An Investigation of Idiom Processing Advantage using Translated Familiar Idioms

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Abstract

The facilitatory effect shown in native speakers processing idiomatic phrases compared to matched novel phrases may be explained by a dual route model. This postulates that all phrases are processed literally at first, and if a phrase was recognized as familiar during processing, it would then be processed by a faster retrieval-route; if the phrase was not perceived as familiar, it would continue to be processed literally by the slower computation-route. The goals of the current project were to test the dual route model and to decipher the underlying mechanism in retrieval-route activation. English idioms and translated Chinese idioms were presented to both native English speakers and Chinese-English bilinguals in random order. Participants listened to the idiom up until the last word (e.g., “draw a snake and add”), then saw either the idiom ending (e.g., “feet”) or the matched control ending (e.g., “hair”); to which they made lexical decision and reaction times were recorded. We examined the priming effect for idioms compared to controls across the two language groups. Results showed that the two groups processed idioms of different origins differently. Native English speakers’ faster responses to English idioms than controls supported a dual route model; however, both native English and bilingual speakers’ faster responses to Chinese idioms than controls called for a less straightforward interpretation. For R code and outputs, refer to [Rpubs post](#).

Keywords: Idiom processing, psycholinguistics, bilingualism

Introduction

Idioms are expressions whose meaning cannot be derived from a systematic or literal processing of the component words (Libben & Titone, 2008; Swinney & Cutler, 1979; Vespignani et al., 2010). For example, “a chip off the old block” means “someone who resembles their parent, especially in character”. Despite the discrepancy between the stated and intended meanings, speakers process idioms from their native language effortlessly. Familiar idioms are shown to be responded to faster than matched control phrases (Cacciari et al., 2007; Cacciari & Tabossi, 1988; Conklin & Schmitt, 2008; Tabossi et al., 2009). This fluency and idiomatic control is mainly attributed to the users’ subjective familiarity with the idiomatic strings (Carrol & Conklin, 2020; Libben & Titone, 2008; Schweigert, 1986, 1991; Tabossi et al., 2009). Studies of idiom variation have shown that altering the syntax affects idioms’ acceptability and comprehension to various degrees (Geeraert et al., 2018; McGlone et al., 1994; Tabossi et al., 2009). However, Carrol and colleagues (Carrol et al., 2016; Carrol & Conklin, 2014, 2017) were the only researchers that have examined the extent to which a translated form of an idiom can still be recognized for the original figurative meaning. We examined this question in the current study using a dual route model framework.

The dual route model contends that two approaches become available when a familiar idiom is encountered (Cutting & Bock, 1997; van Lancker Sidtis, 2012; Wray, 2002; Wray & Perkins, 2000). The “computation-route” is assumed to be the default processing route, and it calculates the literal meaning of the constituent words one by

one. This assumption accounts for the evidence from previous literature that idiom components are accessed during processing (Gibbs et al., 1989; Sprenger et al., 2006; Titone & Connine, 1999). This compositional processing continues until the idiomatic key is reached (Cacciari & Tabossi, 1988). The idiomatic key is the point where the phrase is first recognized as idiomatic. Once this point is reached, the “retrieval-route” is activated and the whole idiom is retrieved from long-term memory (Gibbs, 1980; Swinney & Cutler, 1979; Wray, 2002, 2008). The dual route model suggests that retrieval-route activation is the main reason for idiom processing advantage. Using the idiom “a chip off the old block” as an example, when “A chip off the old...” is encountered, the computation-route is activated for compositional analysis. The combination of constituent words in “A chip off the old” triggers the idiomatic configuration, so the last word “block” is automatically activated before it is actually encountered. However, if the idiomatic key activated a certain idiom configuration but unexpected information (e.g., “fence” instead of “block”) showed up, the compositional processing would continue, and results in slower recognition of the unexpected word compared to the pre-activated idiomatic component word (Carrol et al., 2016; Conklin & Carrol, 2018).

Although the evidence of dual processing is well established in L1 speakers (e.g., Kuiper et al., 2007; Titone & Connine, 1999), there is relatively less evidence that idiomatic meaning can influence comprehension across languages. The few studies that have examined the dual route model in the bilingual contexts (Carrol et al., 2016; Carrol & Conklin, 2014, 2017) have aimed at answering the same research question - would the retrieval-route be activated by the translation equivalent of a familiar idiom?

Cross-Language Facilitation

There has been widespread evidence showing single word priming effects for translation equivalents (e.g., apple/manzana) across languages (Chen & Ng, 1989; de Groot & Nas, 1991). Kroll and Stewart (1994) proposed that bilinguals have separate lexical stores for words from each language and a common conceptual store. Numerous studies have shown that cross-language facilitation goes beyond the single word level. Ueno (2009) found that unrelated English word pairs were responded to faster by Japanese-English bilinguals when these were translated from Japanese collocations. Similar results were found for Swedish-English bilinguals during collocation processing (Wolter & Gyllstad, 2011, 2013) and English-French bilinguals during idiom processing (Titone et al., 2015). However, other studies have failed to produce significant congruency effects in Japanese-English bilinguals using collocations (Wolter & Yamashita, 2015, 2018) and German-English bilinguals using idioms (Beck & Weber, 2016). These studies painted a mixed picture of cross-language activation in processing multi-word formulaic expressions.

The majority of studies on cross-language facilitation examined the relationship between pairs of alphabetic languages (de Groot & Nas, 1991; Gollan et al., 1997; Sánchez-Casas et al., 1992). The present study used a logographic-alphabetic pair which eliminates orthographic overlap between the languages. It would further strengthen the evidence for the fact that cross-language facilitation is mediated by underlying conceptual representation. Chinese idioms are suitable for the investigation of cross-language effects because they are formulaic expressions that allow little semantic substitution or syntactic flexibility (Zhou, 2004).

To our knowledge, the series of studies conducted by Carrol and Conklin are the only ones that examined the cross-language effects of idioms between Mandarin Chinese and English. Carrol and Conklin’s work used both behavioral (2014) and eye-tracking (2017) measures. In their behavioral study, Mandarin-English bilinguals read translated Chinese idioms at their own pace until the second-to-last word, then made lexical decisions to either the idiomatic endings or control words. The authors showed that idioms from the native language (L1) were processed faster even when they were presented in the translated form in participants’ second language (L2). However, this study suffered from two limitations. First, the self-paced reading paradigm was not necessarily a measure of on-line processing (Sonbul & Siyanova-Chanturia, 2019). Specifically, participants were given the lexical decision task only after indicating that they have finished reading the prime. It is hard to determine whether participants have used the allotted self-paced reading time to also translate back and forth to consciously generate predictions for the final word. Second, the authors failed to find significant main effects of idioms’ language origin (Chinese vs. English) and phrase type (i.e., idiomatic endings vs. control words), neither

did they find a significant interaction effect between these two variables. This implied that the bilingual participants were oblivious about the experimental manipulations. Although the post hoc analysis that compared only the Chinese phrase types did show a significant difference ($p < .05$), we were not sure how reliable this result is as evidence of cross-language facilitation for familiar idioms. This first limitation was addressed in Carrol and Conklin (2017) through eye-tracking measures. In their Experiment 1, the researchers found evidence of facilitation for L1 idioms (Mandarin) processed in L2 (English). Specifically, idiomatic endings were read faster than control words, but there was no difference for reading times across the whole phrase.

Replications and extensions are crucial in this literature for obtaining more valid and generalizable results. The present study replicated and extended the work of Carrol and Conklin (2014) by addressing the above-mentioned limitations and tripling the sample size used in their study. We too examined whether the knowledge of L1 idioms facilitated the processing of these idioms in L2 through retrieval-route activation. Mandarin-English bilinguals and native English speakers processed English translation equivalents of Chinese idioms and original English idioms. We hypothesized that native English speakers would show an idiom processing advantage for English idioms over controls but no RT difference for translated Chinese phrase types. Based on Carrol and Conklin's (2014, 2017), we predicted that Mandarin-English bilinguals would respond faster to translated Chinese idioms than non-idiomatic phrases, and show no RT difference for English phrase type conditions due to their lack of familiarity with the strings.

Methods

Materials

Idiom and Filler Stimuli. The complete list of idioms and controls¹ can be found in Appendix A (translated Chinese phrase types) and B (English phrase types) in the supplementary materials. Matched control phrases were formed by replacing the last word of the corresponding idiom with an idiomatically irrelevant word which was matched with the idiomatic endings for part of speech, length, frequency². Filler phrases with word and non-word phrase endings were included. Non-word fillers were composed of 86 unused English or translated Chinese idioms, and 58 literal phrases. Non-words were taken from the ARC non-word database (Rastle et al., 2002). Familiarity norming (See Appendix C in the supplementary materials) was completed by 28 native English speakers and 8 Mandarin-English bilinguals³. It was shown that native English speakers' ratings were high for English idioms ($M = 5.40$, $SD = .722$), and low for translated Chinese idioms ($M = 1.40$, $SD = .309$). The bilingual familiarity ratings were low for English idioms ($M = 2.07$, $SD = .482$), and high for translated Chinese idioms ($M = 4.14$, $SD = .075$). The final stimuli were divided into two counterbalanced lists with an idiom and its control appearing on opposite lists. See Table 1 for conditions and stimuli count each participant received and an example stimulus from each condition. Auditory stimuli (e.g., "barking up the wrong ...") were recorded with Audacity digital editor by a native English speaker from Ontario, Canada.

Table 1. Example of stimulus materials in each condition

Condition	Prime	Target	Number
English Idiom	Barking up the wrong	tree	24
English Control	Barking up the wrong	wall	24
Chinese Idiom	Mark the boat to seek the	sword	24
Chinese Control	Mark the boat to seek the	steel	24
Filler phrase + Word	Explain the facts to	mother	48
Filler phrase + Non-word	Don't cry over spilt	prutt	144

¹ The full list of English idioms were selected from Titone and Connine (1994), Carrol and Conklin (2014) <http://www.idiomsite.com> and <http://www.ef.com/english-resources/english-idioms/>. The full list of Chinese idioms in their original forms were mostly developed by the first author and translated to English using MDBG dictionary (<https://www.mdbg.net/chinese/dictionary>), there were a few translated idioms taken directly from Carrol and Conklin (2014). Footnote 1 in the supplementary materials describes in detail how we filtered the full lists based on familiarity ratings of each speaker group, to arrive at the final experimental stimuli for our experiment.

² T-tests were done to ensure the match between idiomatic endings and control endings. Frequency (Freq_HAL): English phrase types: $t(47) = 0.44$, $p = .66$; translated Chinese phrase types: $t(47) = 0.35$, $p = .73$). Unprimed reaction times: English phrase types: $t(47) = 0.15$, $p = .88$; translated Chinese phrase types: $t(47) = 0.58$, $p = .56$. Based on norming data provided by the English Lexicon Project (ELP; Balota et al., 2007).

³ Detailed norming procedure is described in footnote 1 in the supplementary materials.

Participants

English Participants. Sixty-six native English speakers participated for course credit. Age of participants ranged from 17 to 20 years old ($M = 18.16$, $SD = 0.74$). Participants were raised in Canada or the U.S. Sixty-one participants were included in the final analysis⁴: 31 completed counterbalanced List 1, and 30 completed counterbalanced List 2.

Chinese Participants. Seventy-two Mandarin-English bilinguals (Mandarin as their native language) participated either for course credit or \$10 CAD compensation. Only people that were born and raised in China until at least age 11 and had lived in Canada for more than 3 years qualified. This ensured that participants received sufficient formal education and cultural exposure in China to acquire the common Chinese idioms, and to have the English proficiency for understanding the words used in this experiment. Participants' ages ranged from 17 to 30 years old ($M = 20.10$, $SD = 2.70$). See Appendix D in supplementary materials for demographic questions. Participants' years of residency in China ranged from 11 to 21 years ($M = 15.30$, $SD = 2.55$) years, and in Canada ranged from 3 to 8 years ($M = 4.89$, $SD = 1.39$). Fifty-eight Mandarin-English bilinguals⁵ were included in the final analysis, 29 completed each counterbalanced list.

Procedure

Each participant completed a language knowledge questionnaire (see Appendix D in supplementary materials). The experiment was constructed using PsychoPy (an open-source software; Peirce, 2007) and was conducted using desktop computers. All stimuli were presented free of context. Participants listened to partial phrases (e.g., barking up the wrong___) through the headphones while "#####" appeared on the screen. At the offset of each audio, they saw either the idiomatic ending (e.g., tree), control ending (e.g., wall) or a non-word (e.g., plud) show up on the screen, to which they had 5s to make a lexical decision through button-press (1 for word, 0 for non-word). All non-words were in filler trials, and these trials were removed from analysis. Auditory feedback in the form of a short buzz was presented when an incorrect response was given. Mandarin-English bilinguals and native English speakers received the same two counterbalanced lists and trials were presented in a random order. RT and accuracy were recorded.

Results

Participants were grouped by their native language and RTs more than 2 standard deviations away from each group mean were removed (7% of raw data)⁶. Table 2 shows condition mean RTs and standard deviations. See Figure 1 for a visualization of RT distribution.

⁴ Five participants were excluded from the analysis for various reasons: software crash, low performance, not following instructions, and failing to disclose knowledge of Mandarin.

⁵ Fourteen participants were excluded from the analysis due to: low performance (i.e., < 80%); knowing Cantonese but not Mandarin, and software error.

⁶ The words 'gold' and 'water' each appeared twice as endings for different idioms which led to modeling errors, so we removed one of the idioms containing each word from the analyses.

Table 2. Mean RT (SD) in msec for each condition. We used the same layout as Table 3 in Carrol and Conklin (2014) for direct comparisons between the two studies.

	English Idioms	English Controls	Chinese Idioms	Chinese Controls
Native English Speakers				
Raw RT	576 (138)	646 (127)	610 (122)	637 (127)
Log RT	6.33 (0.24)	6.45 (0.20)	6.39 (0.20)	6.44 (0.20)
Bilinguals Speakers				
Raw RT	699 (163)	729 (172)	702 (160)	728 (169)
Log RT	6.52 (0.23)	6.56 (0.23)	6.53 (0.22)	6.56 (0.23)

Figure 1. Distribution of RTs in each condition across all participants. Left panel shows native English speakers' performance and the right panel shows Mandarin-English bilinguals' performance. CN = Chinese phrase types, EN = English phrase types. Red box plot represents control condition, green box plot represents idiomatic condition.

The analyses were implemented using the lme4 package (Bates et al., 2015) in R (R Core Team, 2020). Our primary interest was in the three treatment-coded variables: idiom language (Chinese or English), phrase type (Idiom or control), and native language (Mandarin or English). The dependent variable was log transformed RT on the lexical decision task⁷. We report results from the 'BOBYQA' optimizer because it improved convergence. Participants were separated by native language and each group's data were fitted to a series of linear mixed-effects models. The full model for each language group included random intercepts for participants and items, and by-participant random slopes of idiom language and phrase type (Barr et al., 2013). Idiom language, phrase type and their interaction were added to the default models as fixed effects. Final word length, log-transformed final word frequency (freq_HAL; Lund & Burgess, 1996), averaged familiarity ratings⁸, literal

⁷ RTs were log transformed to both reduce skewness and be comparable to Carrol and Conklin (2014)

⁸ Familiarity ratings were obtained through norming study, and was done by another set of participants.

plausibility⁹, and semantic relatedness between each prime and its corresponding final words¹⁰ (Pilehvar et al., 2013) were also included as fixed effects.

We first analyzed the data of all participants through an omnibus linear mixed effects model, this model also includes the above-described fixed and random effects¹¹. There was a significant 3-way interaction among idiom language, participant's native language and phrase type, [$\beta = 0.078$, $SE = 0.015$, $t(8605) = 5.03$, $p < .001$]. Based on this result, we then explored the ways in which the two native language groups differed in processing phrases in different conditions.

Native English Speakers

The full linear mixed-effects model incorporated the fixed and random effects mentioned in the previous section. Backward elimination of all non-significant effects was carried out using the "step" function within the "lmerTest" package in R (Kuznetsova et al., 2017). The predictors in the final reduced model were phrase type, idiom language, the interaction between phrase type and idiom language, log-transformed final word frequency, final word length, and literal plausibility.

There was no significant main effect of idiom language, [$\beta = 0.013$, $SE = 0.013$, $t(161) = 0.97$, $p = .33$], and there was no significant main effect of phrase type, [$\beta = -0.025$, $SE = 0.015$, $t(166) = -1.69$, $p = .09$]. There was a significant interaction between idiom language and phrase type, [$\beta = -0.071$, $SE = 0.019$, $t(156) = -3.80$, $p < .001$]. Literal plausibility was significant, [$\beta = -0.035$, $SE = 0.006$, $t(174) = -5.66$, $p < .001$], with more literally plausible phrases being responded to faster. Final word length was significant, [$\beta = 0.009$, $SE = 0.004$, $t(161) = 2.17$, $p < .05$], with shorter words being responded to faster. Finally, log final word frequency was a significant fixed effect, [$\beta = -0.016$, $SE = 0.004$, $t(160) = -4.40$, $p < .001$], with more frequent words being responded to faster.

To further investigate the ways in which native English speakers responded to phrases from different languages differently, we fitted separate mixed effects models to English phrases and Chinese phrases. Phrase type was significant for both English items, [$\beta = -0.091$, $SE = 0.017$, $t(98) = -5.40$, $p < .001$]; and for Chinese items, [$\beta = -0.033$, $SE = 0.013$, $t(70) = -2.44$, $p < .05$], with idioms being responded to faster. The interaction effect between idiom language and phrase type may be due to the much larger RT difference between English phrase types than between Chinese phrase types. Through the same models, we found that frequency significantly predicted RT for Chinese phrases and was marginally significant for English phrases¹². Literal plausibility had a significant effect in predicting RT for both languages¹³.

Mandarin-English Bilinguals

The predictors in the final reduced model were phrase type, log-transformed final word frequency, and final word length and literal plausibility. There was no significant main effect of idiom language, [$\beta = -0.005$, $SE = .020$, $t(173) = -0.25$, $p = .80$]. A significant main effect of phrase type was observed, [$\beta = -0.026$, $SE = 0.012$, $t(164)$

⁹ Twenty-six native English speakers (MTurk workers) rated the literal plausibility of all phrases. The instructions given were identical to the literal plausibility instruction used in Bulkes and Tanner (2017).

¹⁰ Mann-Whitney U test showed that the semantic relatedness did not differ between Chinese phrase types, $U = 1058$, $n_1 = n_2 = 48$, $p = 1$. However, this was significantly different between English phrase types, $U = 745$, $n_1 = n_2 = 48$, $p < .01$, with idiomatic endings being more semantically related to the primes than control endings.

¹¹ Familiarity rating was not included because the two native language groups gave opposite ratings to phrases from different languages.

¹² Final word frequency significantly predicted RT in Chinese phrases, [$b = -0.017$, $SE = 0.004$, $t(73) = -3.76$, $p < .001$], with more frequent words being responded to faster; and was marginally significant in English phrases, [$b = -0.010$, $SE = 0.005$, $t(80) = -1.95$, $p = .054$].

¹³ Literal plausibility significantly predicted RT for both Chinese phrases, [$b = -0.022$, $SE = 0.009$, $t(78) = -2.45$, $p < .05$]; and in English phrases, [$b = -0.038$, $SE = 0.009$, $t(88) = -4.46$, $p < .001$], with more literally plausible phrases being responded to faster.

= -2.18, $p < .05$], with idiomatic phrases being responses to faster. The interaction between idiom language and phrase type was not significant, [$\beta = 0.007$, $SE = 0.022$, $t(159) = 0.30$, $p = .76$]. Final word length was significant, [$\beta = 0.022$, $SE = 0.005$, $t(167) = 4.69$, $p < .001$], with shorter words being responded to faster. Log final word frequency was also a significant fixed effect, [$\beta = -0.028$, $SE = 0.004$, $t(164) = -7.00$, $p < .001$], with more frequent words being responded to faster. Literal plausibility was also a significant fixed effect, [$\beta = -0.021$, $SE = 0.007$, $t(179) = -2.96$, $p < .01$], with more literally plausible phrases being responded to faster.

To further investigate the ways in which bilingual speakers responded to Chinese phrases vs. English phrases, we fitted separate mixed effects models to each idiom language. Phrase type was significant for Chinese phrases, [$\beta = -0.036$, $SE = 0.017$, $t(80) = -2.14$, $p < .05$], with idioms being responded to faster; but not for English items, [$\beta = -0.013$, $SE = 0.017$, $t(83) = -0.76$, $p = .45$]. Through the same models, we found that frequency significantly predicted RT for both idiom languages¹⁴. Literal plausibility had a significant effect only for English phrases¹⁵.

Discussion

As a replication and extension to Carrol and Conklin (2014), the present study examined whether familiar L1 idioms can be accessed through L2 and still display an idiom processing advantage. Native English speakers responded faster to English idioms than control phrases, demonstrating possible retrieval-route activation. The results from our English participants partially overlapped with Carrol and Conklin (2014). Both studies found an idiom facilitation effect in familiar L1 idioms processed in L1, aligning with results from other studies (Cacciari et al., 2007; Cacciari & Tabossi, 1988; Conklin & Schmitt, 2008; Libben & Titone, 2008; Tabossi et al., 2009). To our surprise, English speakers also responded faster to Chinese idioms than control phrases. However, Carrol and Conklin's study found no response difference when native English speakers processed Chinese idioms and control phrases. We speculated that these contradictory results may be partially explained by the significant effect of literal plausibility (Connell & Keane, 2006). It has been suggested that high literal plausibility facilitates processing (Carrol & Conklin, 2017). In our study, literal plausibility rating (see Appendices A and B) was a significant predictor of RT in the analysis of Chinese phrase conditions, it may be the case that idioms tend to be more literally plausible than control phrases in our experimental materials. We did not evaluate the literal plausibility of our control items, this limitation should be addressed by future studies. On the other hand, with literal plausibility being accounted for, phrase type is still a significant predictor of RT, indicating other factors also contributed to the RT difference between Chinese phrase conditions.

Bilingual participants' results were similar to results observed in Carrol and Conklin (2014). Specifically, we observed an idiom processing advantage when familiar L1 idioms were processed in L2, and participants did not process unfamiliar idioms differently from control phrases. Carrol and Conklin interpreted this as supporting evidence for cross-language direct access to familiar idioms. In our study, however, it was unclear how much can the processing advantage of translated idioms be explained by retrieval-route activation, given that native English speakers also displayed the same RT difference. On the other hand, bilingual participants did not process English phrase conditions differently, indicating that the significant RT difference between English phrase conditions seen in native English speakers can be attributed to retrieval-route activation led by familiarity.

There have been inconsistent results regarding cross-language activation in processing multi-word formulaic expressions: some studies found supporting evidence (Carrol et al., 2016; Carrol & Conklin, 2014, 2017; Titone et al., 2015), while others did not (Beck & Weber, 2016; Wolter & Yamashita, 2015, 2018). The present study found clear evidence of an idiom processing advantage in a single language, but the results relating to cross-language

¹⁴ Frequency significantly predicted RT in both Chinese phrases, [$b = -0.025$, $SE = 0.006$, $t(79) = -4.42$, $p < .001$]; and in English items, [$b = -0.033$, $SE = 0.006$, $t(83) = -5.65$, $p < .001$].

¹⁵ Literal plausibility significantly predicted RT in English phrases, [$b = -0.033$, $SE = 0.009$, $t(92) = -3.49$, $p < .001$]; but not significant in predicting RT for Chinese items, [$b = -0.007$, $SE = 0.011$, $t(86) = -0.60$, $p = .55$].

effects were less straightforward. We provided tentative support for the cross-language direct retrieval of familiar idioms, but as we discussed, other factors may also be at play. The present study refrained from the discussion of idiom decomposability because it already had a complex design with many variables. Studies have shown that decomposability contributes to idiom processing speed (Libben & Titone, 2008; Titone & Libben, 2014), and therefore it may potentially help to explain the results we are seeing. Future studies should consider incorporating decomposability-based analysis into their experimental design.

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