures on kanji naming latencies as compared to unrelated pictures was not significant, all *t*s < 1. However, for SOA = −150, homophonic pictures sped up naming of the target kanji as compared to unrelated pictures by 37 ms, $t_1(20) = 5.85$, $SD = 29.00$, $p < .001$; $t_2(21) = 2.34$, $SD = 70.08$, $p < .05$.

Error results

An identical ANOVA was performed on the error percentages. This analysis showed no main effect of SOA, all *F*s < 1, but there was a main effect of phonological relatedness, $F_1(1, 20) = 6.2$, $MSE = 1.6$, $p < .05$; $F_2(1, 21) = 5.6$, $MSE = 1.7$, $p < .05$, indicating that more errors were made with unrelated pictures. Furthermore, there was an interaction (marginally significant by items) between SOA and phonological relatedness, $F_1(1, 20) = 6.2$, $MSE = 0.69$, $p < .05$; $F_2(1, 21) = 3.4$, $MSE = 1.2$, $p = .08$. To explore the interaction in more detail, planned comparisons were carried out; at SOA = 0 there was no effect of phonological relatedness on error rates, all *t*s < 1; however, at SOA = −150, more errors were made in the phonologically unrelated condition, $t_1(20) = 3.1$, $SD = 1.68$, $p < .01$; $t_2(21) = 2.5$, $SD = 2.07$, $p < .05$.

Discussion

Our results show that homophonic distractor pictures speed up kanji naming latencies when presented 150 ms before target onset. These findings corroborate the results from Verdonschot et al. (2010), who found semantic context effects of pictures on the naming latencies of kanji at SOA −150 and SOA 0. Our current findings can be accounted for by assuming that the distractor pictures activate their conceptual representations and that this activation cascades to the lexical–syntactic and the lexical–phonological level and exerts an effect at the latter level. Note that the phonologically related picture name is unable to affect the processing of the target word at the lexical–syntactic level, as picture and word are not semantically or orthographically related. The target word is supposed to activate its representation in the orthographic lexicon and, via the fast direct route (Route 2), its phonological word-form. Although Route 2 is usually fast, the results show an effect of homophonic distractor pictures when the pictures are given a 150-ms head start. This susceptibility of kanji naming to context effects stands in marked contrast to the general lack of context effects in naming single words in alphabetic languages (Glaser & Düngelhoff, 1984; La Heij, Happel, & Mulder, 1990; Roelofs, 2003).

The most parsimonious explanation for the homophonic facilitation effect is based on the fact that the Japanese kanji characters used have multiple readings, thereby requiring a time-consuming selection process at the word-form level. To test this hypothesis, logographic characters in Japanese should be examined that do not have multiple readings. However, as it turns out to be hard to find a set of single ON or KUN reading characters that could be equally well matched with homophonic pictures in Japanese, we decided to employ Chinese logographs in Experiment 2. Chinese hànzì characters (leaving specific grammatical differences between languages aside) are similar to the Japanese kanji stimuli with the difference that a Chinese hànzì character usually has a single pronunciation.

EXPERIMENT 2: NAMING CHINESE HÀNZÌ WITH HOMOPHONIC PICTURES

The set-up of this experiment is identical to that of Experiment 1. In this experiment, word targets are again accompanied by homophonic and control distractor pictures. The issue is whether the significant facilitation effects of homophonic pictures on naming latencies of Japanese kanji can be replicated using Chinese hànzì.

Method

Participants

Twenty-four undergraduate university students (who were enlisted in a database of the psychology department of the Chinese Academy of Sciences in Beijing, China; 17 female, average age: 24.0 years; $SD = 1.6$) took part in the experiment in exchange for financial compensation. All participants were native speakers (and fluent readers) of Mandarin Chinese and had normal or corrected-to-normal vision.

Stimuli

As in Experiment 1, we selected 22 hànzì characters and corresponding semantically unrelated pictures with the same name. For instance, the hànzì 珠 for "pearl", which is pronounced /zhu1/, was superimposed on a picture of a pig (the Chinese name that has the same pronunciation and tone, e.g., /zhu1/). The control picture of a chicken /ji1/ does not bear any phonological relationship with the target hànzì. For target hànzì and distractor pictures, tones were always kept the same. There was no significant difference in mean target frequency (per million) between Japanese (594) and Chinese stimuli (365), $t(42) = 1.20$, *ns* (taken from Yokoyama, Sasahara, Nozaki, & Long, 1998, and Da, 2004, respectively). Again, we created equal pairs (as in Experiment 1). Figure 4 provides examples of hànzì–picture pairs, and Appendix B lists all Chinese stimuli. We also selected 30 hànzì characters paired with unrelated pictures to act as filler items, to reduce the likelihood that participants became aware of the homophonic relation between some of the target–picture pairs.

Design

The design was identical to that of Experiment 1.

Procedure

Participants were seated approximately 60 cm from a 17-inch CRT computer screen in a quiet room at the Institute of Psychology at the Chinese Academy of Sciences. The rest of the procedure was identical to that of Experiment 1.

Results

Reaction time results

Naming latencies below 300 ms and above 1,500 ms were counted as outliers (comprising 1.0% of the data); other errors (e.g., incorrect target names) accounted for another 1.0%. Table 2 shows the mean correct reaction times in the various conditions. An ANOVA was performed with SOA (0 ms vs. –150 ms) and phonological relatedness (homophonic vs. unrelated) as within-subject variables. The analysis showed no main effect of SOA, $F_1(1, 23) = 1.5$, $MSE = 900.6$, *ns*; $F_2(1, 21) = 3.4$, $MSE = 376.7$, $p = .08$, and no main effect of phonological relatedness, all $F\text{s} < 1$, and

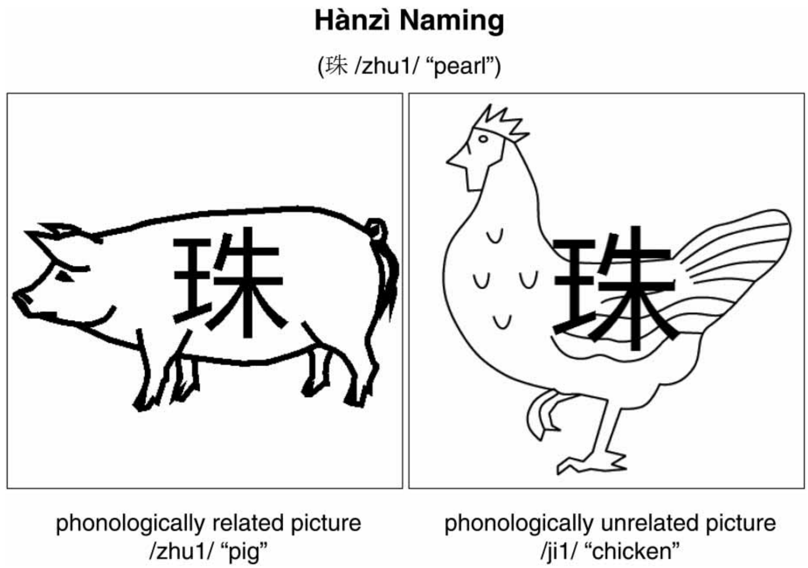

Figure 4. *Examples of Chinese experimental stimuli.*

Table 2. *Mean naming latencies and error rates in the Chinese hànzì naming task as a function of SOA and phonological relatedness*

	SOA = –150 *ms*		*SOA* = 0 *ms*	
	M	*%E*	*M*	*%E*
Homophonic	539 (68)	0.4 (0.1)	531 (61)	1.2 (0.1)
Phonologically unrelated	538 (61)	2.0 (0.1)	530 (59)	0.4 (0.1)
Phonological context effect	1 (26)	–1.6 (0.0)	1 (23)	0.8 (0.0)

Note: Naming latencies in milliseconds; standard deviations in parentheses. %E = percentage error rates; percentage standard deviations in parentheses. SOA = stimulus onset asynchrony.

there was no interaction between SOA and phonological relatedness, all Fs < 1.

Error results

An identical ANOVA was performed on the error percentages. This analysis showed no main effect of SOA in the subjects analysis, $F_1 < 1$, but it approached significance in the items analysis, $F_2(1, 21) = 4.1$, $MSE = 0.07$, $p = .06$. There was no main effect of phonological relatedness, $F_1(1, 23) = 1.0$, *ns*; $F_2(1, 21) = 1.3$, *ns*, but there was a significant interaction between SOA and phonological relatedness in the subjects analysis, $F_1(1, 23) = 4.8$, $MSE = 0.22$, $p < .05$, but not the items analysis, $F_2 < 1$. Planned t tests showed that at SOA = 0 ms there was no effect of phonological relatedness on error rates, $t_1(23) = 1.1$, *ns*; $t_2 < 1$; however, it was marginally significant at SOA = –150 ms in the subjects analysis, $t_1(23) = 2.1$, $SD = 0.7$, $p = .05$, but not the items analysis, $t_2(21) = 1.3$, *ns*, reflecting slightly more errors (1.3%) in the unrelated than in the homophonic condition.

Discussion

Our results show that phonological relatedness (homophony) of distractor pictures with target hànzì does not speed up naming latencies at any SOA. Mean reaction times obtained with homophonic and control distractor pictures are virtually identical. Therefore, the homophonic context effect observed in naming Japanese kanji (Experiment 1) does not generalize to naming Chinese hànzì (Experiment 2). One possible way to account for the absence of this effect in Chinese is to assume that the activation of the phonological representation of a Chinese word (via Route 2 in Figure 1) builds up too fast for context pictures to exert an effect on naming latencies. A fast build-up of activation would also prevent context stimuli presented at negative SOAs to exert an effect. Some support for this assumption is provided by the faster overall naming latencies in Chinese than in Japanese (a difference of 46 ms), $F_1(1, 43) = 6.44$, $MSE = 14{,}658.14$, $p < .05$; $F_2(1, 42) = 12.76$, $MSE = 11{,}310.82$, $p < .001$. Nevertheless, as hànzì and kanji words differ both in form and in pronunciation, it is difficult to draw strong conclusions regarding this observation. However, the absence of context effects in Chinese word reading clearly corroborates our hypothesis that the context effects observed in Japanese kanji reading is due to a processing cost induced by the activation of multiple word-form candidates in that language.

GENERAL DISCUSSION

In two experiments, we investigated whether or not reading aloud words in Japanese and Chinese can be influenced by context pictures. We found that homophonic context pictures induced facilitation on naming Japanese kanji characters with multiple readings (Experiment 1). However, comparable homophonic context pictures induced no such effect on naming Chinese hànzì (Experiment 2). The interaction (at SOA = –150) between experiment (Japanese, Chinese) and relatedness (homophonic, unrelated) was significant, $F_1(1, 43) = 20.84$, $MSE = 378.63$, $p = .001$, $F_2(1, 42) = 3.99$, $MSE = 1{,}606.26$, $p = .052$. These findings parallel results obtained in earlier work in our lab, which showed the same pattern for *semantic* context effects in Japanese and Chinese character naming (Verdonschot et al., 2010).

How to interpret these findings? First of all, Chinese hànzì naming did not show a homophonic facilitation effect. This finding suggests that Chinese hànzì are read via the fast, *direct*, route from orthography to phonology (Route 2 in Figure 1). Secondly, in contrast to the Chinese results, we found a homophonic facilitation effect in Japanese. It is unlikely that this effect arose at the lexical–syntactic level, as there was no semantic (nor orthographic) relation between target words and related context pictures. Furthermore, there is ample neuropsychological evidence showing that kanji activation spreads via orthography to phonology. For instance, Sasanuma et al. (1992) as well as Nakamura et al. (1998) showed that patients with Alzheimer's dementia, whose comprehension of kanji was deteriorated, still maintained their ability to read kanji aloud. In addition, Fushimi et al. (2003) reported that a Japanese surface-dyslexic patient (T.I.) had an intact orthography-to-phonology route in combination with a decrease of activation coming from semantics. It seems as such plausible that the effect we observed in reading kanji arises at the lexical–phonological level and is due to a processing cost that results from the heterophony in Japanese kanji. If participants face a cost at some point in this process, context pictures get a chance to induce a measurable effect on the activation of the phonological word form.

Our conclusion that context effects could arise as a consequence of processing costs will be tested in future experiments in which target frequency and the degree of consistency between orthography and phonology are manipulated. In these experiments, Japanese high-frequency target characters with a high degree of consistency should show a diminished effect of phonologically related pictures, and Chinese low-frequency (or low consistency) target hànzì should also become susceptible to context effects.[1]

A point of consideration concerns the magnitude of the context effects as observed in Experiment 1 and in the Japanese data by Verdonschot et al. (2010). As the homophonic context stimuli would

[1] We thank an anonymous reviewer for bringing this to our attention.

activate matching word-forms directly (without semantic mediation), one may expect the current experiment to show a larger context effect. This was observed at SOA = –150 (24 vs. 37 ms); however, at SOA = 0, the present context effect was not significant, whereas the semantic context effect (14 ms) in Verdonschot et al. (2010) was. One possible explanation might be a relatively weak link between a distractor picture's concept and the corresponding phonological representations (as evidence for cascaded processing of context pictures is not always obtained, e.g., Jescheniak et al., 2009). However, the small size difference of the SOA = 0 effect between the two experiments, the higher variability in the present SOA = 0 data (compared to SOA = –150), and the between-groups comparison complicate a clear-cut interpretation. Consequently, the empirical evidence concerning the effect sizes for both SOAs for the current experiments and the experiments of Verdonschot et al. (2010) is at present insufficient to draw any strong conclusions. In future studies, using well-matched stimuli, it would be interesting to establish whether this pattern of results generalizes to a within-group design.

To summarize, we propose that kanji characters (like Chinese characters and alphabetic words) are most likely named via a direct route from orthography to phonology (Route 2 in Figure 1). In addition, context pictures can affect processing along this route when characteristics of the target stimulus induce a processing cost.

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APPENDIX A

Japanese stimuli

Table A1. *Stimulus Materials from Experiment 1*

Target		*Related Picture Distractor*		*Unrelated Picture Distractor*	
Pronunciation (kun/on)[a]	*Meaning*	*Pronunciation*	*Meaning*	*Pronunciation*	*Meaning*
箸 "hashi: 6.42" "chou: 4.08"	chopsticks	hashi	bridge	me	eye
器 "utsuwa: 6.02" "ki: 6.58"	bowl	ki	tree	zou	elephant
刃 "ha: 6.42" "jin: 4.08"	blade	ha	leaf	su	nest
芽 "me: 6.42" "ga: 5.42"	seedling/sprout	me	eye	hashi	bridge
緒 "o: 6.12" "sho: 5.75"	cord/strap	o	tail/ridge	hata	flag
応 "kota: 5.92" "ou: 6.71"	application	ou	king	nami	wave
可 "be: 3.42" "ka: 6.58"	possible/passable	ka	mosquito	shita	tongue
雨 "ame: 6.79" "u: 6.00"	rain	ame	candy	kutsu	shoes
端 "hashi: 6.04" "tan: 5.96"	edge	hata	flag	o	tail
下 "shita: 6.71" "ka: 5.79"	under	shita	tongue	ka[b]	mosquito
券 "fuda: 2.17 "ken: 6.54"	ticket	ken	sword	shima	island
並 "nami: 6.42" "hei: 5.75"	ordinary	nami	wave	ou	king
縞 "shima: 5.58" "kou: 5.21"	stripe	shima	island	ken	sword
白 "shiro: 6.67" "haku: 6.12"	white	shiro	castle	hi	fire
酢 "su: 6.58" "saku: 4.58"	vinegar	su	nest	ha	leaf
造 "tsuku: 6.17" "zou: 6.21"	construction	zou	elephant	ki	tree
比 "kura: 5.83" "hi: 6.62"	comparison/ratio	hi	fire	shiro	castle
便 "tayo: 5.21" "ben: 6.46"	mail/post/flight	bin	bottle	hon	book
屈 "kaga: 4.29" "kutsu: 6.25"	leading/outstanding	kutsu	shoes	ame	candy
回 "mawa: 6.33" "kai: 6.38"	counter occurrence	kai	seashell	nou	brain
翻 "hirugae: 5.5" "hon: 6.54"	change ones mind	hon	book	bin	bottle
農 "nariwai: 1.75[b]" "nou: 6.54"	farming/agriculture	nou	brain	kai	seashell

[a]Numbers denote kanji-reading correspondences. These indices were taken from the NTT Japanese Word Database (Amano & Kondo, 2000). This index ranges from 1 (not adequate at all) to 7 (very adequate) judging kanji to sound correspondence.
[b]This unrelated item accidentally turned out to be the ON-reading for 下. A re-analysis without this distractor and the low kun-reading correspondence character 農 did not change the experimental findings and interpretation; therefore we decided to leave both in.

Appendix B
Chinese stimuli

Table B1. *Stimulus Materials from Experiment 2*

Target		*Related Picture Distractor*		*Unrelated Picture Distractor*	
Pronunciation	*Meaning*	*Pronunciation*	*Meaning*	*Pronunciation*	*Meaning*
离 "li2"	to leave	li2	pear	wang2	king
晚 "wan3"	late	wan3	bowl	fu3	axe
掩 "yan3"	to cover	yan3	eye	tong3	bucket
亡 "wang2"	die away	wang2	king	li2	pear
螳 "tang2"	mantis	tang2	candy	qi2	flag
棋 "qi2"	chess	qi2	flag	tang2	candy
件 "jian4"	a piece	jian4	sword	bao4	leopard
播 "bo1"	to broadcast	bo1	wave	xia1	shrimp
抱 "bao4"	to hug	bao4	leopard	jian4	sword
评 "ping2"	to evaluate	ping2	bottle	xie2	shoes
斜 "xie2"	slanted	xie2	shoes	ping2	bottle
备 "bei4"	back-up	bei4	seashell(s)	ku4	trousers
瞎 "xia1"	blind	xia1	shrimp	bo1	wave
珠 "zhu1"	pearl	zhu1	pig	ji1	chicken
陵 "ling2"	tomb	ling2	bell	yun2	cloud
腐 "fu3"	rotten	fu3	axe	wan3	bowl
匀 "yun2"	equal	yun2	cloud	ling2	bell
公 "gong1"	male	gong1	a bow	gu3	bone
古 "gu3"	old, ancient	gu3	bone	gong1	a bow
酷 "ku4"	cool	ku4	trousers	bei4	seashell(s)
机 "ji1"	machine	ji1	chicken	zhu1	pig
统 "tong3"	to unify	tong3	bucket	yan3	eye