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Cross-language activation of idiom meanings: Evidence from French– Vietnamese– and Indonesian–English bilinguals

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Research Article

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Abstract

The aim of the present study was to determine whether bilinguals activate the figurative meaning of an idiom that is specific to one language when they are exposed to its translation in their other language. We used a cross-modal priming task in which participants heard L2 English sentences that ended with an idiom translated from their L1. They then saw a visually presented stimulus that was either related to the meaning of the L1 idiom, a matched control word, or a nonword, and made a lexical decision. Three experiments were run, each with a different group of bilinguals (French–English, Vietnamese–English, and Indonesian–English), and each with a monolingual English control group. In all three studies, the effect of relatedness for bilinguals and monolinguals differed, demonstrating cross-language activation of idiom meanings. Evidence was obtained that suggested that culture-specific information in idioms influenced processing.

Introduction

Idiomatic expressions present a challenge to comprehenders because they do not have a single interpretation. For example, when an English speaker hears that their neighbour has *kicked the bucket*, they could interpret the phrase to mean that the neighbour hit a bucket with his foot, but the speaker may have intended to convey that the neighbour died. The comprehender's reaction to the news may be quite inappropriate if they choose the wrong interpretation. Idioms are especially challenging for bilinguals because there are typically many idioms that are unique to one of their languages. A French idiom with the same meaning as *kick the bucket* is not the direct translation but rather *casser sa pipe* (*break one's pipe*). An obvious difficulty for bilinguals is that they might not know an idiom specific to their second language (L2). Indeed, the appropriate usage and comprehension of idioms are some of the most difficult aspects of language to grasp (e.g., Carrol & Conklin, 2014, 2017; Milburn et al., 2021). Another potential difficulty, and the one explored here, is that a bilingual might interpret a literal statement in L2 based on knowledge of idioms in their first language (L1). For instance, when a French–English bilingual encounters an English sentence such as *My father broke his pipe*, do they activate the meaning "to die" based on their knowledge of the French idiom?

The focus of many studies on bilingualism has been on the cross-language activation of single-word representations (for reviews, see Dijkstra & van Heuven, 2018; Jared, 2015,). Of relevance here, studies have shown that the brief presentation of a prime in one language produces facilitation for its translation equivalent in the other language (see Wen & van Heuven, 2017, for a review). Other research has shown that when individuals speak two languages, the culture- and language-specific associations they acquire in L1 influence the ways they interpret words in L2 (e.g., Matsuki et al., 2021; Pan & Jared, 2021; Pan et al., 2021). However, the literature on bilingualism has paid much less attention to the processes underlying the comprehension of multiword units (see Zeng et al., 2020, for a review). Specifically, there is only a small body of research on how bilinguals process idioms, despite the fact that idioms have received considerable attention in the monolingual English literature (see Cacciari & Tabossi, 2014; Conklin & Schmitt, 2012; Titone et al., 2019, for reviews). The definition of "idiom" used here, taken from Titone et al. (2015), is that they are "a multiword unit whose figurative meaning is distinct from their component words". There have been studies that examined whether bilinguals activate idiomatic meanings when they are processing their L2 and explored factors that might influence whether they do so (e.g., Cieślicka, 2006; Cieślicka et al., 2021; Conklin & Schmitt, 2008; Milburn et al., 2021; Senaldi & Titone, 2022; Siyanova-Chanturia et al., 2011; van Ginkel & Dijkstra, 2020) – however, here we focus on studies that examined whether there is cross-language activation of

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the meanings of idioms in bilinguals. We first briefly review that literature before presenting our own study on this question.

Cross-language similarity

One way to investigate cross-language activation of idioms is to look for an effect of the presence of the same idiom in two languages on the processing of idioms in one of the languages. Beck and Weber (2016) had German–English bilinguals complete a cross-modal priming task. Participants heard English sentences and then made a lexical decision to a visually presented stimulus. Critical sentences ended with an idiom, and their visual targets were words that were either related to the literal meaning of the idiom, related to the figurative meaning of the idiom, or were unrelated. Half of the idioms were a direct translation of a German idiom and half did not have a matching translation in German. Participants produced faster decisions for both types of related words than for unrelated words, suggesting that they activated both literal and figurative meanings of the idioms in their second language, but there was no influence of the existence of the idiom in German.

Translations of language-specific idioms

Another way to investigate cross-language activation of idioms, and the approach taken here, is to examine whether an idiom's figurative meaning can be activated from its translated form. Carrol and Conklin (2014) presented participants with word-for-word translated sets of Chinese idioms ("chengyu") in English. The idioms were chosen such that they had a similar word order to English when translated, and a monosyllabic final word in English (e.g., *Draw a snake and add feet*, which means "to ruin something by adding over-elaborate and unnecessary detail"). Furthermore, the idioms chosen were high in familiarity to Chinese speakers but did not exist as idioms in English. The idioms also had to be literally plausible to ensure that the phrase made sense in English. All the words of an idiom except for the last one served as a prime. Once participants had read the prime, they were shown a target that was either the translated final word of the idiom (e.g., *feet*), a matched control word (e.g., *hair*), or a nonword, and they were asked to make a lexical decision on the target. Chinese–English bilinguals had faster responses on translated idiom words than on control words. In contrast, English monolinguals showed no difference in response times on the two types of words. The authors interpreted the findings as evidence for cross-language activation of L1 idioms in L2. However, the fact that participants had unlimited viewing time for the first three prime words might have allowed bilinguals to use a conscious translation strategy to help guess the target word.

To address this limitation, Zhu and Minda (2021) conducted a similar study using a cross-modal priming task. As in Carrol and Conklin's (2014) study, the Chinese idioms chosen were literally plausible and highly familiar. In the cross-modal priming task, all but the last word of translated Chinese idioms were presented auditorily, which allowed the researchers to control exposure time. Participants were instructed to make a lexical decision on a visually presented target that was either the translated final idiom word, a control word, or a non-word. Like Carrol and Conklin (2014), the researchers observed faster responses by bilinguals on translated idiom words than on control words. However, English monolinguals also demonstrated the same pattern of results, suggesting that the finding for bilinguals was not due to cross-language activation of the Chinese idiom. Instead, the target words in the idiom condition may have been more plausible given the context than the target words in the control condition even without knowledge of the Chinese idioms. This study highlights the importance of including a monolingual control group to ascertain whether differences between idiom and control conditions in bilinguals are due to cross-language activation.

In both of the previous studies, the idioms were presented as phrases out of context, which may have drawn attention to the idioms. Carrol and colleagues (Carrol & Conklin, 2017; Carrol et al., 2016) subsequently conducted experiments in which the stimuli of interest were embedded in English sentences, and participants' eye movements were monitored as they read. In Carrol et al. (2016), participants were Swedish–English bilinguals and English monolinguals. Of primary interest here were sentences which contained an idiom specific to Swedish (e.g., *I'm not sure I can shoulder his coat because he's had so much success in the past*; *shoulder his coat* means "to live up to his success"). Comparison sentences involved a change of word at the start of the translated idiom (e.g., *carry* instead of *shoulder*). Swedish–English bilinguals had shorter total reading times on the translated idioms than on controls (both for the whole idiom and for the last word specifically), whereas English monolinguals showed the opposite pattern. Furthermore, the facilitation effect for bilinguals was larger for Swedish idioms that those participants rated as being more familiar. The authors concluded that L1 knowledge of idioms influences processing in L2.

Carrol and Conklin (2017) reported two experiments that followed up on their earlier study with Chinese–English bilinguals. In Experiment 1, the stimuli of interest were idioms (e.g., *draw a snake and add feet*) and control phrases (e.g., *draw a snake and add hair*), and sentence contexts supported the figurative meaning of the idioms. Chinese–English bilinguals had shorter first fixation and total time durations for the last word of the translated idioms than for control words, and English monolinguals showed no difference between the two types of words. The authors concluded that their results provided evidence that there was some degree of cross-linguistic influence that provided a boost to lexical access for the items that were known in the L1. However, they acknowledged that these results, as well as those of their earlier study, did not reveal whether the meanings of the Chinese idioms were activated or whether the activation was at a lexical level only. According to a lexical explanation (see Figure 1), each English word in the prime activated its Chinese equivalent. These first three words of the idiom would activate a known character sequence in Chinese, which would then make the final character available. This character would in turn activate its English translation. Therefore, faster reading times for the final word of the idiom than the control word could have been produced without the meaning of the Chinese idiom having been activated.

In Experiment 2, only the English sentences with translated idioms were included, but a condition in which idioms were placed in a context that biased the literal meaning was added. The authors reasoned that if the facilitation observed in Experiment 1 occurred because the bilinguals had activated the meaning of the Chinese idiom, then in Experiment 2, they should read the idiom equally quickly in the two contexts, whereas monolingual English speakers should take longer to read the idiom in the figurative context than in the literal context. Although English monolinguals did show the predicted pattern, Chinese–English bilinguals also had shorter reading times for the idioms in the literal contexts than in the figurative contexts. The authors concluded that activation did not extend to the Chinese meaning of the idioms (see conceptual route in Figure 1).

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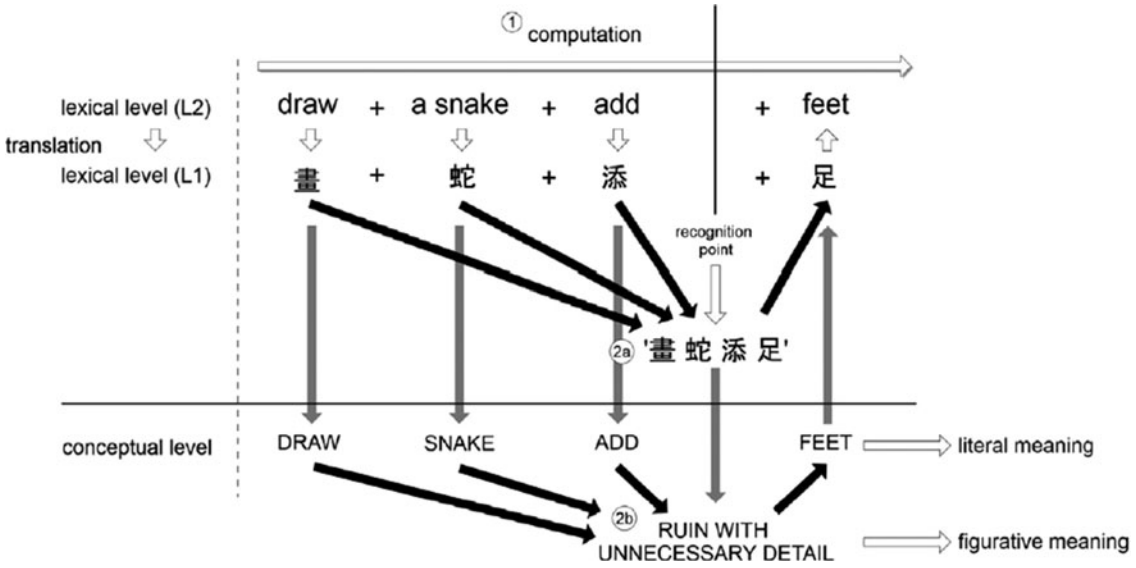

Figure 1. The Dual Route Model of idiom processing modified for bilinguals.
Note. Compositional processing for the translated Chinese idiom *draw a snake and add feet* is shown in (1). Direct access to the lexical representation of the whole idiom is shown in (2a) and direct access to the conceptual representation of the idiom is shown in (2b). Reprinted from Carrol, G., and Conklin, K. (2014) Getting your wires crossed: Evidence for fast processing of idioms in an L2. *Bilingualism: Language and Cognition, 17(4), 784-797.*

The present study

The aim of the present study was to determine whether bilinguals activate the figurative meaning of an idiom that is specific to one language when they are exposed to its translation in their other language. For example, when a French–English bilingual encounters the English sentence *My father broke his pipe*, do they activate the meaning "to die" based on their knowledge of the French idiom? To probe for the figurative meaning of the idiom we used the cross-modal priming methodology used by Beck and Weber (2016). Participants heard English sentences that contained a translated idiom at the end, and then they made a lexical decision to a stimulus that appeared on their computer screen immediately afterwards. On critical trials, the visually presented word was either related to the figurative meaning in L1 (e.g., *die*) or was an unrelated control word (e.g., *dig*). A difference in decision latencies for related words compared to unrelated words would suggest that bilingual participants had activated the L1 meaning of the idiom through the English translation. However, there could be two alternative explanations of any priming effect. One is that the related and unrelated words were not sufficiently matched for difficulty in English. The second is that words in the related condition were not just related to the L1 meaning of the idiom but were also more related to the English context than the words in the unrelated condition. Critically, we included English monolingual controls in each experiment. Because these individuals did not know the L1 of the bilinguals, any priming effects they produced would have to be due to one of these within-English explanations. We hoped to find a priming effect for bilinguals but not for monolinguals.

We tested three groups of bilinguals, each with a different L1. Because the idioms in a language originate from the commonly held experiences, history, politics, values, and norms of a community, they can be quite different in languages that are associated with different cultures. It is possible that cross-language activation of idiom meanings is more likely to occur with greater similarity in the cultures associated with the two languages. Therefore, it is important to investigate several language pairs before making general statements about cross-language activation of idiom meanings in bilinguals. One group of participants were French–English bilinguals, whose languages are associated with relatively similar cultures. The other groups of participants were Vietnamese–English bilinguals and Indonesian–English bilinguals, whose two languages are typically associated with quite different cultures.

Vietnamese is an Austroasiatic language and Indonesian (*Bahasa Indonesia*) is an Austronesian language. *Ethnologue* (Eberhard et al., 2022) lists Vietnamese as the 20th most spoken language in the world, with 84.6 million L1 speakers and 0.7 million L2 speakers, and it lists Indonesian as the 11th most spoken language in the world, with 43.6 million L1 speakers and 155.4 million L2 speakers (French is the 5th most spoken language in the world). Both languages use the Latin alphabet. Vietnamese is a tonal language that uses digraphs and diacritics to mark tones and some phonemes.

Although spoken by many millions of people, Vietnamese and Indonesian are understudied languages in the psycholinguistics of bilingualism. The English-language literature involving Vietnamese–English bilinguals has investigated the phenomenon of code-switching (Tuc, 2014), grammaticality analysis (McDonald, 2000), sentence interpretation (Pham & Kohnert, 2010), and auditory processing (Nguyen-Hoan & Taft, 2010). We are aware of only one study that has investigated Indonesian–English bilinguals (Hartanto & Suarez, 2016); that study investigated cross-language activation of gender categories. Leksono et al. (2020) compared colour idioms in Vietnamese, Indonesian, and Thai – however, to our knowledge, idiomatic expressions have not yet been explored in psycholinguistic research with bilinguals in these languages.

Vietnamese idioms reflect the agricultural culture and daily life events, thus they are often high in literal plausibility (Nguyen, 2007). For example, *buôn dưa* (*to sell melons*) means "to gossip". Indonesian idioms are often composed of only two words in a noun + noun (e.g., *book lice*) or adjective + noun (e.g., *itchy*

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hands) form (Haiyan et al., 2016). The open-ended nature of Indonesian idioms is meant to reflect daily-life experiences as observed in Indonesia. Many idioms involve *tebu* (sugar cane), *nasi* (rice), *nyamuk* (mosquitoes), *durian* (a fruit), and *ayam* (chicken) and other culture-specific encounters.

Of interest, we discovered a thesis (Adisetia, 2013) that analyzed how the 450 idiomatic expressions in the novel *Chocolat* (Harris, 1999) were translated in the Indonesian version. Adisetia found that only 9.3% of English idioms were translated using an Indonesian idiom with similar meaning and form, and another 7.6% were translated using an Indonesian idiom with a similar meaning but different form. The remainder of the English idioms were either paraphrased (70.7%), omitted (1.8%), or were translated into their literal equivalent (10.7%). This analysis provides evidence that the idioms in the two languages are quite different.

In summary, we used a cross-modal priming task to examine whether the meanings of idioms from a bilingual's L1 are activated when they encounter a translation of the idiom in L2 English. Three versions of the experiment were run, with French–English, Vietnamese–English, and Indonesian–English bilinguals, to examine the generalizability of our findings. Because all three experiments used the same basic methodology, we first present a General Method, and then report only information specific to each language version in sections for Experiments 1-3. After each experiment, we give a brief interpretation, then consider the pattern of results across the three experiments more fully in the General Discussion.

General method

Materials

The development of materials started with the selection of idioms in French, Vietnamese, and Indonesian that were expected to be familiar, low in semantic decomposability, and literally plausible when translated into English. Furthermore, the figurative meaning of the idioms in these languages could be captured by a single English word. For each set of idioms, a pilot experiment was run with English monolinguals to collect data about decomposability and plausibility. The semantic decomposability and plausibility scales were adapted from Titone et al. (2015). For the semantic decomposability ratings, participants were provided with English translations of the idioms and their figurative meaning and answered the question "how easily can the meaning of the idiom be determined from the words that are used in the idiom?" on a 7-point Likert scale ranging from (1) *very difficult* to (7) *very easy*. Participants were also asked to rate the literal plausibility of the translated idioms on a 7-point Likert scale ranging from (1) *very unlikely* to (7) *very likely*. Idioms that had high decomposability ratings and/or low plausibility ratings were not included in the final set of materials for each language.

The translated idioms were then placed in English sentence contexts such that the idiom was at the end of the sentence and the sentence was plausible (e.g., *She likes to get together with her neighbour and sell melons*). For each idiom, a word was chosen to reflect the figurative meaning of the idiom (e.g., *gossip*). Unrelated control words (e.g., *gallop*) were chosen to match the related words on beginning letters, length, and log frequency per million using the subtitle corpus of Brysbaert and New (2009). The degree of semantic association between a sentence and each of the target words was determined using Latent Semantic Analysis (LSA; Landauer et al., 1998). These LSA values provide evidence as to whether, within English, the related and unrelated words were equally unrelated to the sentence contexts. For the purposes of the lexical decision task, literally plausible English filler sentences were written, and each was paired with a pseudoword. Pseudowords were matched in length to target words. The sentences were then recorded by a native English speaker using Audacity.

Two counterbalanced lists of the stimuli were used for each study, each having all of the recorded idiom sentences along with an equal number of filler sentences. Half of the target words on each list were related to the idiom and half were unrelated. The same pseudowords appeared on each list.

Familiarity scales for each study were created based on Titone et al. (2015). Idioms were presented in their original language, and familiarity was measured on a 7-point Likert scale ranging from (1) *very unfamiliar* to (7) *very familiar*. Knowledge of the idiomatic meaning was assessed by asking participants to write down their interpretation of each idiom. The participant's rating was changed to 0 if the incorrect meaning of the idiom was given. A questionnaire was also used to obtain information about language proficiency and use.

Experiment procedure

Each experiment used a cross-modal priming task programmed in PsychoPy (Pierce et al., 2019) and uploaded to Pavlovia. The link to each study was posted on Prolific. Participants were asked to do the experiment on a computer (not on a tablet or phone) and told that audio was involved. When participants clicked the study link, a letter of information was presented using Qualtrics survey software, and after consenting to participate in the study, they were redirected to Pavlovia for the cross-modal priming experiment. The experiment instructions informed participants that they would be listening to English sentences and then making an English lexical decision on a printed stimulus that would appear on their computer screen after each sentence. They were asked to make their decision as quickly and as accurately as possible using the *f* key for word responses and the *j* key for nonword responses. During the auditory sentences, a plus sign appeared in the centre of their computer screen. The letter string then appeared in the centre of their screen in 18-point Courier font and stayed on the screen until the participant responded or for a maximum of 5s. Decision latencies and accuracy were recorded. Trials were presented in a different random order for each participant. The program randomly assigned participants to lists. After completing the experiment, participants were directed from Pavlovia to another Qualtrics form. Bilinguals were first given the familiarity rating scale and then a language questionnaire; monolinguals only completed a language questionnaire. Participants then saw a debriefing page. Finally, they were redirected back to Prolific for payment. The bilingual participants were paid £7.50 and the monolingual participants were paid £4.00. The authors assert that all procedures contributing to this work comply with the ethical standards of the relevant national and institutional committees on human experimentation and with the Helsinki Declaration of 1975, as revised in 2008.

Analysis procedure

Participants with an overall accuracy rate (words and nonwords) of <75% were excluded from the analyses, as were participants who rated their proficiency in the language of interest as very low. Decision latencies for correct responses were trimmed by

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first excluding RTs <300 ms or >2500 ms, and then excluding RTs that were >3 *SD*s from remaining scores. The second trim was done separately for bilinguals and monolinguals.

The RT data were analyzed using generalized linear mixed models (GLMMs) in R (Baayen, 2008; Baayen et al., 2008; R Core Team, 2018). These models are an alternative to linear mixed models, which assume a normally distributed dependent variable and possible data transformation to achieve that (see Lo & Andrews, 2015). GLMMs do not assume a normal distribution, but rather allow the user to specify a frequency distribution that fits skewed latency data (the Gamma distribution was used here). Lo and Andrews argue that this method is more appropriate for interpreting interactions than using linear mixed effects models with a data transformation. The lme4 package (Bates et al., 2015) version 1.1-29 was used. The models were fit by maximum likelihood with the Laplace approximation technique. The significance of the fixed effects was determined with type-II Wald tests using the Anova function provided by the car package (Fox & Weisberg, 2019) version 3.0–13. These are reported in the text, and the full model outputs appear in tables. Before running the models, R-default treatment contrasts were altered to sum-to-zero contrasts (Levy, 2014; Singmann & Kellen, 2019). Fixed effects of interest included Group (bilingual vs monolingual) and Condition (related, unrelated); the log frequency of the target word and length of the target word in letters were also included as fixed factors. Random intercepts were participants and items (target words). Model formulas were: glmer(RT~Group*Condition + scale(logFrequency) +scale(length)+(1|Participant)+(1|Item), datafile, family = Gamma (link="identity"), control = glmerControl(optimizer="bobyqa", optCtrl = list(maxfun = 1e6))).

Subsequent analyses investigated whether effects of Condition for bilinguals were modulated by idiom characteristics or the language skills of the participants. Models were run that were just like the previous one except that in each model, Group was replaced by a variable of interest as a fixed factor (e.g., *scale(variable)). Idiom characteristics included familiarity, decomposability, and plausibility. Recall that idioms were chosen to have high familiarity, low decomposability and high literal plausibility in English, and therefore there were somewhat restricted ranges on these variables. Two variables were investigated for L1 (in separate models), overall rated proficiency in L1 (sum of ratings out of 10 for understanding, speaking, reading, and writing), and percentage of time spent speaking L1. Five variables were investigated for L2, again, each in a separate analysis (number of years living in an English-speaking country, age at which English was acquired, overall rated proficiency in English, percentage of time spent listening in English, and percentage of time spent reading in English). We also examined whether the frequency with which the bilinguals reported code-switching interacted with Condition.

Experiment 1: French

Method

Participants

Complete data were collected from 51 French–English bilinguals and 55 English monolinguals. The filters used on Prolific for bilinguals were: first language (French), nationality (France), fluent languages (French and English), age (18-30); and for monolinguals were: first language (English), monolingual (only know English), raised monolingual, age (18-30). The data from 1 bilingual were excluded because they had an accuracy score less than 75% on the lexical decision task. The final data set, therefore, included 50 French–English bilingual participants (M_{age} = 24.3 years, *SD* = 3.2; 32 female) and 55 English monolinguals (M_{age} = 24.6 years, *SD* = 3.2; 33 female). The mean age of acquisition of English for bilingual participants was 8.4 years (*SD* = 3.7). They had lived in France for a mean of 21.6 years (*SD* = 5.4) and lived in an English-speaking country for a mean of 1.8 years (*SD* = 3.3). Bilinguals rated their frequency of code switching on a scale of 1 to 7 (*M* = 2.8, *SD* = 1.9). See Table 1 for other language information about the bilinguals.

Materials

One hundred and twenty French idioms were initially selected from a variety of online sources, such as http://expression.fr, and previously generated idiom banks, including one from Caillies (2009). Seventy-four idioms were judged by the experimenters to be different from English idioms and to be literally plausible and low in semantic decomposability (e.g., *tomber dans les pommes-fall in the apples,* which means "to faint"). Translation of idioms from French to English was done through multiple online sources, and translations were then verified by two native French speakers. The English versions of the idioms were then given to 22 native English speakers to rate for semantic decomposability and literal plausibility. Fourteen idioms were eliminated based on high decomposability ratings and/or low plausibility ratings, leaving 60 for the experiment. The translated idioms were then placed in sentence contexts such that the idiom was at the end of the sentence (e.g., *She was nervous that I might fall in the apples*). For each idiom, a target word was chosen to reflect the figurative meaning of the idiom (e.g., *faint*) and an unrelated word was chosen to match the target in length and frequency (e.g., *flush*). See Table 2 for a descriptive summary of the experimental stimuli. See Supplemental Materials for the experimental stimuli. Another 60 literally plausible English sentences were written, and each was paired with a pseudoword. See the General Method for further details.

Results

The bilingual participants had a mean overall accuracy (words and nonword) of 94.0% and the monolingual participants had a mean overall accuracy of 95.9% indicating that they were attending well to the lexical decision task. The mean accuracy for bilinguals on the critical word stimuli was 95.7% for related words and 93.4% for unrelated words, and the mean accuracy for monolinguals was 98.1% for related words and 97.5% for unrelated words. Given these very high accuracy rates, analyses were conducted on correct RTs only. Bilinguals had 2.9% of their trials excluded by the trimming procedure described previously and monolinguals had 2.7% of trials excluded.

Decision times for bilinguals were significantly slower than for monolinguals, $\chi^2(1) = 34.85$, $p < .001$. There was also a significant effect of Condition, $\chi^2(1) = 4.36$, $p = .037$, and a significant interaction of Group and Condition, $\chi^2(1) = 12.51$, $p < .001$. The bilinguals had faster RTs on related words than on unrelated words whereas the monolinguals produced similar decision latencies for the two types of target words. Figure 2 presents the model-adjusted means and Table 3 the model details.

We then examined whether any variables modulated the effect of Condition for French–English bilinguals (see Supplemental Materials for Figures). With respect to the characteristics of the idioms, there was no significant interaction of Condition and

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Table 1. Language characteristics of the bilinguals in Experiments 1-3.

	Experiment 1				Experiment 2				Experiment 3			
	French		English		Vietnamese		English		Indonesian		English	
Measure	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Skill (% use)												
Listen	56.2	24.2	40.9	24.6	29.3	21.4	60.5	26.5	27.0	18.9	61.5	27.1
Speak	74.1	24.5	24.2	24.3	35.3	27.4	52.9	31.8	29.5	20.1	57.2	28.9
Read	51.0	22.2	46.3	21.7	30.7	26.5	62.0	27.6	24.4	25.7	67.3	28.6
Write	62.4	29.3	35.2	28.6	17.8	22.7	74.4	27.4	23.1	22.5	69.7	27.5
Context (% use)												
Family	90.9	21.0	4.1	13.4	80.2	24.2	17.9	23.6	73.5	30.7	18.0	22.6
Friends	72.7	31.9	24.7	30.3	37.0	31.1	55.4	33.0	37.8	30.5	53.4	34.9
Work/School	67.2	35.7	29.5	33.8	8.7	21.1	79.7	31.5	7.8	22.6	75.5	35.5
Proficiency (/10)												
Listen	9.9	0.3	8.8	1.1	9.7	0.9	8.9	1.1	9.5	1.2	8.6	1.2
Speak	9.9	0.5	7.7	1.5	9.0	1.7	8.4	1.4	9.0	2.0	8.2	1.3
Read	10.0	0.3	9.1	0.9	8.6	2.9	8.9	1.1	9.2	1.8	9.0	1.1
Write	9.8	0.7	7.9	1.6	7.9	3.2	8.1	1.6	8.6	2.2	8.1	1.5

Note. The data from 5 bilingual participants in Experiment 2 were not included in the % use statistics because they did not follow the instruction to have totals = 100 (e.g., one indicated that they speak Vietnamese 100% and English 90% of the time). See the Supplemental Materials for language data on the monolinguals in each experiment.

Table 2. Characteristics of the stimuli in Experiments 1-3.

	Experiment 1		Experiment 2		Experiment 3	
	M	*SD*	*M*	*SD*	*M*	*SD*
Idioms						
Decomposability	3.63	0.90	3.04	0.79	3.02	0.85
Literal plausibility	4.03	1.56	3.27	1.06	3.54	1.39
Familiarity	4.93	2.70	4.93	2.36	3.17	3.25
Target words						
Word Length						
Related targets	6.19	1.66	7.06	2.09	6.95	2.43
Unrelated targets	6.16	1.70	7.06	2.09	6.95	2.43
Log Frequency						
Related targets	1.25	0.70	0.74	0.82	1.01	0.68
Unrelated targets	1.26	0.70	0.72	0.71	0.79	0.66
Semantic Similarity (to Sentence)						
Related targets	0.27	0.13	0.02	0.08	0.21	0.11
Unrelated targets	0.21	0.12	-0.01	0.05	0.20	0.11

Familiarity, $\chi^2(1) = 1.78$, $p = .18$, Condition and Decomposability, $\chi^2(1) = 0.37$, $p = .55$, or Condition and Plausibility, $\chi^2(1) = 0.13$, $p = .72$.

Next, language characteristics of the participants were considered. There was no main effect of rated French proficiency, $\chi^2(1) = 0.27$, $p = .60$, and no interaction of French proficiency and Condition, $\chi^2(1) = 1.40$, $p = .24$, likely because of a restricted range on proficiency ratings. Surprisingly, English lexical decisions were significantly faster for bilinguals who spent a greater percentage of time speaking French, $\chi^2(1) = 6.86$, $p = .001$, but there was no interaction of this variable with Condition, $\chi^2(1) = 0.01$, $p = .97$.

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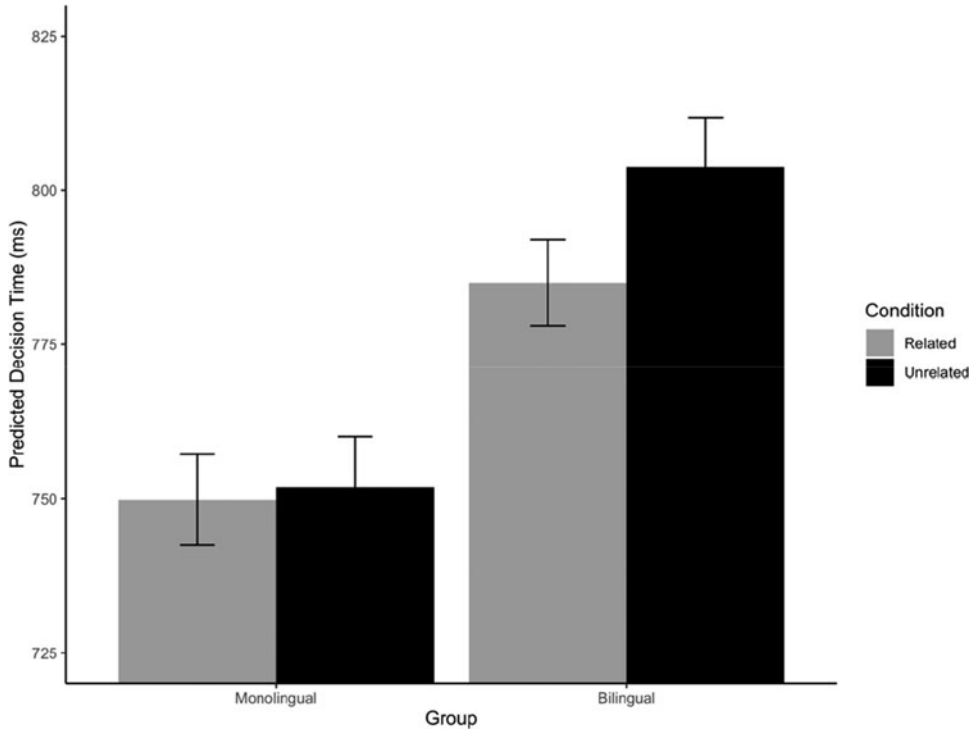

Figure 2. Model adjusted mean RTs for French–English bilinguals and English monolinguals.

Table 3. Model output for Experiment 1.

Fixed Effects	*b*	*SE*	*t*	*p*
Intercept	774.32	6.26	123.65	$p < .001$
Group	−43.61	6.92	−6.30	$p < .001$
Condition	10.40	4.91	2.12	$p = .034$
Log Frequency	−32.59	4.02	−8.11	$p < .001$
Length	18.89	4.26	4.43	$p < .001$
Group x Condition	−16.87	4.77	−3.54	$p < .001$
Random Effects (Intercepts)	Variance	*SD*		
Participants	4459	66.78		
Items	1233	35.12		
Model Fit AIC = 76579.8				

Significantly slower lexical decision times for the English target words were found for participants who had spent more years living in an English-speaking country, $\chi^2(1) = 4.86$, $p = .03$ – however, since 38/50 participants had spent 1 year or less living in an English-speaking country, this may not be a reliable result. There was no effect of age at which English was acquired, $\chi^2(1) = 0.35$, $p = .55$, overall rating of their English skills, $\chi^2(1) = 1.20$, $p = .27$, percentage of time spent listening in English, $\chi^2(1) = 0.16$, $p = .69$, or reading in English, $\chi^2(1) = 0.29$, $p = .59$. Two of these variables interacted with Condition. There was a significant interaction of Condition and rated English skills, $\chi^2(1) = 4.09$, $p = .04$, and a significant interaction of Condition and percentage of time spent reading in English, $\chi^2(1) = 6.53$, $p = .01$. Bilinguals who had higher rated English proficiency and who spent more time reading in English showed greater facilitation for English words related to the French idiom than words unrelated to the French idiom.

The frequency with which bilinguals reported code-switching did not interact with Condition, $\chi^2(1) = 0.11$, $p = .74$.

Discussion

The finding of faster responses to related words than unrelated words for French–English bilinguals provided evidence that they activated the French meaning of translated idioms when reading exclusively in English. Importantly, the lack of priming effect for monolinguals, and specifically the interaction of Group and Condition, allows us to be more confident that the priming effect for bilinguals is truly a cross-language effect rather than due to within-English confounds.

Experiment 2: Vietnamese

Method

Participants

Complete data were collected from 56 Vietnamese–English bilinguals and 54 English monolinguals. The filters used on Prolific for bilinguals were: first language (Vietnamese), nationality (Vietnam), fluent languages (Vietnamese and English), age (18-35), and for monolinguals were: first language (English), monolingual (only know English), raised monolingual, age (18-30). The data from 3 bilinguals and 1 monolingual were excluded because they had an accuracy score less than 75% on the lexical decision task, and the data from 1 bilingual were excluded because of low self-rated proficiency in understanding Vietnamese. The final data set, therefore, included 52 Vietnamese–English bilingual participants ($M_{age} = 24.7$ years, $SD = 4.0$; 33 female) and 52 English monolinguals ($M_{age} = 25.2$

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years, $SD = 3.4$; 35 female). The mean age of acquisition of English for bilingual participants was 7.3 years ($SD = 3.8$). They had lived in Vietnam for a mean of 15.5 years ($SD = 7.7$) and lived in an English-speaking country for a mean of 7.7 years ($SD = 7.5$). Bilinguals rated their frequency of code switching on a scale of 1 to 7 ($M = 4.5$, $SD = 1.8$). See Table 1 for other language information about the participants.

Materials

Sixty Vietnamese idioms were initially chosen. The English translations of the literal meaning of these idioms were obtained using an online Vietnamese dictionary (https://vtudien.com//). The idioms were judged by the experimenters to be different from English idioms and to be literally plausible and low in semantic decomposability (e.g., *buôn dưa - to sell melons,* which means *to gossip*). The English versions of the idioms were then given to 30 native English speakers to rate for semantic decomposability and literal plausibility. Twelve idioms were eliminated from the original set of idioms based on high decomposability ratings and/or low plausibility ratings, leaving 48 for the experiment. The translated idioms were then placed in sentence contexts such that the idiom was at the end of the sentence (e.g., *She likes to get together with her neighbour and sell melons*). For each idiom, a target word was chosen to reflect the figurative meaning of the idiom (e.g., *gossip*) and an unrelated word was chosen to match the target in length and frequency (e.g., *gallop*). See Table 2 for a descriptive summary of the experimental stimuli. See Supplemental Materials for the experimental stimuli. Another 48 literally plausible English sentences were written, and each was paired with a pseudoword. See the General Method for further details.

Results

The bilingual participants had a mean overall accuracy (words and nonwords) of 88.8% and the monolingual participants had a mean overall accuracy of 94.5% indicating that they were attending well to the lexical decision task. The mean accuracy for bilinguals on the critical word stimuli was 96.2% for related words and 94.1% for unrelated words, and the mean accuracy for monolinguals was 97.9% for related words and 96.8% for unrelated words. Given these very high accuracy rates, analyses were conducted on correct RTs only. Bilinguals had 4.1% of their trials excluded by the trimming procedure described previously and monolinguals had 3.6% of trials excluded.

Decision times for bilinguals were significantly slower than for monolinguals, $\chi^2(1) = 336.86$, $p < .001$. There was no significant effect of Condition, $\chi^2(1) = 0.13$, $p = .72$, but there was a significant interaction of Group and Condition, $\chi^2(1) = 3.93$, $p = .047$. The bilinguals had slightly slower RTs on related words than unrelated words whereas the monolinguals showed the reverse. Figure 3 presents the model-adjusted means and Table 4 the model details.

We then examined whether any variables modulated the effect of Condition for Vietnamese–English bilinguals (see Supplemental Materials for Figures). With respect to the characteristics of the idioms, there was a trend towards an interaction of Condition and Familiarity, $\chi^2(1) = 2.73$, $p = .098$, a trend towards an interaction of Condition and Decomposability, $\chi^2(1) = 2.92$, $p = .088$, but no interaction of Condition and Plausibility, $\chi^2(1) = 0.59$, $p = .44$. The inhibitory effect for related targets was smaller with greater idiom familiarity and decomposability.

Next, language characteristics of the participants were considered. Significantly slower English lexical decision latencies were found for participants whose overall rating of their Vietnamese skills was higher, $\chi^2(1) = 4.78$, $p = .029$. Overall rated proficiency in Vietnamese interacted with Condition, $\chi^2(1) = 6.23$, $p = .013$. Similarly, English lexical decisions were significantly slower for bilinguals who spent a greater percentage of time speaking Vietnamese, $\chi^2(1) = 13.97$, $p < .001$, and there was a significant interaction of this variable with Condition, $\chi^2(1) = 4.10$, $p = .043$.

Significantly faster lexical decision times for the English target words were found for participants who had acquired English at an earlier age, $\chi^2(1) = 42.14$, $p < .001$, who had spent more years living in an English-speaking country, $\chi^2(1) = 6.19$, $p = .013$, and whose overall rating of their English skills was higher, $\chi^2(1) = 39.60$, $p < .001$ – however, there was no effect of percentage of time spent listening in English, $\chi^2(1) = 0.20$, $p = .65$, or reading in English, $\chi^2(1) = 1.65$, $p = .20$. Two of these variables interacted with Condition. There was a significant interaction of Condition and number of years living in an English-speaking country, $\chi^2(1) = 4.32$, $p = .038$, and a significant interaction of Condition and rated English skills, $\chi^2(1) = 4.47$, $p = .035$.

To summarize the interactions just described, bilinguals showed a facilitatory effect for related targets compared to unrelated targets when they had lower English proficiency and spent a larger percentage of time speaking Vietnamese, and they showed an inhibitory effect when they had lower proficiency in Vietnamese, spoke Vietnamese less frequently, had higher proficiency in English, and had spent more years living in an English-speaking country.

The frequency with which bilinguals reported code-switching did not interact with Condition, $\chi^2(1) = 0.83$, $p = .36$.

Discussion

Here, there was also a significant Group by Condition interaction, suggesting some activation by bilinguals of the Vietnamese meaning of translated idioms when reading exclusively in English. However, Vietnamese–English bilinguals showed a different pattern of results from the French–English bilinguals in Experiment 1. In the General Discussion we consider potential reasons for these differences.

Experiment 3: Indonesian

Method

Participants

Complete data were collected from 44 Indonesian–English bilinguals and 43 English monolinguals. The filters used on Prolific for bilinguals were: first language (Indonesian), nationality (Indonesia), fluent languages (Indonesian and English), age (18-50), and for monolinguals were: first language (English), monolingual (only know English), raised monolingual, age (18-30). In addition to those recruited on Prolific, four Indonesian–English bilinguals were recruited by QR. The data from 2 bilinguals were excluded because they had an accuracy score less than 75% on the lexical decision task. The final data set, therefore, included 42 Indonesian–English bilingual participants ($M_{age} = 28.8$ years, $SD = 8.5$; 22 female) and 43 English monolinguals ($M_{age} = 26.4$ years, $SD = 3.2$; 18 female). The mean age of acquisition of English for bilingual participants was 7.3 years ($SD = 4.3$). They had lived in Indonesia for a

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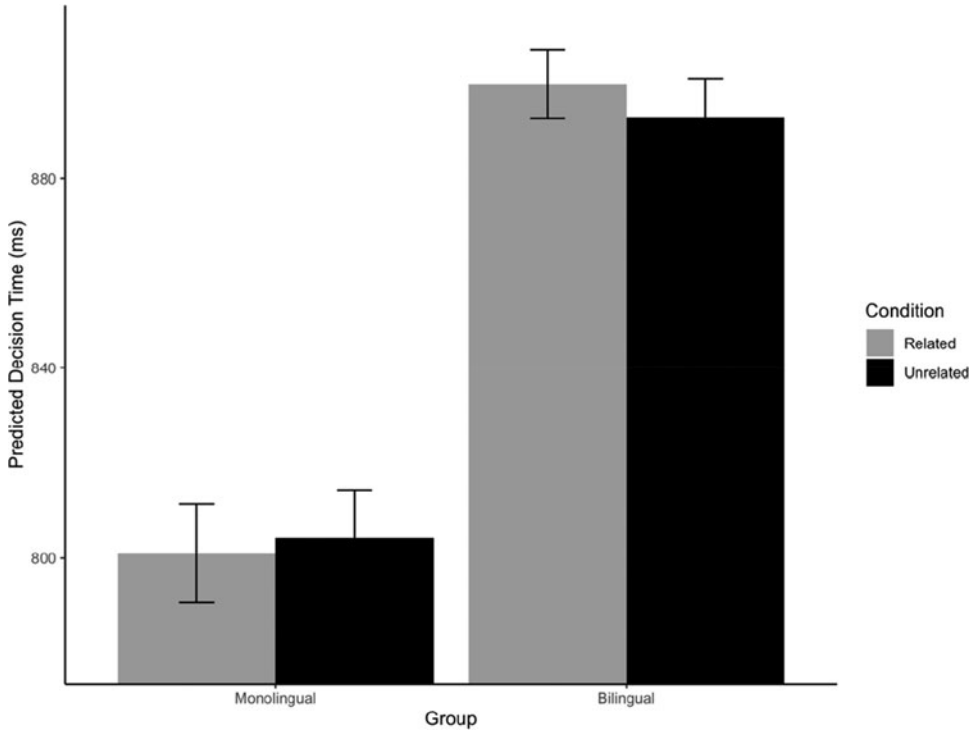

Figure 3. Model adjusted mean RTs for Vietnamese–English bilinguals and English monolinguals.

Table 4. Model output for Experiment 2.

Fixed Effects	*b*	*SE*	*t*	*p*
Intercept	851.45	5.58	152.59	$p < .001$
Group	−93.76	5.14	−18.24	$p < .001$
Condition	1.87	4.57	0.41	*ns*
Log Frequency	−40.27	4.21	−9.56	$p < .001$
Length	35.33	4.52	7.81	$p < .001$
Group x Condition	−10.25	5.17	−1.98	$p = .048$
Random Effects (Intercepts)	Variance	*SD*		
Participants	7536	86.81		
Items	1122	33.50		
Model Fit AIC = 61538.3				

mean of 21.2 years ($SD = 8.0$) and lived in an English-speaking country for a mean of 6.0 years ($SD = 6.0$). Bilinguals rated their frequency of code switching on a scale of 1 to 7 ($M = 3.9$, $SD = 2.1$). See Table 1 for other language information about the participants.

Materials

One hundred Indonesian idioms were initially chosen from Kamus Besar Bahasa Indonesia (KBBI; https://kbbi.web.id). The figurative meanings of the idioms were derived from the KBBI and two websites: https://maksudperibahasa.com and https://jagokata.com. Fifty-six of the idioms were judged by the experimenters to be different from English idioms and to be literally plausible and low in semantic decomposability (e.g., *mencari nasi- to look for a bite of rice,* which means *to work for money*). The meanings were translated to English using Google Translate and validated by a native Indonesian speaker.

The English versions of the idioms were then given to 25 native English speakers to rate for semantic decomposability and literal plausibility. Twelve idioms were eliminated from the original set of idioms based on high decomposability ratings and/or low plausibility ratings, leaving 44 for the experiment. The translated idioms were then placed in sentence contexts such that the idiom was at the end of the sentence (e.g., *I told my mom that it is time that I look for a bite of rice*). For each idiom, a target word was chosen to reflect the figurative meaning of the idiom (e.g., *money*) and an unrelated word was chosen to match the target in length and frequency (e.g., *might*). See Table 2 for a descriptive summary of the experimental stimuli. See Supplemental Materials for the experimental stimuli. Another 44 literally plausible English sentences were written, and each was paired with a pseudoword. See the General Method for further details.

Results

The bilingual participants had a mean overall accuracy (words and nonwords) of 90.2% and the monolingual participants had a mean overall accuracy of 93.9% indicating that they were attending well to the lexical decision task. The mean accuracy for bilinguals on the critical word stimuli was 95.7% for related words and 94.5% for unrelated words, and the mean accuracy for monolinguals was 97.3% for related words and 97.7% for unrelated words. Given these very high accuracy rates, analyses were conducted on correct RTs only. Bilinguals had 4.4% of their trials excluded by the trimming procedure described previously and monolinguals had 3.2% of trials excluded.

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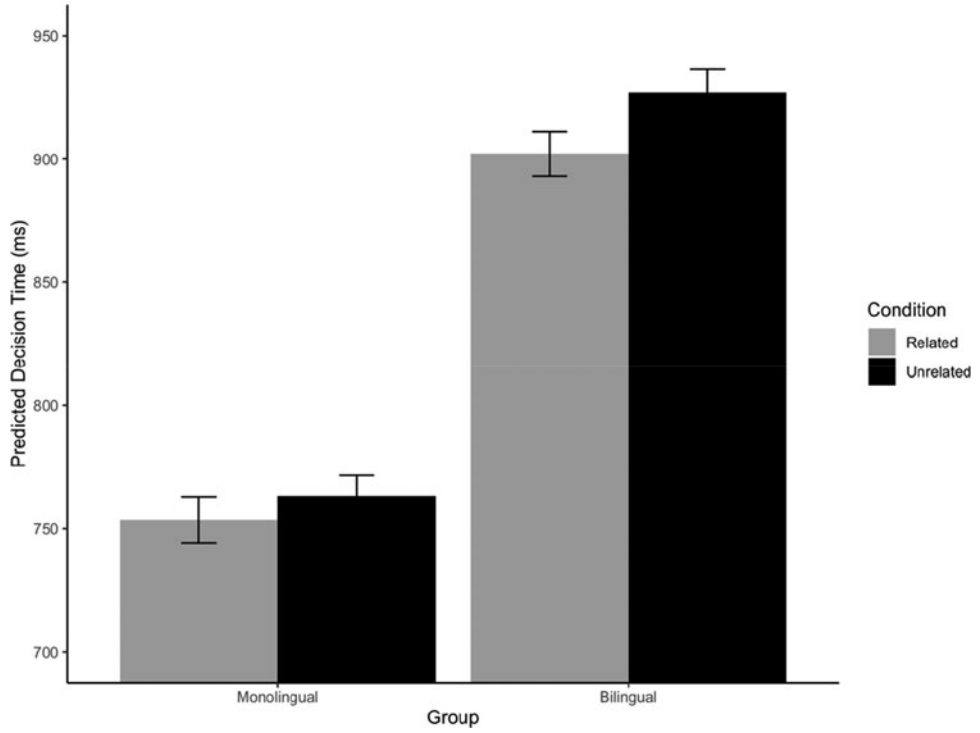

Figure 4. Model adjusted mean RTs for Indonesian–English bilinguals and English monolinguals (38 items).

Decision times for bilinguals were significantly slower than for monolinguals, $\chi^2(1) = 412.29$, $p < .001$. There was a significant effect of Condition, $\chi^2(1) = 22.58$, $p < .001$, but no significant interaction of Group and Condition, $\chi^2(1) = 0.98$, $p = .32$. Both groups of participants had faster decision latencies for related than unrelated words. The priming effect for monolinguals indicates that a source of this priming effect was within English. We inspected the monolinguals' mean decision latencies for related and unrelated words for each of the 44 experimental sentences and found six items where the decision latency for related words was >90 ms faster than for unrelated items. We then removed these problematic items from the data of both monolinguals and bilinguals and reran the analysis. Decision times for bilinguals were again significantly slower than for monolinguals, $\chi^2(1) = 284.43$, $p < .001$. There was still a significant effect of Condition, $\chi^2(1) = 5.90$, $p < .05$, but now there was a significant interaction of Group and Condition, $\chi^2(1) = 3.73$, $p = .05$. Figure 4 presents the model-adjusted means and Table 5 the model details.

We then examined whether any variables modulated the effect of Condition for Indonesian–English bilinguals (see Supplemental Materials for Figures). With respect to the characteristics of the idioms, there was no sign of an interaction of Condition and Familiarity, $\chi^2(1) = 0.74$, $p = .39$, Condition and Decomposability, $\chi^2(1) = 0.19$, $p = .66$, or Condition and Plausibility, $\chi^2(1) = 1.22$, $p = .27$.

Next, language characteristics of the participants were considered. Consistent with the L1 analyses for the French–English bilinguals, there was no main effect of rated Indonesian proficiency, $\chi^2(1) = 2.40$, $p = .12$, and no interaction of Indonesian proficiency and Condition, $\chi^2(1) = 2.63$, $p = .10$. Similarly, there was no main effect of percentage of time speaking Indonesian, $\chi^2(1) = 2.67$, $p = .10$ – however, there was a significant interaction of this variable with Condition, $\chi^2(1) = 6.77$, $p = .01$. There was a larger facilitatory effect of relatedness for participants who spoke Indonesian less often.

Table 5. Model output for Experiment 3 (38 items).

Fixed Effects	*b*	*SE*	*t*	*p*
Intercept	838.03	6.70	125.01	$p < .001$
Group	−156.25	9.37	−16.68	$p < .001$
Condition	17.22	6.95	2.48	$p = .01$
Log Frequency	−28.83	6.43	−4.49	$p < .001$
Length	36.79	6.57	5.60	$p < .001$
Group x Condition	−15.07	7.81	−1.93	$p = .05$
Random Effects (Intercepts)	Variance	*SD*		
Participants	8405	91.68		
Items	1418	37.66		
Model Fit AIC = 39300.1				

Significantly faster lexical decision times for the English target words were found for participants who had acquired English at an earlier age, $\chi^2(1) = 15.22$, $p < .001$, whose overall rating of their English skills was higher, $\chi^2(1) = 48.59$, $p < .001$, and who spent a greater percentage of time reading in English, $\chi^2(1) = 4.54$, $p = .03$ – however, there was no effect of percentage of time spent listening in English, $\chi^2(1) = 2.22$, $p = .14$, or number of years living in an English-speaking country, $\chi^2(1) = 0.42$, $p = .52$. Just one of these variables interacted with Condition. There was a significant interaction of Condition and age of acquisition of English, $\chi^2(1) = 13.65$, $p < .001$. There was a larger facilitatory effect of relatedness for participants who acquired English later.

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The frequency with which bilinguals reported code-switching did not interact with Condition, $\chi^2(1) = 0.0004$, $p = .98$.

In summary, bilinguals showed a larger facilitatory effect for related targets compared to unrelated targets when they spent a lower percentage of time speaking Indonesian and had acquired English later.

Discussion

Again, there was a significant Group by Condition interaction, suggesting some activation by bilinguals of the Indonesian meaning of translated idioms when reading exclusively in English. Here the importance of including an English control group was evident because their data revealed some sentences where priming effects were within English. The bilinguals' facilitatory effect for related words was similar to that for French–English bilinguals in Experiment 1 but differed from the inhibitory effect observed for Vietnamese–English bilinguals in Experiment 2.

General discussion

The aim of the present study was to examine whether the meanings of idioms from a bilingual's L1 are activated when they encounter a translation of the idiom in L2 English. Previous studies have demonstrated that there can be cross-language activation of idioms (e.g., Carrol & Conklin, 2014, 2017; Carrol et al., 2016), but they have not unequivocally shown that the activation extends beyond lexical representations to idiom meanings. Here we used a cross-modal priming task that specifically tapped the meaning of the L1 idiom. Three versions of the task were run, with French–English, Vietnamese–English, and Indonesian–English bilinguals, to examine the generalizability of our findings. We found evidence that bilinguals do produce cross-language activation of idiom meanings because priming effects in all three bilingual groups differed from monolingual English controls.

A puzzling aspect of the results, however, was that the direction of the effect differed for the Vietnamese–English bilinguals and the other two bilingual groups. For French–English and Indonesian–English bilinguals, target words that were related in meaning to the L1 idiom had faster decision latencies than words that were unrelated, as expected. We can use Carrol and Conklin's (2014) model shown in Figure 1 to understand the processing involved. Each English word of the translated idiom would activate its corresponding word in L1. The L1 words activate the lexical representation of the L1 idiom, which would then activate its figurative meaning (route 2a in Figure 1). Once this figurative meaning is activated by the spoken sentence, then we could expect that processing a visual word that was related in meaning would be faster than processing one that is unrelated in meaning. Alternatively, or in addition, words activated by the spoken sentence could each activate their corresponding conceptual representation and the ensemble of conceptual representations corresponding to an idiom would activate the figurative meaning of the idiom (route 2b in Figure 1). Again, that activated idiom meaning should facilitate the processing of a related word compared to an unrelated word. We think that it is unlikely that this route had much impact in our experiments because we chose idioms that were not very decomposable – that is, the meanings of the idioms were typically not easily determined from the words that are contained in the idiom.

To try to understand why facilitation might not always occur, we need to examine the assumptions that underlie the reasoning above. For facilitation to occur from processing along route 2a, we first have to assume that the L1 lexical representations are sufficiently activated by the L2 English lexical representations. Prior research on translation priming has suggested that L2-L1 priming effects may be stronger the more proficient a bilingual is in L2 (e.g., McPhedran & Lupker, 2021; Nakayama et al., 2016; Zhao et al., 2011; but see Chaouch-Orozco et al., 2021; Dimitropoulou et al., 2011), the earlier L2 is learned (e.g., Sabourin et al., 2014) or the more immersed the bilingual is in L2 (e.g., Chaouch-Orozco et al., 2021; but see Chaouch-Orozco et al., 2023). The L1 lexical representations for the individual words in the idiom then must sufficiently activate the L1 idiom lexical representation, which in turn must sufficiently activate the L1 figurative meaning. These activation levels are presumably influenced by L1 proficiency and/or current exposure to the L1. And finally, there must not be substantial inhibition of the figurative meaning by the literal meaning. In our experiments, the literal meaning would have been activated by both English and L1 lexical representations, whereas the figurative meaning would have been activated only by L1 lexical representations. We tried to choose L1 idioms that were as familiar as possible to make it likely that the L1 figurative meaning would be sufficiently activated by the L1 lexical representations.

The French–English bilinguals here had strong L1 skills, and they were primarily living in an L1 environment. Their English L2 skills varied somewhat, which would have impacted the strength of activation of L1 lexical representations for the idiom words from the L2 lexical representations. However, because French proficiency was very high and idioms were chosen to be familiar, L1 lexical representations for the individual words should have activated the lexical representation for the L1 idiom fairly strongly and in turn robustly activated the figurative meaning of the idiom. Consistent with the above account, bilinguals who had higher rated English proficiency and who spent more time reading in English showed greater facilitation for English words that were related to the French idiom than words unrelated to the French idiom.

Vietnamese–English bilinguals differed from French–English bilinguals not only in the language that is their L1, but also in relative L1 and L2 exposure. The Vietnamese–English bilinguals generally used their L1 less, especially with friends and at work or school, than the French–English bilinguals, probably because they were more likely to be living in an L2 environment. Here, Vietnamese–English bilinguals' decision latencies for related words were LONGER than for unrelated words, particularly for participants with lower proficiency in Vietnamese and who speak it less, and who had spent more years in an English-speaking country and had better proficiency in English. Good L2 skills should have activated L1 lexical representations fairly highly. Weaker Vietnamese skills might have resulted in somewhat weaker activation of the L1 figurative meaning from L1 lexical representations, but these participants were native speakers of Vietnamese, and the idioms were chosen to be as familiar as we could find, so activation of the figurative meaning should still have been at a reasonable level. One possibility is that the literal meaning of the idiom was activated more highly than the figurative meaning. Better L2 English skills would have activated the literal meaning more highly and produced greater competition for the figurative meaning. But we did not see an inhibitory effect in the French–English bilinguals with better L2 proficiency. It appears that these Vietnamese–English bilinguals who are living in an L2 environment have developed a mechanism to inhibit L1 figurative

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meanings, preventing misinterpretations in L2 such as interpreting *to sell melons* as meaning to *gossip*. Extensive exposure to an English environment may result in inhibitory connections developing between English lexical representations and the lexical representation for the L1 idiom, which would in turn inhibit the L1 figurative meaning when English was the language being used.

While this account for Vietnamese–English bilinguals seems reasonable, we now have a new challenge, which is to explain why Indonesian–English bilinguals produced a facilitatory priming effect, like the French–English bilinguals, when they had a language profile much like the Vietnamese–English bilinguals (see Table 1). Specifically, the Indonesian–English bilinguals in our study also typically had extensive exposure to an English-speaking environment. Since the profile of language skills is unlikely to be the source of the different results, we need to consider the nature of the idioms. One possibility we considered is that the strength of the inhibitory connections between L2 lexical representations and the L1 lexical representation of the idiom may depend on the frequency with which the translated form of the idiom is encountered. This could be a variable that differs across language pairs with translated idioms more likely to appear across some language pairs than others, particularly if idioms in one language often refer to everyday occurrences or common objects. Our initial hypothesis was that inhibitory links would be more likely to develop with more exposure to a multiword unit in English that had a different interpretation in L1. To examine how often the translated idioms occur in English, we consulted the Corpus of Contemporary American English (COCA), which contains more than one billion words of text (https://www.english-corpora.org/coca). Of the 60 English translations of French idioms, 25 appeared in the corpus at least once but only 10 appeared more than 10 times. None of the translated Vietnamese idioms appeared in the corpus. Of the 38 translated Indonesian idioms used in the analyses, 15 appeared in the corpus at least once, but only 5 appeared more than 10 times. It is unlikely, then, that the bilinguals in these experiments developed inhibitory connections between the English translations and L1 meanings of the idioms because of exposure to the translations, and this explanation certainly does not account for the Vietnamese results.

The observation that none of the translated Vietnamese idioms occurred in the large corpus of English text is a clue to a different explanation of our findings. Indeed, the explanation may lie in the content of the idioms. The Vietnamese idioms (mean length = 4.4 words in Vietnamese, 7.4 words in English) were considerably longer than the Indonesian idioms ($M = 2.4$ words in Indonesian, 3.9 words in English) and somewhat longer than the French idioms ($M = 4.0$ words in French, 4.9 words in English), and may have contained more culturally specific expressions that were recognized as such by the Vietnamese–English bilinguals. Although we have used *to sell melons* as our example for Vietnamese throughout, other idioms were longer and perhaps more obviously not from English culture, such as *to eat congee and kick the bowl* and *to grasp chopsticks as a bunch*. Vietnamese–English bilinguals, especially those living for some time in L2 environments, may have inhibited meanings that had Vietnamese cultural content in this English experiment, with only the L1 lexical representations for the most familiar idioms counteracting this inhibition somewhat. If this explanation is correct, one might expect that the Vietnamese cultural content would have become more noticeable as the experiment progressed. In an analysis not reported in Experiment 2, we examined whether the inhibitory effect (i.e., longer RTs for related than unrelated trials) increased over the course of the experiment, and it did, although the interaction of trial number and condition was not statistically significant. The French idioms may have had less noticeable culture-specific content because of the greater similarity of English and French cultures, and culture-specific aspects of Indonesian idioms may have been less evident than for Vietnamese because many Indonesian idioms contain just two key words that are used in a variety of contexts. The somewhat less robust facilitation for Indonesian than for French might be due to a small amount of Indonesian-specific cultural content being noticed by the Indonesian–English bilinguals.

Conclusion

The three experiments reported here provide evidence that bilinguals produce cross-language activation of idiom meanings. An implication of our findings is that when listening to spoken English, bilinguals may activate a wider range of meanings than an English monolingual, possibly to the detriment of communication. These findings extend research on word recognition in bilinguals by examining multiword units, and they extend research on bilingual idiom processing by focusing on the activation of idiom meanings. Furthermore, this work not only includes bilinguals who speak a well-studied pair of languages, French and English, but also extends research on bilingualism to speakers of two understudied languages, Vietnamese and Indonesian. The contrast in results for Vietnamese and Indonesian speakers points to an important role of the cultural information in multiword expressions when considering how effects of cross-language transfer will be observed in an experiment. This would not have been evident had we tested only French–English bilinguals. Further research that explicitly manipulates the presence and absence of culture-specific information in multiword units would provide more insight into the impact of this type of information.

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