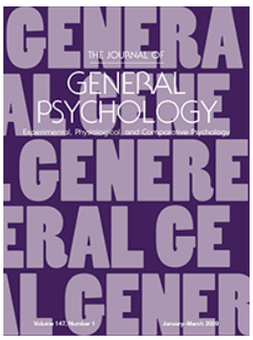

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Recognition without Cued Recall across Chinese and English: Exploring the Role of Phonological, Orthographic, and Semantic Features

Yongping Jia[a,b*], Hanyue Liu[b*], Bingjie Li[b], Chu Zhou[c], Lin Li[b], Li Zheng[b], and Xiuyan Guo[b]

[a]Xinjiang Normal University; [b]East China Normal University; [c]Fudan University

ABSTRACT

Recognition without cued recall (RWCR) is a phenomenon that participants can effectively discriminate cues that resemble studied items from the ones that do not, even when they are not able to recall a studied item which is cued at test. It has been shown that a word's features could give rise to the RWCR effect. In the present study, by using this paradigm, we systematically investigated whether particular types of features alone, including orthographic, phonological, and semantic features, could evoke feelings of familiarity. By taking the advantage of a logographically scripted language (i.e., Chinese) to dissociate phonological from orthographic features in Experiment 1 and vice versa in Experiment 2, we examined whether phonological and orthographic features could induce a significant RWCR effect. In Experiment 3, by using a cross-language design to dissociate sematic features from orthographic and phonological features, we further explored whether separate semantic features could elicit the RWCR effect. A significant RWCR effect was found in all these experiments. These results have demonstrated that familiarity could be based on separate phonological, orthographic, and semantic features. The results are further discussed in relation to several theoretical explanations of familiarity.

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Cross-language; familiarity; recognition memory; RWCR effect

People often have the experience that they could recognize an event, even when they fail to recall specific details of the event. For instance, one might recognize that he or she had seen someone before without any memories about when or where they met. This phenomenon is termed as recognition without identification (RWI). RWI has been examined and replicated by using different stimuli, including words or word fragments (Cleary, 2004; Lloyd, Westerman, & Miller, 2007), pictures (Cleary, Langley, & Seller,

CONTACT Chu Zhou zhouchu@fudan.edu.cn Department of Psychology, Fudan University, Handan Road 220, Shanghai 200433, P. R. China.
*Yongping Jia and Hanyue Liu contributed equally to this work.
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2004), scenes (Cleary & Reyes, 2009), and odors (Cleary, Konkel, Nomi & Mccabe, 2010). Recognition without identification indicates that recognition can be based on familiarity process.

One important theoretical question is what specific mechanisms might underlie this familiarity-based recognition during retrieval failure. Several models provide important insight into this question. For instance, according to the Source of Activation Confusion model (Reder et al., 2000), recognition can be based on both recollection and familiarity. It assumes that a conceptual node (also referred to as word node) representing a particular word already exists even before it is studied in the encoding session. This node further has association with the word' s phonemic and orthographic information, as well as semantic information, such as related concepts. Furthermore, an episode node represents the experience of studying the word in the experiment. The link between the conceptual and episode node is formed during the encoding session. Importantly, familiarity and recollection is based on the activation of the conceptual and episode node, respectively. The activation of a particular node in turn depends on both frequency and recency of exposure to the word, as well as activation spreading from associated nodes.

In contrast, global matching models (see Clark & Gronlund, 1996 for a review), such as MINERVA2 (Hintzman, 1988) and REM (Shiffrin & Steyvers, 1997), assumes that recognition is based solely on familiarity, and familiarity is determined by the overall evaluation of the level of match between the features in the test items and features of the memory trace stored during encoding. Thus, A higher level of match would produce a stronger feeling of familiarity.

According to global matching models, separable features play a role in the process of familiarity. Inspired by this idea, Cleary (2004) investigated whether specific types of features in a whole-word unit, such as orthography, phonology, and meaning, could facilitate a later familiarity process. To isolate familiarity from recollection, *the recognition without cued recall* (RWCR) paradigm was developed. In this paradigm, participants firstly studied a list of words during encoding session. Then in the test session, they were presented with test cues and asked to recall a word similar to the cue from the study list. Importantly, irrespective of whether they could recall the word, they were then instructed to rate how likely it was that a similar word had been presented on the study list. The key manipulation was the study status of the target words, which the test cues were similar to. That is, half of the cues were similar to studied words in orthographical, phonological, or semantic feature, while the other half resembled non-studied words on the corresponding dimension. It was found that even for test cues whose corresponding targets were not identified, the ratings were still higher for cues similar to studied targets compared to cues similar to

unstudied targets. These results suggest that separable features of words, such as orthography, phonology, and meaning, can result in a feeling of familiarity.

If the feature-matching process described in the global matching models is the mechanism underlying the RWCR effect, then increasing the degree of feature overlap between the cues and studied items should result in a larger RWCR effect. Two studies conducted by Cleary and colleagues (Cleary, Ryals, and Wagner, 2016; Ryals and Cleary, 2012) systematically examined this hypothesis. The degree of feature-match was manipulated by changing the number of studied items the test cue resembled graphemically (e.g., *potchbork* as a cue for studied words *pitchfork*, *patchwork*, *pocketbook*, *pullcork*, or as a cue only for the studied word *pitchfork* , Ryals and Cleary, 2012) or semantically (Cleary, Ryals, and Wagner, 2016). It was found that test cues similar to more studied words received higher familiarity ratings. These results thus support that feature-matching process could account for the RWCR effect when the cues resemble the studied words graphemically or semantically.

One important fact relevant to the current study is that all these studies mentioned above used English words as materials. In English, about 75% of the words are regularly mapped between orthography and phonology (Ziegler, Stone, & Jacobs, 1997), indicating that the orthography-to-phonology mapping is direct, and grapheme information can directly activate the sound of a word. Thus, the test cue and target used in previous research may be similar not only in orthography, but also in phonology (e.g., the cue cheetah and studied words cheetohs in Cleary (2004), or the cue *potchbork* and studied words *pitchfork* or *patchwork* in Ryals and Cleary, 2012). This fact to some extent raises doubt on the conclusion that separate orthographic or phonological features alone could evoke the feeling of familiarity (Cleary, 2004). In contrast to English, Chinese is a logographic language in which the features of orthography and phonology can be largely dissociated. That is, in Chinese, the writing of a word can be largely irrelevant to its pronunciation. Thus, by using Chinese words, cues and targets similar in orthography but not in phonology (e.g., although "土"and 士" is similar in orthography, the former is pronounced as [tʻu], meaning dust, whereas the latter is pronounced as [ʂʻi] , meaning scholar), and vice versa (e.g., both "烧," meaning burn, and "稍," meaning slightly, are pronounced as [ʂʻɑu]) can be created. This would help to isolate the orthographical and phonological features more stringently and therefore investigate whether separate orthographic (or phonological) features alone could elicit the RWCR effect. Therefore, the first purpose of the present study was to explore whether separate phonological (Experiment 1) and orthographic features (Experiment 2) alone could elicit the RWCR effect by using Chinese characters.

The second purpose of the current study was to further investigate whether separate semantic features (Experiment 3) alone could elicit the RWCR effect by using a novel method, i.e., cross-languages, to dissociate semantic features from orthographic and phonological features. That is, bilingual participants studied the Chinese words (e.g., "医生," meaning doctor) and were tested with semantically similar English words (e.g., "nurse") as retrieval cues in Experiment 3a, and vice versa in Experiment 3b. Because the Chinese and English words are only similar semantically and dissimilar in both orthographic and phonological dimension, so the RWCR effect, if it was found, could only be attributed to semantic features' similarity. Therefore, using cross-language word pairs as targets and cues can be an effective method to isolate semantic features and further explore whether semantic features alone could evoke feelings of familiarity.

Experiment 1

In Experiment 1, we examined whether phonological features alone can evoke RWCR effect.

Method

Participants

Twenty-one students from East China Normal University (11 females, average age of 22.35 years, $SD = 4.38$) participated in Experiment 1 for either course credits or financial rewards. All of them were native Chinese speakers.

Materials

One hundred twenty pairs of Chinese single words with high-frequency usage in daily life (from 90 to 900 per million) were selected from the *Modern Chinese Words in Common Use* (Liu, 1990). The two words in each pair were only phonologically similar to each other and different in both semantic and orthographic dimension. One word in each pair were assigned as target words and the other as test cues. For instance,"去 "(meaning go, pronounced as [tɕ'u]) was assigned as target words, and the corresponding test cues is"趣"(meaning "interest," also pronounced as [tɕ'u]). During the experiment, half of the word pairs were assigned as studied cue-target pairs, while the other half were assigned as unstudied cue-target pairs. Moreover, the assignment of which half to a certain condition was counterbalanced across participants. All the word pairs used in this

experiment, as well as those used in the other experiments, and the corresponding familiarity ratings were presented in the Appendix.

In order to make sure that all participants were quite familiar with the selected stimuli, 20 subjects who did not participate in the formal experiment were recruited to rate the familiarity of all the words on a seven-point scale (*1= very unfamiliar, 7= very familiar*). All the words were with average ratings larger than 5. Importantly, the familiarity ratings for cues assigned as the first half ($M = 6.58$, $SD = .42$) did not differ significantly from that for cues assigned as the second half ($M = 6.49$, $SD = .41$) [$t(118) = .11$, $p = .91$]. Moreover, the familiarity ratings for targets assigned as the first half ($M = 6.62$, $SD = .39$) did not differ significantly from that for targets assigned as the second half ($M = 6.61$, $SD = .43$) [$t(118) = 1.25$, $p = .21$].

Procedure

The 120 cue-target pairs were assigned equally to four study-test blocks. During each block, the 30 cue-target pairs were assigned equally to studied or unstudied condition. Therefore, each block consisted of a 15-word study list and a 30-cue test list. In each test list, half of the cues resembled studied items phonologically, and the other half resembled non-studied items phonologically. Within each block, the presentation order of study and test items were random.

As shown in Figure 1, in the study phase, each item was presented in the upper left corner of the screen for 2 s, with 1 s intervals between the studied

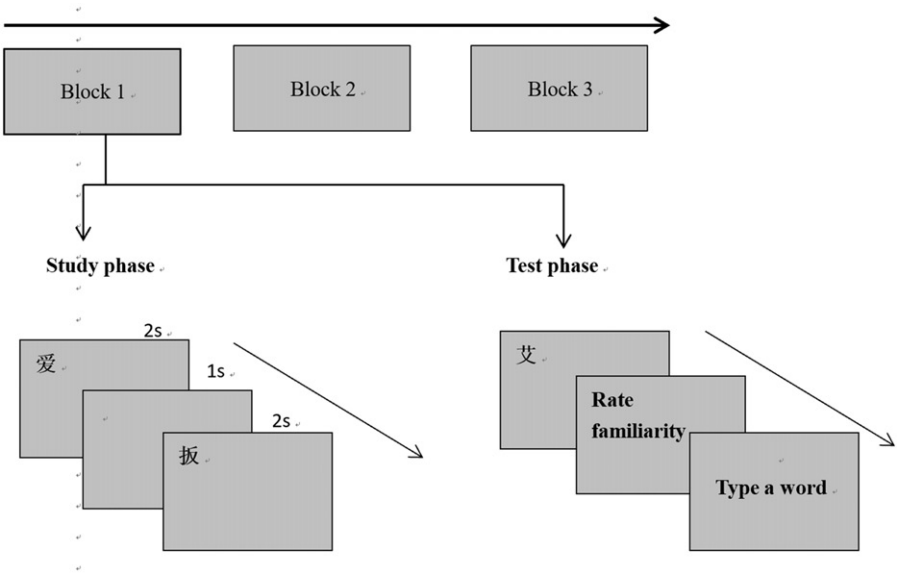

Figure 1. A schematic of the procedure used in Experiment 1.

items. The participants were asked to remember as many words as possible for a following cue recall test. After each study list, participants were asked to complete two tasks in the test phase. They were first instructed to indicate the likelihood that the cue resembled a word from the study list by rating the familiarity of the cue itself (0 = *very unfamiliar*, 10 = *very familiar*). Then they were instructed to type a studied word that was similar to the cue. If they could not remember, they were encouraged to guess.

Results and discussion

The cued recall data was presented first to demonstrate the validity of the study status manipulation. Then we mainly focused on analyzing the familiarity ratings of test cues corresponding to unidentified targets to determine whether even when identification fails, cues similar to studied targets still received higher familiarity ratings than cues similar to unstudied targets. That is, whether the RWCR effect was significant. All analyses reported below used a $p < .05$ significance criterion. The same procedure for reporting the data was also used for other experiments.

Proportion of targets recalled

A paired-sample *t*-test showed that the proportion of correctly identifying the studied target words ($M = .72$, $SD = .1$) was significantly higher than the proportion of correctly guessing the unstudied target words corresponding to the test cue ($M = .49$, $SD = .07$) [$t(20) = 10.3$, $p < .001$, $d = 2.22$], indicating that the manipulation of study status was valid.

Familiarity ratings

A paired-samples *t*-test showed that the familiarity ratings for test cues similar to unidentified studied targets ($M = 4.46$, $SD = 1.28$) were significantly higher than that for test cues similar to unidentified unstudied targets ($M = 3.48$, $SD = 1.07$) [$t\ (20) = 5.00$, $p < .001$, $d = 1.09$].

This result indicates that even when target words were not successfully identified, test cues similar only phonologically to studied targets still received higher familiarity ratings than cues similar only phonologically to unstudied targets, demonstrating a significant RWCR effect. Thus, the results of Experiment 1 support that phonological features alone can evoke feelings of familiarity.

Experiment 2

In Experiment 2, we tried to explore whether graphic features alone could induce RWCR effect. To fulfill this purpose, initially 120 pairs of graphemically similar words were used as materials in the experiment. However, careful post hoc examination of these word pairs revealed that 58 of them were similar not only graphemically, but also phonologically or semantically. The RWCR effect found by using these pairs of words would not tell whether graphic features alone could induce RWCR effect. Instead of excluding these pairs from the analysis, we combined them as another category, i.e., similar more than graphemically. According to the global matching models, increasing the degree of feature overlap between the cues and studied items should result in stronger feeling of familiarity. Therefore, compared to cues resembling only graphemically to targets, cues resembling to targets more than graphemically should result in larger RWCR effect. In other words, including these pairs in the analysis offer a chance to further test the feature matching hypothesis.

Method

Participants

17 students from East China Normal University (10 females, average age of 22.74 years, $SD = 4.20$) participated in Experiment 2 for either course credits or financial rewards. All of them were native Chinese speakers.

Materials

One hundred twenty pairs of Chinese single words with high-frequency usage in daily life (from 90 to 900 per million) were selected from the *Modern Chinese Words in Common Use* (Liu, 1990). Sixty-two pairs of words were only graphemically similar to each other and different in both semantic and orthographic dimension. The remaining 58 pairs were similar not only graphemically, but also phonologically or semantically. One word in each pair were assigned as target words and the other as test cues.

As in Experiment 1, the 120 pairs of words were split into two halves. During the experiment, half of the word pairs were assigned as studied cue-target pairs, while the other half were assigned as unstudied cue-target pairs. Moreover, the assignment of which half to a certain condition was counterbalanced across participants. Importantly, the two categories of word pairs were nearly equally distributed in these two halves (similar only graphemically: 28 and 34; similar more than graphemically: 32 and 26).

In order to make sure that all participants were quite familiar with the selected stimuli, 20 students were recruited to rate the familiarity of all the

Table 1. The mean familiarity ratings for cues and targets in Experiment 2.

	First half		Second half	
Condition	*M*	*SD*	*M*	*SD*
Cue				
Similar only graphemically	6.53	.51	6.51	.47
Similar more than graphemically	6.54	.26	6.49	.47
Target				
Similar only graphemically	6.64	.32	6.65	.37
Similar more than graphemically	6.60	.45	6.56	.49

Table 2. Mean proportion of targets correctly identified in Experiment 2.

	Studied		Nonstudied	
Condition	*M*	*SD*	*M*	*SD*
Similar only graphemically	0.42	0.13	0.20	0.07
Similar more than graphemically	0.47	0.13	0.23	0.09

words on a seven-point scale (*1 = very unfamiliar, 7 = very familiar*). Words with average ratings smaller than 5 were discarded. The mean familiarity ratings for cues and targets are presented in Table 1. A 2 (cued condition: similar only graphemically vs. similar more than graphemically) ×2 (half: first vs. second) between-subject ANOVA on cue familiarity ratings showed that there was neither significant main effect of half [F (1, 116) = .21, MSE = .19, p = .65, η^2_p = .002] nor interaction between cued condition and half [F (1, 116) = .04, MSE = .19, p = .84, η^2_p = .001]. In addition, a 2 (cued condition: similar only graphemically vs. similar more than graphemically) ×2 (half: first vs. second) between-subject ANOVA on target familiarity ratings showed that there was neither significant main effect of half [F (1, 116) = .04, MSE = .17, p = .84, η^2_p = .001] nor interaction between cued condition and half [F (1, 116) = .13, MSE = .17, p = .72, η^2_p = .001].

Procedure

As in Experiment 1, the 120 cue-target pairs were assigned equally to four study-test blocks. Importantly, the two categories of word pairs were also nearly equally distributed in these four blocks (similar only graphemically: 14, 16, 15 and 17, similar more than graphemically: 16, 14, 15 and 13). The other aspects of the procedure are identical to Experiment 1.

Results and Discussion

Proportion of targets recalled

Table 2 presents the mean proportion of identified studied and non-studied items in Experiment 2. A 2 (cued condition: similar only graphemically vs.

similar more than graphemically) ×2 (Study Status: studied vs. nonstudied) repeated measures ANOVA showed that there was a significant main effect of study status [F (1, 16) = 63.39, MSE = .014, p < .001, η^2_p = .80], indicating that participants recalled more studied words than nonstudied words, and the manipulation of study status was valid. A significant main effect of cued condition was also found [F (1, 16) = 5.00, MSE = .004, p < .05, η^2_p = .24], showing that participants recalled more target words corresponding to cues similar more than graphemically. The interaction between these two variables was not significant [F (1, 16) = .24, MSE = .007, p = .63, η^2_p = .015].

Familiarity ratings

The mean familiarity ratings given to cues whose targets could not be identified (i.e., targets unidentified) are presented in Table 3. A 2 (cued condition: similar only graphemically vs. similar more than graphemically) ×2 (Study Status: studied vs. nonstudied) repeated measures ANOVA showed that there was a significant main effect of study status [F (1, 16) = 21.53, MSE = .54, p < .001, η^2_p = .80], with familiarity rating for cues corresponding to studied targets was higher than that for cues corresponding to unstudied targets. Neither the main effect of cued condition [F (1, 16) = 1.11, MSE = .14, p = .31, η^2_p = .065] nor the interaction between these two variables was significant [F (1, 16) =2.00, MSE = .31, p = .18, η^2_p = .11],

In order to further investigate whether the RWCR effect was significant when cues resembled targets only graphemically, the effect of study status was examined separately in this condition. A paired-samples t-test showed that the familiarity ratings for cues resembling studied targets were significantly higher than that for cues resembling unstudied targets [t (16) = 2.62, p = .018, d = .63]. This result indicates a significant RWCR effect even when cues resembled targets only graphemically, suggesting that orthographic features alone can evoke feelings of familiarity. Moreover, replicating previous studies (Cleary, 2004) , a significant RWCR effect was also found when cues resembled targets in both orthographic and phonological or semantic dimension [t (16) = 5.02, p < .001, d = 1.22]. Furthermore, although the interaction between the cued condition and study status was not significant, the difference between familiarity rating to

Table 3. Mean familiarity ratings of test cues (targets unidentified) in Experiment 2.

	Studied		Nonstudied	
Condition	*M*	*SD*	*M*	*SD*
Similar only graphemically	5.10	1.21	4.47	1.40
Similar more than graphemically	5.39	1.19	4.37	1.49

cues similar to studied and unstudied targets under similar more than graphemically condition (difference = 1.02) was numerically larger than that under similar only graphemically condition (difference = .63), which was consistent with the feature-matching hypothesis. As the main purpose of Experiment 2 was not to examine this question, it could be systematically explored in future studies.

Experiment 3

Experiment 1 and 2 showed that particular features (orthography & phonology) of Chinese characters alone could induce the RWCR effect. To further explore whether semantic feature alone can evoke feeling of familiarity even without target identification in Experiment 3, we used a cross-language design to dissociate semantic feature from other features. In Experiment 3a, Chinese characters were assigned as target words, and English words were assigned as test cues, whereas in Experiment 3b, the former were assigned as test cues, and the latter were assigned as target words.

Method

Participants

Twenty students from East China Normal University (10 females, average age of 22.12 years, $SD = 3.05$) participated in Experiment 3a and another 20 students from East China Normal University (11 females, average age of 22.24 years, $SD = 3.26$) participated in experiment 3b for either course credits or financial rewards. All participants were native Chinese speakers and had started learning English since middle school, receiving at least 8 years of formal English language training.

Material

Ninety pairs of Chinese-English semantically related nouns were chosen according to the following procedure. First, a set of English words with high-frequency (greater than 20 per million) were selected from the word list pool of Paivio et al. (1968). Then, three Chinese-English bilingual speakers who did not take part in the formal experiments translated all the English words (e.g., "doctor") into Chinese words (e.g., 医生). All the English words corresponding to two or more different Chinese translations were excluded. Another five pilot participants were asked to produce Chinese words (e.g., 护士, meaning "nurse") semantically related to the Chinese translations (e.g., 医生, meaning "doctor") in a free association

task. Thus, we got a set of stimuli consisting of English words, corresponding Chinese translations and corresponding Chinese meaning-associated words (e.g., doctor, 医生, 护士). The English words and corresponding Chinese meaning-associated words (e.g., "doctor" and 护士, meaning "nurse") were used to create target-cue pairs in the experiments. As in Experiment 1, the 120 pairs of words were split into two halves. During the experiment, half of the word pairs were assigned as studied cue-target pairs, while the other half were assigned as unstudied cue-target pairs. Moreover, the assignment of which half to a certain condition was counterbalanced across participants.

A final sample of 21 students who did not participate in the formal experiments were recruited to rate the familiarity of these stimuli on a seven-point scale (*1 = very unfamiliar, 7= very familiar*). The word pairs with rating less than 5 were excluded. Importantly, the familiarity ratings for Chinese words assigned as the first half ($M = 6.77$, $SD = .17$) did not differ significantly from that for Chinese words assigned as the second half ($M = 6.83$, $SD = .13$) [t (88) $= 1.87$, $p = .064$]. Moreover, the familiarity ratings for English words assigned as the first half ($M = 6.53$, $SD = .42$) did not differ significantly from that for English words assigned as the second half ($M = 6.53$, $SD = .49$) [t (88) $= .048$, $p = .96$].

Procedure

As shown in Figure 2, the procedure of Experiment 3a and 3b were identical to that in Experiment 1, except that (a) participants completed three

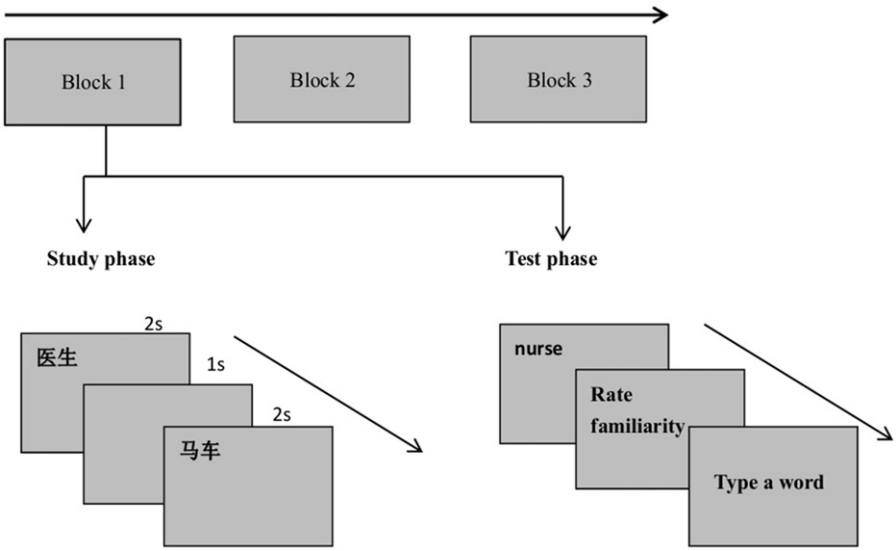

Figure 2. A schematic of the procedure in Experiment 3a.

study-test blocks; (b) in Experiment 3a, Chinese words were presented in the study phase and English meaning-associated words were used as test cues, whereas in Experiment 3b, English words were used as study items and Chinese meaning-associated words were presented as test cues.

Results and Discussion

Proportion of targets recalled

Table 4 presents the mean proportions of identified words (both studied and nonstudied) in Experiment 3a and 3b. A 2 (cued condition: English-cued vs. Chinese-cued) × 2 (study status: studied vs. nonstudied) mixed measures ANOVA showed a significant main effect of study status [F (1, 38) = 206.87, MSE = .10, p < .001, η^2_p = .85], indicating that participants identified more studied words than nonstudied words. There was no significant main effect of the cued condition [F (1, 38) =1.76, MSE = .10, p = .19] and no interaction effect between the two variables [F (1, 38) = 1.35, MSE = .10, p = .25]. These results indicate that the manipulation of study status was valid in both experiments.

Familiarity ratings

The mean familiarity ratings given to cues whose targets could not be identified (i.e., targets unidentified) in Experiment 3a and 3b are presented in Table 5. A 2 (cued condition: English-cued vs. Chinese-cued) ×2 (Study Status: studied vs. nonstudied) mixed measures ANOVA showed a significant main effect of study status [F(1 , 38) = 27.91, MSE =.58, p <.001, η^2_p = .42], suggesting the presence of the RWCR effect. A significant main effect of cued condition was also found, [F (1, 38) = 5.95, MSE = .58,

Table 4. Mean proportion of targets correctly identified in Experiment 3.

	Studied		Nonstudied	
Cued condition	*M*	*SD*	*M*	*SD*
Experiment 3a (Chinese cue)	0.48	0.14	0.13	0.05
Experiment 3b (English cue)	0.43	0.09	0.13	0.08

Note—The proportion of the "non-studied" referred to the situation that participants correctly guessed the target word (i.e. participants typed the correct word corresponding to the test cue, even though they had not studied the word).

Table 5. Mean familiarity ratings of test cues (targets unidentified) in Experiment 3.

	Studied		Non-studied	
	M	*SD*	*M*	*SD*
Experiment 3a	4.74	1.25	3.80	0.79
Experiment 3b	3.88	1.49	3.02	1.09

$p < .05$, $\eta^2_p = .14$], showing that the familiarity ratings on English-cued condition were higher than those on Chinese-cued condition. There was no interaction effect [F (1, 38) = .05, MSE = .58, p = .82]. In order to further investigate whether RWC effect was significant in both of these two experiments, we directly examine the effect of study status on familiarity ratings separately in the two experiments. In Experiment 3a, a paired-sample t-test showed that the familiarity ratings for cues resembling studied targets were significantly higher than that for cues resembling unstudied targets [t (19) = 4.22, $p < .001$, $d = 1.47$]. Likewise, in Experiment 3b, the familiarity ratings for cues resembling studied targets were also significantly higher than that for cues resembling unstudied targets [t (19) = 3.34, $p < .001$, $d = 1.24$]. These findings have demonstrated that even when target words were not successfully identified, test cues similar only semantically to studied targets still received higher familiarity ratings than cues similar only semantically to unstudied targets, demonstrating a significant RWCR effect. Therefore, a significant RWCR effect was found when a cross-language design was used to dissociate semantic feature from phonological and orthographic features. This result suggests that semantic features alone can evoke feelings of familiarity.

General discussion

By using the RWCR paradigm to isolate familiarity from recollection, the current study was conducted to examine whether particular features of a word, including phonological, orthographic and semantic features, could solely evoke feelings of familiarity. Specifically, by taking the advantage of a logographically scripted language (i.e., Chinese) to dissociate phonological from orthographic features in Experiment 1 and vice versa in Experiment 2, we found that phonological and orthographic features could respectively induce a significant RWCR effect on their own. Furthermore, by using a cross-language design to dissociate semantic features from orthographic and phonological features in Experiment 3, we explored whether separate semantic features alone could elicit the RWCR effect. A significant RWCR effect was again found in this experiment. Together, these results have demonstrated that familiarity could be based on separate phonological, orthographic, and semantic features of a word.

The current findings extend previous work (Cleary, 2004; Cleary, Langley, & Seller, 2004; Cleary, Ryals, and Wagner, 2016; Kostic, Cleary, Severin, & Miller, 2010; Ryals and Cleary, 2012) in two aspects. Firstly, previous research used English words as materials, in which the orthography-to-phonology mapping is direct. As a result, the test cue and target were

similar in both orthography and phonology, making it unknown whether separate orthographic or phonological features alone could evoke the feeling of familiarity. Therefore, the current study specially used a logographically scripted language (i.e., Chinese) to dissociate these two types of features from each other and found that both of them can solely induce familiarity. Secondly, the current study also used a novel method (i.e., cross-language design) to dissociate sematic features from both orthographic and phonological features, and found that separate semantic features alone could elicit the RWCR effect, thus replicating and extending the results of previous research.

Regarding the theoretical explanations of familiarity, the results of the current study is consistent with global matching models (see Clark & Gronlund, 1996 for a review). According to these models, familiarity is determined by the overall evaluation of the level of match between the features in the test items and features of the memory trace stored during encoding. Therefore, because the test cues similar to studied words in one feature dimension (phonological, orthographic, or semantic) match the memory trace in a greater degree than test cues similar to unstudied words, they would receive higher ratings of familiarity, which is exactly what we found in the current study.

In addition, the current findings can also be explained by the SAC model (Reder et al., 2000). This model assumes that familiarity is based on the activation of a conceptual node representing a particular word, which already exists even before the encoding session, and has association with its phonemic, orthographic, and semantic information. Importantly, the activation of a node in turn depends on both frequency and recency of exposure, as well as activation spreading from other associated nodes. In the current study, as some test cues and studied words were similar in one particular feature dimension (e.g., phonologically), they may share the same componential feature node(s). As a result, during encoding, the conceptual node of the test cue similar to studied words may receive activation from the shared feature nodes, which in turn receive activation spreading from the conceptual node of the studied word itself. Therefore, during test the conceptual node of test cues similar to studied words would have higher levels of activation compared to that of test cues similar to unstudied words, since the former was recently activated during the encoding session, whereas the latter was not. Thus, test cues similar to studied words would receive higher familiarity ratings.

In conclusion, by making use of novel methods to systematically dissociate phonological, orthographic, and semantic feature from each other, the current study extended previous work and found that phonological, orthographic, and semantic feature could produce the feelings of familiarity on

their own. These results can be explained by both the SAC model and global matching models.

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Appendix

Table A1. Materials in Experiment 1.

Target	Cue	Block	Halves	Target familiarity	Cue familiarity
厂	敞	1	1	6.8	6.2
里	礼	1	1	6.95	6.8
要	药	1	1	6.95	6.8
操	糙	1	1	6.7	6.05
去	趣	1	1	6.9	6.8
到	道	1	1	7	6.8
扰	绕	1	1	6.7	6.55
得	德	1	1	7	6.6
烧	稍	1	1	6.55	6.6
占	绽	1	1	6.7	6
智	质	1	1	6.75	6.75
士	是	1	1	6.75	7
先	仙	1	1	6.9	6.65
残	蚕	1	1	6.55	6.35
断	段	1	1	6.75	6.65
双	霜	1	2	6.85	6.4
入	褥	1	2	6.9	5.6
评	屏	1	2	6.75	6.5
禾	合	1	2	6.35	6.85
窃	怯	1	2	6.35	6.35
男	难	1	2	6.95	6.9
凉	良	1	2	6.75	6.85
叫	教	1	2	6.95	6.8
晚	碗	1	2	6.95	6.6
卖	脉	1	2	6.85	6.45
栋	动	1	2	6.25	6.95
锹	敲	1	2	5.3	6.7
吃	痴	1	2	6.95	6.5
铺	瀑	1	2	6.35	6.2
爱	艾	1	2	7	6.55
旁	庞	2	1	6.75	6.15
插	叉	2	1	6.7	6.6
儿	而	2	1	6.95	7
乌	屋	2	1	6.55	6.8
辛	心	2	1	6.7	6.95
冠	惯	2	1	6.5	6.6
可	渴	2	1	6.95	6.75
林	临	2	1	6.9	6.65

(*continued*)

Table A1. Continued.

Target	Cue	Block	Halves	Target familiarity	Cue familiarity
妒	度	2	1	6.2	6.85
深	身	2	1	6.8	6.9
壶	胡	2	1	6.35	6.75
错	挫	2	1	6.9	6.05
江	将	2	1	6.9	6.7
橙	成	2	1	6.4	6.95
载	宰	2	1	6.5	5.95
禽	勤	2	2	6.15	6.7
军	均	2	2	6.8	6.65
吊	掉	2	2	6.7	6.9
帅	率	2	2	6.95	6.4
才	裁	2	2	7	6.025
澈	彻	2	2	6.15	6.7
低	滴	2	2	6.85	6.7
足	卒	2	2	6.9	5.95
闻	文	2	2	6.65	6.9
皿	敏	2	2	5.6	6.45
绿	滤	2	2	6.85	6.05
诺	挪	2	2	6.45	5.95
睛	经	2	2	6.65	6.95
戒	借	2	2	6.35	6.75
学	穴	2	2	6.95	6.65
夕	西	3	1	6.85	6.95
永	勇	3	1	6.9	6.8
盈	迎	3	1	6.2	6.7
早	枣	3	1	6.9	6.6
扳	般	3	1	5.55	6.9
博	驳	3	1	6.65	6.15
代	带	3	1	6.9	6.95
迫	破	3	1	6.55	6.8
谈	坛	3	1	6.85	6.55
思	司	3	1	6.9	6.75
痊	泉	3	1	5.9	6.6
陵	灵	3	1	5.95	6.8
彤	童	3	1	5.85	6.65
睡	税	3	1	6.85	6.45
簇	醋	3	1	5.7	6.5
流	刘	3	2	6.9	6.9
天	添	3	2	7	6.55
害	骇	3	2	6.8	6
呕	偶	3	2	6.45	6.55
旧	就	3	2	6.95	7
作	坐	3	2	6.85	6.85
牵	千	3	2	6.75	6.95
寻	循	3	2	6.75	6.05
骗	片	3	2	6.6	6.95
乐	勒	3	2	7	5.8
庵	安	3	2	5.6	6.9
篡	窜	3	2	5.2	6.3
雏	厨	3	2	5.8	6.6
冲	充	3	2	6.75	6.9
补	捕	3	2	6.75	6.5
抄	超	4	1	6.75	6.9
也	亦	4	1	6.9	6.65
囚	求	4	1	6.55	6.85
忱	陈	4	1	5.1	6.9
匆	囱	4	1	6.85	4.5
杂	砸	4	1	6.65	6.5
唇	醇	4	1	6.45	5.65
类	累	4	1	6.65	6.9
愧	溃	4	1	6.15	6.05

(*continued*)

Table A1. Continued.

Target	Cue	Block	Halves	Target familiarity	Cue familiarity
明	鸣	4	1	6.9	6.55
吉	即	4	1	6.85	6.65
虚	需	4	1	6.7	6.8
哭	枯	4	1	6.95	6.65
殿	电	4	1	6.15	6.95
每	枚	4	1	6.9	5.9
开	揩	4	2	6.95	5.4
却	确	4	2	6.7	6.75
挖	洼	4	2	6.65	5.65
高	糕	4	2	6.95	6.4
由	游	4	2	6.8	6.65
住	助	4	2	6.95	6.7
贫	频	4	2	6.6	6.35
蹦	泵	4	2	6.2	5.8
浑	魂	4	2	6.2	6.45
玉	欲	4	2	6.75	6.7
崇	虫	4	2	6.05	6.85
强	墙	4	2	6.95	6.75
翻	帆	4	2	6.65	6.35
容	茸	4	2	6.85	5.5
愁	筹	4	2	6.6	6.15

Table A2. Chinese words and corresponding English Translations in Experiment 1.

Target	Translation	Cue	Translation
厂	Factory	敞	Open
里	Inside	礼	Present
要	Want	药	Medicine
操	Exercise	糙	Crude
去	Go	趣	Interest
到	Arrive	道	Road
扰	Disturb	绕	Around
得	Get	德	Virtue
烧	Burn	稍	Slightly
占	Occupy	绽	Blossom
智	Wisdom	质	Quality
士	Bachelor	是	Is
先	Before	仙	God
残	Disabled	蚕	Silkworm
断	Break	段	Paragraph
双	Pair	霜	Frost
入	In	褥	Blanket
评	Judge	屏	Screen
禾	Grain	合	Combine
窃	Steal	怯	Shy
男	Man	难	Hard
凉	Cool	良	Good
叫	Shout	教	Teach
晚	Night	碗	Bowl
卖	Sell	脉	Vein
栋	Building	动	Move
锹	Spade	敲	Knock
吃	Eat	痴	Silly
铺	Pave	瀑	Waterfall
爱	Love	艾	Mugwort
旁	Beside	庞	Large
插	Stick	叉	Fork

(*continued*)

Table A2. Continued.

Target	Translation	Cue	Translation
儿	Son	而	But
乌	Crow	屋	House
辛	Laborious	心	Heart
冠	Champion	惯	Spoil
可	But	渴	Thirsty
林	Wood	临	Close
妒	Envy	度	Degree
深	Deep	身	Body
壶	Jug	胡	Reckless
错	Mistake	挫	Frustrate
江	River	将	Will
橙	Orange	成	Complete
载	Carry	宰	Slaughter
禽	Bird	勤	Diligent
军	Army	均	Average
吊	Hang	掉	Fall
帅	Handsome	率	Lead
才	Tanlent	裁	Tail
澈	Clean	彻	Thorough
低	Low	滴	Drop
足	Foot	卒	Die
闻	Smell	文	Writing
皿	Container	敏	Quick
绿	Green	滤	Filter
诺	Promise	挪	Shift
睛	Eye	经	Usual
戒	Ring	借	Borrow
学	Study	穴	Cave
夕	Evening	西	West
永	Forever	勇	Courage
盈	Full	迎	Welcome
早	Morning	枣	Jujube
扳	Pull	般	Like
博	Erudite	驳	Refute
代	Generation	带	Bring
迫	Force	破	Broke
谈	Talk	坛	Altar
思	Think	司	Company
痊	Heal	泉	Spring
陵	Tomb	灵	Spirit
彤	Red	童	Child
睡	Sleep	税	Tax
簇	Bunch	醋	Vinegar
流	Water	刘	Lau
天	Sky	添	Add
害	Harm	骇	Terrify
呕	Vomit	偶	Model
旧	Old	就	Then
作	Do	坐	Sit
牵	Involve	千	Thousand
寻	Look for	循	Follow
骗	Deceive	片	Piece
乐	Happy	勒	Strangle
庵	Temple	安	Safe
篡	Falsify	窜	Run away
雏	Squab	厨	Kitchen
冲	Flush	充	Fill
补	Patch	捕	Arrest
抄	Copy	超	Exceed
也	Also	亦	Too
囚	Prisoner	求	Beg

(*continued*)

Table A2. Continued.

Target	Translation	Cue	Translation
忱	Sincere	陈	Chan
匆	Hurry	囱	Chimney
杂	Mixed	砸	Crush
唇	Lip	醇	Wine
类	Kind	累	Tired
愧	Guilt	溃	Burst
明	Light	鸣	Chirp
吉	Lucky	即	i.e.
虚	Empty	需	Need
哭	Cry	枯	Wither
殿	Palace	电	Electricity
每	Each	枚	Trunk
开	Open	揩	Wipe
却	But	确	Exactly
挖	Dig	洼	Hollow
高	Tall	糕	Cake
由	Reason	游	Swim
住	Live	助	Help
贫	Poor	频	Frequent
蹦	Jump	泵	Pump
浑	Dirty	魂	Soul
玉	Jade	欲	Desire
崇	Worship	虫	Worm
强	Strong	墙	Wall
翻	Turn over	帆	Sail
容	Contain	茸	Downy
愁	Worry	筹	Tally

Table A3. Materials in Experiment 2.

Target	Cue	Block	Halves	Target familiarity	Cue familarity	Category
厂	广	1	1	6.8	6.9	SMO
里	埋	1	1	6.95	6.7	SMO
要	票	1	1	6.95	6.7	SMO
操	澡	1	1	6.7	6.75	SMO
去	云	1	1	6.9	6.9	SNO
到	倒	1	1	7	6.65	SMO
扰	拢	1	1	6.7	6.15	SMO
得	碍	1	1	7	6.35	SMO
烧	饶	1	1	6.55	6.15	SMO
占	古	1	1	6.7	6.85	SNO
智	暂	1	1	6.75	6.7	SNO
士	土	1	1	6.75	6.9	SNO
先	光	1	1	6.9	6.95	SNO
残	线	1	1	6.55	6.8	SMO
断	继	1	1	6.75	6.65	SMO
双	奴	1	2	6.85	6.35	SNO
入	人	1	2	6.9	6.95	SNO
评	砰	1	2	6.75	6.2	SMO
禾	木	1	2	6.35	6.95	SMO
窃	窍	1	2	6.35	6.4	SMO
男	果	1	2	6.95	6.9	SNO
凉	惊	1	2	6.75	6.75	SNO
叫	纠	1	2	6.95	6.45	SNO
晚	唤	1	2	6.95	6.55	SMO
卖	实	1	2	6.85	6.9	SNO
栋	拣	1	2	6.25	6.3	SNO

(*continued*)

Table A3. Continued.

Target	Cue	Block	Halves	Target familiarity	Cue familarity	Category
锹	揪	1	2	5.3	5.55	SMO
吃	乞	1	2	6.95	6.5	SNO
铺	捕	1	2	6.35	6.5	SMO
爱	受	1	2	7	6.8	SNO
旁	傍	2	1	6.75	6.2	SMO
插	播	2	1	6.7	6.75	SMO
儿	几	2	1	6.95	6.95	SNO
乌	鸟	2	1	6.55	6.95	SNO
辛	幸	2	1	6.7	6.75	SMO
冠	寇	2	1	6.5	5.6	SNO
可	句	2	1	6.95	6.85	SNO
林	材	2	1	6.9	6.6	SMO
妒	炉	2	1	6.2	6.45	SMO
深	探	2	1	6.8	6.6	SMO
壶	壳	2	1	6.35	6.7	SNO
错	腊	2	1	6.9	6.25	SNO
江	扛	2	1	6.9	6.25	SMO
橙	登	2	1	6.4	6.5	SMO
载	裁	2	1	6.5	6.025	SMO
禽	篱	2	2	6.15	5.65	SNO
军	罕	2	2	6.8	6.35	SNO
吊	员	2	2	6.7	6.8	SNO
帅	师	2	2	6.95	6.7	SMO
才	寸	2	2	7	6.75	SNO
澈	撒	2	2	6.15	6.5	SNO
低	纸	2	2	6.85	6.85	SMO
足	是	2	2	6.9	7	SNO
闻	间	2	2	6.65	6.95	SNO
皿	血	2	2	5.6	6.7	SNO
绿	碌	2	2	6.85	6.2	SMO
诺	浩	2	2	6.45	6.5	SNO
睛	晴	2	2	6.65	6.75	SMO
戒	戎	2	2	6.35	5.95	SNO
学	字	2	2	6.95	6.95	SMO
夕	歹	3	1	6.85	6.65	SNO
永	水	3	1	6.9	6.95	SNO
盈	盔	3	1	6.2	6.2	SNO
早	旱	3	1	6.9	6.6	SMO
扳	叛	3	1	5.55	6.2	SMO
博	傅	3	1	6.65	5.85	SNO
代	伐	3	1	6.9	6.2	SMO
迫	追	3	1	6.55	6.75	SMO
谈	淡	3	1	6.85	6.85	SMO
思	恩	3	1	6.9	6.9	SMO
痊	疾	3	1	5.9	6.55	SMO
陵	俊	3	1	5.95	6.65	SNO
彤	形	3	1	5.85	6.85	SNO
睡	睦	3	1	6.85	5.8	SNO
簇	族	3	1	5.7	6.5	SMO
流	统	3	2	6.9	6.6	SNO
天	夫	3	2	7	6.8	SNO
害	割	3	2	6.8	6.6	SMO
呕	枢	3	2	6.45	5.5	SNO
旧	日	3	2	6.95	7	SMO
作	诈	3	2	6.85	6.45	SNO
牵	荤	3	2	6.75	5.9	SNO
寻	导	3	2	6.75	6.85	SNO
骗	编	3	2	6.6	6.625	SMO
乐	东	3	2	7	6.95	SNO
庵	淹	3	2	5.6	6.3	SMO
篡	算	3	2	5.2	6.7	SMO

(*continued*)

Table A3. Continued.

Target	Cue	Block	Halves	Target familiarity	Cue familarity	Category
雏	锥	3	2	5.8	5.6	SNO
冲	中	3	2	6.75	7	SMO
补	仆	3	2	6.75	6.4	SMO
抄	秒	4	1	6.75	6.85	SMO
也	他	4	1	6.9	6.95	SNO
因	因	4	1	6.55	7	SNO
忱	沈	4	1	5.1	6.45	SMO
匆	勿	4	1	6.85	6.5	SNO
杂	朵	4	1	6.65	6.8	SMO
唇	辱	4	1	6.45	6.3	SNO
类	娄	4	1	6.65	5.2	SNO
愧	槐	4	1	6.15	5.85	SNO
明	朋	4	1	6.9	6.9	SNO
吉	舌	4	1	6.85	6.9	SNO
虚	虐	4	1	6.7	6.2	SMO
哭	咒	4	1	6.95	6.45	SMO
殿	殷	4	1	6.15	5.75	SNO
每	母	4	1	6.9	6.9	SNO
开	并	4	2	6.95	6.95	SNO
却	卸	4	2	6.7	6.35	SNO
挖	控	4	2	6.65	6.65	SMO
高	蒿	4	2	6.95	4.95	SMO
由	甲	4	2	6.8	6.8	SNO
住	佳	4	2	6.95	6.85	SMO
贫	贪	4	2	6.6	6.6	SMO
蹦	蹋	4	2	6.2	5.95	SMO
浑	挥	4	2	6.2	6.55	SNO
玉	王	4	2	6.75	6.95	SNO
崇	祟	4	2	6.05	5.25	SNO
强	弹	4	2	6.95	6.45	SMO
翻	翩	4	2	6.65	6.15	SMO
容	客	4	2	6.85	6.75	SNO
愁	秋	4	2	6.6	6.8	SMO

SMO indicates that the cue and target is similar more than orthographically, whereas the SNO indicates that the cue and target is similar only orthographically.

Table A4. Chinese words and corresponding English Translations in Experiment 2.

Target	Translation	Cue	Translation
厂	Factory	广	Wide
里	Inside	埋	Bury
要	Want	票	Ticket
操	Exercise	澡	Shower
去	Go	云	Cloud
到	Arrive	倒	Fall
扰	Disturb	拢	Gather
得	Get	碍	Hinder
烧	Burn	饶	Forgive
占	Occupy	古	Ancient
智	Wisdom	暂	Temporary
士	Bachelor	土	Dust
先	Before	光	Light
残	Disabled	线	Line
断	Break	继	After
双	Pair	奴	Slave
入	In	人	Man
评	Judge	砰	Bang
禾	Grain	木	Wood
窃	Steal	窍	Key
男	Man	果	Fruit
凉	Cool	惊	Surprise
叫	Shout	纠	Tangle
晚	Night	唤	Call
卖	Sell	实	Fact
栋	Building	拣	Pick up
锹	Spade	揪	Seize
吃	Eat	乞	Beg
铺	Pave	捕	Capture
爱	Love	受	Receive
旁	Beside	傍	Beside
插	Stick	播	Broadcast
儿	Son	几	Several
乌	Crow	鸟	Bird
辛	Laborious	幸	Lucky
冠	Champion	寇	Bandit
可	But	句	Sentence
林	Wood	材	Wood
妒	Envy	炉	Stove
深	Deep	探	Detect
壶	Jug	壳	Shell
错	Mistake	腊	Winter
江	River	扛	Carry
橙	Orange	登	Climb
载	Carry	裁	Tai
禽	Bird	篱	Fence
军	Army	罕	Seldom
吊	Hang	员	Member
帅	Handsome	师	Teacher
才	Talent	寸	Inch
澈	Clean	撒	Scatter
低	Low	纸	Paper
足	Foot	是	Is
闻	Smell	间	Between
皿	Container	血	Blood
绿	Green	碌	Busy
诺	Promise	浩	Vast
睛	Eye	晴	Fine
戒	Ring	戎	Army
学	Study	字	Character
夕	Evening	歹	Bad

(*continued*)

Table A4. Continued.

Target	Translation	Cue	Translation
永	Forever	水	Water
盈	Full	盔	Helmet
早	Morning	旱	Dry
扳	Pull	叛	Betray
博	Erudite	傅	Master
代	Generation	伐	Cut
迫	Force	追	Chase
谈	Talk	淡	Weak
思	Think	恩	Favor
痊	Heal	疾	Quick
陵	Tomb	俊	Handsome
彤	Red	形	Shape
睡	Sleep	睦	Harmonious
簇	Bunch	族	Race
流	Water	统	Unite
天	Sky	夫	Husband
害	Harm	割	Cut
呕	Vomit	枢	Pivot
旧	Old	日	Sun
作	Do	诈	Deceive
牵	Involve	荤	Meat
寻	Look for	导	Lead
骗	Deceive	编	Weave
乐	Happy	东	East
庵	Temple	淹	Drown
篡	Falsify	算	Calculate
雏	Squab	锥	Drill
冲	Flush	中	Middle
补	Patch	仆	Servant
抄	Copy	秒	Second
也	Also	他	He
囚	Prisoner	因	Because
忱	Sincere	沈	Shen
匆	Hurry	勿	Not
杂	Mixed	朵	A
唇	Lip	辱	Insult
类	Kind	娄	Basket
愧	Guilt	槐	Sophora
明	Light	朋	Friend
吉	Lucky	舌	Tongue
虚	Empty	虐	Cruel
哭	Cry	咒	Curse
殿	Palace	殷	Abundant
每	Each	母	Mother
开	Open	并	And
却	But	卸	Unload
挖	Dig	控	Control
高	Tall	蒿	Wormwood
由	Reason	甲	Nail
住	Live	佳	Good
贫	Poor	贪	Corrupt
蹦	Jump	蹋	Kick
浑	Dirty	挥	Wave
玉	Jade	王	King
崇	Worship	祟	Ghost
强	Strong	弹	Play
翻	Turn over	翩	Fleeting
容	Contain	客	Customer
愁	Worry	秋	Autumn

Table A5. Materials in Experiment 3.

English	Chinese	Block	Halves	Chinese familiarity	English familiarity
Potato	番茄	1	1	6.90	6.71
Dream	睡觉	1	1	7.00	6.62
Tool	锤子	1	1	6.38	6.43
Development	变化	1	1	6.76	6.43
Market	销售	1	1	6.81	6.60
Boy	女孩	1	1	7.00	7.00
Apple	桔子	1	1	6.95	6.90
Garden	公园	1	1	6.76	6.76
Shock	惊讶	1	1	6.76	6.38
Horse	马车	1	1	6.43	6.52
Bottle	容器	1	1	6.62	6.52
Coast	海洋	1	1	6.57	5.76
Skin	光滑	1	1	6.81	6.67
Picture	照片	1	1	6.95	7.00
Charm	吸引	1	1	6.90	5.57
Competition	比赛	1	2	6.67	6.14
Law	律师	1	2	6.81	6.62
Arm	肩膀	1	2	6.90	7.00
Flower	草地	1	2	6.95	6.95
Gift	节日	1	2	6.86	7.00
Sugar	香甜	1	2	6.81	6.33
Shoes	袜子	1	2	7.00	6.71
Victory	成功	1	2	6.95	5.76
Book	知识	1	2	6.90	7.00
Similarity	相同	1	2	6.45	6.52
Silence	安静	1	2	6.95	6.62
Lip	牙齿	1	2	7.00	5.62
King	王后	1	2	6.71	7.00
Clothing	裤子	1	2	6.95	7.00
Cool	寒冷	1	2	6.63	6.53
Circle	戒指	2	1	6.43	6.29
Amount	数字	2	1	6.86	6.19
Hour	分钟	2	1	6.86	6.62
Industry	商业	2	1	6.76	6.24
Style	特点	2	1	6.81	6.67
Winter	夏天	2	1	6.90	6.76
Mountain	平原	2	1	6.48	6.71
Street	马路	2	1	6.81	6.76
Intellect	聪明	2	1	6.62	5.10
Chair	桌子	2	1	6.81	6.57
Elephant	非洲	2	1	6.76	6.38
History	过去	2	1	6.81	6.90
Honor	自豪	2	1	6.90	6.43
Baby	儿童	2	1	6.86	7.00
Science	技术	2	1	6.90	6.24
Building	房物	2	2	6.57	6.71
Sky	蔚蓝	2	2	6.90	6.76
Coffee	牛奶	2	2	6.90	6.76
Friend	友谊	2	2	7.00	6.86
Hotel	住宿	2	2	6.76	7.00
Cotton	柔软	2	2	6.95	5.71
Cat	小狗	2	2	6.86	6.71
Answer	问题	2	2	6.95	6.86
Officer	政府	2	2	6.76	6.57
Doctor	护士	2	2	6.95	7.00
Army	军人	2	2	6.71	6.57
Poet	诗歌	2	2	6.71	6.76
Temple	和尚	2	2	6.90	6.57
Star	月亮	2	2	7.00	6.57
Fox	狡猾	2	2	6.90	6.52
Theory	实践	3	1	6.81	5.62

(*continued*)

Table A5. Continued.

English	Chinese	Block	Halves	Chinese familiarity	English familiarity
Length	宽度	3	1	6.86	6.33
Life	生存	3	1	6.76	6.76
Car	的士	3	1	6.86	6.95
Party	生日	3	1	7.00	7.00
Humor	笑话	3	1	6.81	6.14
Window	大门	3	1	6.95	6.95
Steam	水汽	3	1	6.57	6.10
Ship	飞机	3	1	6.62	6.62
Hide	秘密	3	1	6.29	6.19
Newspaper	信息	3	1	6.71	6.71
World	地球	3	1	6.81	7.00
Attitude	立场	3	1	6.67	6.71
Dollar	金钱	3	1	6.86	7.00
City	乡镇	3	1	6.76	7.00
Wheat	水稻	3	2	6.76	5.38
Pencil	钢笔	3	2	6.90	6.67
Lake	河流	3	2	6.95	6.57
Blood	红色	3	2	6.86	6.38
Professor	专家	3	2	6.67	6.62
Clock	手表	3	2	6.90	6.52
Vision	眼睛	3	2	6.95	6.19
Virtue	善良	3	2	6.95	4.52
Gentleman	淑女	3	2	6.71	6.86
Fork	刀子	3	2	6.81	6.10
Letter	单词	3	2	6.76	6.71
Forest	树木	3	2	7.00	6.62
Stone	坚硬	3	2	6.81	6.62
Camp	帐篷	3	2	6.10	6.10
Woman	男人	3	2	7.00	7.00

Table A6. Chinese words and corresponding English translations in Experiment 3.

Chinese	Translations
番茄	Tomato
睡觉	Sleep
锤子	Hammer
变化	Change
销售	Sale
女孩	Girl
桔子	Orange
公园	Park
惊讶	Surprise
马车	Wagon
容器	Container
海洋	Ocean
光滑	Smooth
照片	Photo
吸引	Attract
比赛	Game
律师	Lawyer
肩膀	Shoulder
草地	Grass
节日	Festival
香甜	Sweet
袜子	Sock
成功	Success
知识	Knowledge
相同	Same
安静	Quiet
牙齿	Teeth
王后	Queen
裤子	Trousers
寒冷	Cold
戒指	Ring
数字	Number
分钟	Minutes
商业	Commerce
特点	Characteristic
夏天	Summer
平原	Plain
马路	Road
聪明	Clever
桌子	Desk
非洲	African
过去	Past
自豪	Proud
儿童	Child
技术	Technology
房屋	House
蔚蓝	Blue
牛奶	Milk
友谊	Friendship
住宿	Accommodation
柔软	Soft
小狗	Puppy
问题	Question
政府	Government
护士	Nurse
军人	Military man
诗歌	Poem
和尚	Buddhist monk
月亮	Moon
狡猾	Sly

(*continued*)

Table A6. Continued.

Chinese	Translations
实践	Practice
宽度	Width
生存	Exist
的士	Taxi
生日	Birthday
笑话	Joke
大门	Gate
水汽	Steam
飞机	Plane
秘密	Secret
信息	Information
地球	Earth
立场	Standpoint
金钱	Money
乡镇	Village
水稻	Rice
钢笔	Pen
河流	River
红色	Red
专家	Expert
手表	Watch
眼睛	Eye
善良	Kindhearted
淑女	Lady
刀子	Knife
单词	Word
树木	Wood
坚硬	Tough
帐篷	Tent
男人	Man