

Bilingual Access of Single and Paired Words in the Context of Episodic Memory

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Abstract. In a series of four experiments, the cued-recall task was used to explore bilingual word representation in episodic memory. When target words were encoded singly, their recall to same-language and to crossed-language extralist cues was found not to be different. These results appear to support a language independent view of bilingual word representation in which words of different languages are mutually accessible. When target words were encoded in a cue-target relational fashion, recall of target words was much higher to original-language than to translated-language intralist cues, thus supporting a language dependent view. In this case information seems to be bound by the language in which it was originally encountered. This difference in results of cross-language cuing of singly and relationally encoded words was assumed to result from shifts in meaning brought about by contrasting word experiences. More broadly, the findings were interpreted within the context of Don Dulany's (1997) mentalistic theory of evocative versus deliberative processing of words.

Keywords: bilingualism, bilingual lexicon, relational processing, memory.

Dvikalbė prieiga prie paskirų ir suporuotų žodžių epizodinėje atmintyje

Santrauka. Keturių tyrimų metu pažvelgta į dviejų kalbų žodžių santykį dvikalbio asmens atmintyje. Dviejų kalbų žodžių santykis buvo tikrinamas, atliekant nuorodų ir tikslinių žodžių užduotį, kai, naudojantis žodžių (anglišku ar lietuvišku, pavyzdžiui, *chair* ar *kėdė*) nuorodomis, dalyviams tekdavo atkurti įsimintus tikslinius žodžius (angliškus ar lietuviškus, pavyzdžiui, TABLE ar STALAS). Vienu atveju dalyviai pirma turėjo įsiminti pavienių tikslinių žodžių (TABLE) sąrašą, o paskui dar kartą juos prisiminti padedami tapačios ar skirtingos kalbos nuorodų (*chair* ar *kėdė*). Atrasta, kad, nesvarbu, ar nuorodos buvo tos pačios, ar skirtingos kalbos, jos lygiai veiksmingai padėdavo prisiminti anksčiau matytus tikslinius žodžius. Taigi skirtingų kalbų žodžiai peržengia kalbos ribas ir kalbiniu atžvilgiu yra nepriklausomi. Išeitų, kad dvikalbiam asmeniui atskirų kalbų žodžiai yra betarpiškai susiję ir lygiai prieinami. Kitu atveju dalyviai pirma turėjo įsiminti nuorodų ir tikslinių žodžių poras (pavyzdžiui, *chair*-STALAS). Vėliau tikslinių žodžių (STALAS) prisiminimas buvo patikrintas dalyviams pateikiant arba kartu buvusias nuorodas (*chair*), arba jų vertimus (*kėdė*). Aptikta, kad tiesiogiai matytos nuorodos, palyginti su jų verstiniais atitikmenimis, kur kas geriau padėdavo prisiminti tikslinius žodžius. Šiuo atveju atrodytų, kad kalba ir žodžiai yra vienas nuo kito priklausomi. Susidaro įspūdis, kad žodžiai yra užsklęsti kalbos rėmuose. Kaip paaiškinti šiuos skirtingų kalbų žodžių santykius, susijusius su pavieniui ir poromis pateiktais žodžiais? Bandyta šiuos skirtingus duomenis aiškinti žodžių reikšme. Manyta, kad pavieniai tapačios kalbos žodžiai reikšmės atžvilgiu yra labai panašūs ir todėl nesunkiai vienas kitą atliepiantys. O žodžiai, esantys poroje, gali lengvai įgauti savitą reikšmės atspalvį ir todėl tapti nelengvai sukeičiami su kitos kalbos verstiniais žodžiais. Aiškinant šiuos duomenis platesniu mastu, jiems buvo pritaikyta Don Dulany (1997) sąmonės sampratos teorija, kuria remiantis, yra skirtumas tarp sukeliančiojo (angl. *evocative*) versus svarsto-mojo (angl. *deliberative*) žodžių apdoravimo.

Pagrindiniai žodžiai: dvikalbystė, dvikalbis leksikonas, santykinis apdorojimas, atmintis.

Received: 1/9/2019. Accepted: 6/12/2019

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The question of language representation in bilinguals continues to be the object of extensive research. How are the different language lexicons related to each other? Are they essentially open ended, thus permitting mutual access, or is the relationship modulated in certain respects, as by the type of words being used (see Heredia & Brown, 2004). Previously much of the research on bilingual word representation was based on what Tulving and Bower (1974) call the probabilities of content retrieval approach. Participants in this case are presented with episodic memory tasks (e.g., free recall, recognition, etc.) under various bilingual conditions. Currently, most of the research is conducted utilizing the latency of content retrieval approach (Tulving & Bower, 1974). Here reaction time measures are used to assess immediate processing in various bilingual task situations, such as translation, word identification, etc. (see also French & Jacquet, 2004).

When bilingual words are tested individually, the findings of the two research approaches show a convergence: in both cases bilingual equivalent words manifest a close relationship. Content retrieval type studies have repeatedly shown that translated equivalents of separately presented bilingual words exhibit a close conceptual affinity (e.g., Kolers, 1966; Lopez & Young, 1974; Saegert, Obermeyer, & Kazarian, 1973). Similarly, studies that measure latency of content retrieval have also demonstrated the conceptual relatedness of individual words (e.g., de Groot & Poot, 1997; Dimitropoulou, Duñabeitia, & Carreiras, 2011; Duyck & Brysbaert, 2004). More broadly, research findings based on immediate processing seem to suggest that the bilingual lexicon operates as an integrated system, seemingly in a language independent fashion. The lexicon is said to be nonselective, implying that the various word forms and meanings of different languages are mutually accessible (Dijkstra, 2009).

However, when bilingual words are tested in the context of other words, the findings associated with the two research approaches diverge. In the case of content retrieval research, memory for bilingual material appears to be language dependent (i.e., selective). Once verbal material has been encoded in a certain language, its recall is much greater in that language (Mariam & Neisser, 2000; Mariam & Fausey, 2006). As for latency-based research, the findings generally continue to show nonselective access of words in a bilingual situation even in the presence of a sentence context (Dijkstra, 2009; Van Assche, Duyck, & Hartsuiker, 2012). But it is also the case that, given a rich semantic context, cross-language activation may be lessened (e.g., Van Hell & De Groot, 2008).

The present series of experiments looked at bilingual representation using the cued-recall task, thus following the “content retrieval” approach. In the cued-recall task, a memory aid (*cue*) is used to help retrieve the contents of a previous episodic experience (TARGET). All four experiments followed the same general procedure. Participants first saw a bilingual set of words. They then participated in an orthogonally related cued recall, such that half of the cue-targets were in the same language: *English*-ENGLISH (*e*-E) and *Lithuanian*-LITHUANIAN (*l*-L) and half were crossed-language: *English*-LITHUANIAN (*e*-L) and *Lithuanian*-ENGLISH (*l*-E). These experiments may be regarded as a test of convergence in relation to the findings associated with the two research approaches.

In Experiments 1 and 2 participants were first shown bilingual lists of single target words. Afterwards, they were orthogonally tested for target recall with semantically related same language (*eE*, *lL*) and different language (*eL*, *lE*) *extralist* cues. The critical comparison in this case is the probability of target recall of cue-target pairs that are in the same language versus different languages.

Interestingly, the findings of both research approaches carry hypothetical implications that would predict the same amount of target recall for the same and different language cue-target pairs. The content retrieval approach has shown that translated equivalents are conceptually identical, and the latency-based approach has demonstrated nonselective accessibility for different language words. Given conceptual identity and nonselective access, one would expect cues in either language to be equally effective in prompting target recall. Thus, there should be no difference in recall between the same (*eE*, *lL*) and different (*eL*, *lE*) language cue-target retrieval conditions.

In Experiments 3 and 4, the participants first studied a bilingual set of cue-target pairs, thus encoding the words in a relational fashion. In subsequent cued recall, bilingual *intra*list cues were orthogonally related to the cue-target pairs: the language of the cue words for half of the cue-target pairs remained the same (*e-e* or *l-l*) and for the other half it was changed (*e-l* or *l-e*).

In this case, predictions of cued-recall performance that flow from the two research approaches show a divergence. The content retrieval approach, having repeatedly shown that contextually encoded verbal materials are language dependent, would predict, perhaps guided by the encoding specificity principle, that same language cues would bring about better target recall than different language cues. As for the latency-based approach, the finding of bilingual word access in sentence contexts suggests the possibility of equivalent target-word recall to original and to translated cue words. If lexical access is powerfully nonselective, and assuming that it can breach the barrier of relational episodic encoding, then the probability of target-word recalls to same and changed language cues should be the same.

Experiment 1

In Experiment 1, participants were first presented a list of words that they recalled, after which they participated in *extralist* cued recall. The purpose of initial recall was to add analytic power to the subsequent analysis of cued recall – to observe any difference between cued recall of recalled target words in relation to nonrecalled target words. The crucial comparison in this experiment was between the within-language (*eE* and *lL*) versus between-language (*eL* and *lE*) cued recall of target words. The presence of a Cue x Target interaction would imply that performance between these two conditions is different, its absence – that it is the same. Both conceptual identity and nonselective accessibility would predict uniform performance in the two conditions and thus no interaction effect.

Method

Participants. The 36 English-Lithuanian bilinguals, 18 men and 18 women, who volunteered for the experiment were students or recent university graduates living in Toronto, Canada. As second-generation Canadians, they first learned Lithuanian in their homes, and then acquired English by encountering Canadian society at large.

The participants' language ability was first evaluated by a continuous word association test (Lambert, 1956). The participants were presented four individual words (forest, school, city, house) that were counterbalanced for language and order, and asked to generate for each of the words as many English and Lithuanian associates as possible in a 45 second period. Overall, there were 56% English and 44% Lithuanian responses. The participants also rated their language ability in English and Lithuanian on a seven-point scale (Macnamara, 1967). Of the 36 participants, 26 rated themselves more proficient in English, nine gave equal ratings, and one rated herself stronger in Lithuanian. The difference between the two languages was significant, $t(35) = 6.44, p < .001$. For these participants, clearly, English was the stronger language of the two.

Lists. A pool of 130 high word-associates was first selected from various normative sources (Bilodeau & Howell, 1965; Postman & Keppel, 1970) and, in a few cases, generated intuitively. Care was taken to avoid potential cross associates between word pairs. The 130 conceptual associates (types) were expressed in both English and Lithuanian, thus creating a total of 260 word-pairs (tokens).

Since the relative associative strength of the word pairs in the two languages was not known, four bilinguals, comparable to those who later served in the experiment, were asked to rate the associative relatedness of English and Lithuanian word pairs on a three-point scale. Based on the ratings, 108 associates showing the highest degree of relatedness were selected for the experiment. These word-associates were then randomly assigned to three lists, each consisting of 36 cue-target word pairs. Of these selected cue-target word pairs, the vast majority of cues were nouns with an occasional adjective and verb; the target words were all nouns (e.g., *hammer-NAIL, plaktukas-VINIS; heavy-ROCK, sunkus-AKMUO; cut-SCISSORS, kirpti-ŽIRKLĖS*).

Design. The experiment consisted of two tests: free recall followed by extralist cued-recall of target words. In the free-recall test, participants were presented a list of individual target words, half of which were English, half were Lithuanian, and then asked to recall them. In cued recall they were shown English and Lithuanian extralist cues to help them recall the previously seen target words. Since the English and Lithuanian cues were crossed with English and Lithuanian targets, cued recall comprised these four experimental conditions: *English cues-ENGLISH targets (eE), Lithuanian cues-ENGLISH targets (lE), English cues-LITHUANIAN targets (eL), and Lithuanian cues- LITHUANIAN targets (lL)*. In brief, the cued-recall portion of the experiment constituted a 2 x 2 within-subjects design.

Participants were given both tests with all three word-lists. The order of the lists was counterbalanced across the participants. Furthermore, the four experimental conditions: eE, eL, lE, and lL, were counterbalanced across the 36 word-associates in all three lists.

Since the cues and targets were high associates, steps were taken to check for target guessing during cued recall (see Watkins & Gardiner, 1982). For this purpose, the target words in all the three word-lists were subdivided randomly into three sets of 12 words each. Every time a target word-list was shown for free recall, one of the three sets of 12 words was removed in a rotational fashion from the 36 target words, thus permitting participants to see only 24 target words. During cued-recall, however, participants were presented all 36 extralist cues and tested for the 24 seen and 12 unseen target words. Target guessing was evaluated by counting the number of times omitted target words were generated by their respective cues: six English and six Lithuanian.

The 36 participants were randomly assigned to one of 36 experimental sequences created by counterbalancing three lists and four experimental conditions, and by rotationally excluding from each list one of the three sets of target words.

Procedure. Participants were tested individually. For each of the three word-lists, they first participated in a free-recall test. At the start, participants were handed a shuffled pack of 24 3 in. x 5 in. index cards with single target words typed on them in lowercase letters. Twelve of the words were English and 12 Lithuanian. The participants had to turn the cards and read the words aloud according to a beat that they heard every three seconds over a cassette player. At the end of the target-word cards, the participants saw a series of two-digit addition and subtraction problems, which they tried to solve within 30 seconds. Two minutes were given for recalling as many target words as possible.

During cued recall, the participants were handed a shuffled pack of 36 3 in. x 5 in. index cards with single cue words typed in lower case letters. Upon turning the card, they had to pronounce the cue word and then try to recall the appropriate target word. The cued-recall session was self-paced. After the participants completed free recall and cued-recall for all three lists, they were tested for their language ability: first they were given the continuous word-association test and then they rated their ability in the two languages.

Results

Free recall. In assessing memory for meaning, the criterion for correct recall in the free-recall analysis and the subsequent cued-recall analysis was based on the reproduction of the target concept (type) irrespective of its linguistic form (token). Free recall of target words was analyzed for the three lists with a 2 x 3 repeated measures analysis of variance. The main effect of language was highly significant, $F(1,35) = 21.54, p < .001, MSE = 53.00$. On the average, participants recalled 5.57 Lithuanian words and 4.61 English words.

Target word translations were rare – only 1.82%. Translation was about equal for the two languages: 11 English words and nine Lithuanian words were translated.

Cued recall. There were very few cases of target guessing, only 1.39% (18/1296), and thus will not be considered further.

The cued-recall data were pooled over the three experimental lists. Table 1 presents correct cued recall for the four experimental conditions under three kinds of data analyses: overall cued-recall, cued-recall of recalled target words, and cued-recall of nonrecalled

target words. A 2 x 2 analysis of variance for repeated measures revealed that there were no interactions in any of the three analyses, respectively, $F(1,35) = 1.98, p > .10, MSE = 7.56$, and the next two $F < 1$.

Table 1. Mean Cued Recall in Relation to Cuing Condition under Three Types of Analyses: Overall, Recalled Targets, and Nonrecalled Targets in Experiment 1

		Recalled	Nonrecalled
Cuing condition	Overall	targets	targets
<i>English</i> ENGLISH	7.28	4.94	2.33
<i>Lithuanian</i> ENGLISH	7.11	4.67	2.44
<i>English</i> LITHUANIAN	8.89	6.47	2.42
<i>Lithuanian</i> LITHUANIAN	7.81	5.47	2.33

Only two results were significant. More Lithuanian than English targets were recalled both for overall cued-recall and cued-recall of recalled target words: $F(1,35) = 8.66, p < .005, MSE = 47.84$ and $F(1, 35) = 15.45, p < .001, MSE = 49.00$, respectively. The latter result implies that the locus of the Lithuanian target effect resides in greater accessibility of recalled Lithuanian target words during cued recall. Interestingly, once cued recall was conditionalized over recalled target words, the difference in recall between Lithuanian and English targets (.70 vs. .68, respectively) disappeared.

Translation of targets in cued recall was also uncommon – 4.20% (47/1119). The translations were distributed among the four experimental conditions as follows: *eE* – 10, *lE* – 19, *eL* – 12, and *lL* – 16.

Discussion

The experiment failed to find a cue and target interaction: recall of a specific language target word (e.g., SLEEP) is the same whether prompted by a word in the same language (e.g., *bed*) or in another language (e.g., in Lithuanian with *lova*). This result implies that translated equivalents have a close conceptual identity and that they are non-selectively accessible. What adds strength to this conclusion is the absence of interaction in all three analyses: for all target words, for recalled target words, and for nonrecalled target words. Especially noteworthy is the case of cued-recall for recalled target words. During free recall, the participants were able to remember these target words intact: to reproduce a meaning in its appropriate lexical form. Even so the same and different language cue words did not exert a differential effect on recall performance.

However, one may question whether the experiment was sufficiently stringent in assessing the impact of same- versus different-language cuing effects on episodic memory for target words. Possibly a 24-item target list is too short to allow for language disparity to manifest itself. A second experiment was therefore carried out to test the generality of the results of Experiment 1 and to do so under more exacting conditions.

Experiment 2

The design of Experiment 2 basically replicated that of Experiment 1. This time, however, participants worked with a much longer list of words. They were asked to recall as many as 72 target words in the free-recall test, following which they participated in an extralist cued-recall test. In addition, after their first cued recall, the participants returned for a second cued-recall experience 24 hours later, this time with the cues reversed for language: *e* becoming *l*, and vice versa. The main interest of the experiment was again in the within (*eE* and *lL*) versus between (*lE* and *eL*) language cuing conditions.

Method

Participants. Sixteen men and 16 women English-Lithuanian bilinguals who volunteered for the study were all university students from the Chicago, Illinois area. Their bilingual condition was like that of their Canadian counterparts. Since the results of the two language proficiency tests in Experiment 1 were closely related, the participants' language ability this time was evaluated only with the self-rating technique. As in the first experiment, participants regarded their English as stronger than Lithuanian, $t(31) = 6.43, p < .001$.

List. A list of 96 word-associates was constructed, mainly based on associates used in Experiment 1. Two people evaluated the 108 word-associates of Experiment 1 and identified clear cases of cross association. As a result, 16 word-associates were discarded, leaving 92 word-associates in all. The four additional associates were generated intuitively.

Design and procedure. Participants worked with a single list, consisting of 96 word-associates. The cue-target experimental conditions, *eE*, *lE*, *eL*, and *lL*, were counterbalanced across the 96 word-associates. Four groups of 24 targets were rotationally eliminated from initial presentation to estimate for target guessing. Thus, during free recall, participants saw only 72 target words that were followed by simple arithmetic problems and then had six minutes to recall them. The first self-paced extralist cued-recall session came right after free recall and involved all 96 cue words. The participants returned a day later for the second cued-recall session, but this time the 96 cue words were translated equivalents of previous cue words. At the end of the second cued-recall session, participants rated their language ability for the two languages.

Overall, the experiment comprised 16 experimental sequences – four counterbalanced experimental conditions combined with the rotational removal of four groups of 24 target words to test for guessing. Two blocks of 16 participants were randomly assigned to the 16 experimental sequences.

Results

Free recall. The participants again recalled significantly more Lithuanian ($M = 9.12$) than English ($M = 5.34$) words, $t(31) = 5.94, p < .001$. Translations, too, were few – 3.89%. The participants translated 13 English words and 5 Lithuanian words.

Cued recall. Although target guessing this time was more common – 6.64% (102/1536) – it was about evenly distributed among the four experimental conditions.

Table 2 shows the mean correct cued recall for the four cuing conditions and for first and second cued recall in relation to three types of data analyses: overall cue recall, cued recall of recalled target words, and cued recall of nonrecalled target words. The data were analyzed with a $2 \times 2 \times 2$ repeated measures analysis of variance. In addition to cue and target languages, order of testing was also considered (first or second).

Table 2. Mean Cued Recall in Relation to Cuing Condition and Order of Testing under Three Types of Analyses: Overall, Recalled Targets, and Nonrecalled Targets in Experiment 2

		Overall	Recalled targets		Nonrecalled targets	
		Order of testing				
Cuing condition	First	Second	First	Second	First	Second
<i>English</i> ENGLISH	3.81	2.88	1.90	1.22	1.90	1.66
<i>Lithuanian</i> ENGLISH	3.50	3.06	1.25	1.47	2.25	1.59
<i>English</i> LIHUANIAN	4.94	4.88	2.59	2.34	2.34	2.53
<i>Lithuanian</i> LITHUANIAN	4.91	4.78	2.31	2.66	2.59	2.12

As in Experiment 1, there was no Cue x Target interaction for overall cued, cued recall of recalled target words, and of nonrecalled target words: $F(1, 31) < 1$; $F(1,15) = 1.92$, $p > .10$, $MSE = 1.53$; $F(1,15) = 2.75$, $p > .10$, $MSE = .07$; respectively. Lithuanian targets were again recalled more frequently than English targets for overall cued recall, $F(1, 31) = 28.79$, $p < .001$, $MSE = 156.25$, and for cued recall of recalled target words, $F(1,15) = 25.90$, $p < .001$, $MSE = 132.03$. As before, once cued recall was conditionalized for recalled target words, there was no difference in recall between languages (.59 vs. .57), for English and Lithuanian, respectively. In this experiment, however, the Lithuanian target effect was also significant for cued recall of nonrecalled target words, $F(1, 31) = 4.78$, $p < .05$, $MSE = 19.14$. This effect is mainly due to a drop in English target recall in the second cued recall.

The number of translations in both first and second cued recall was 15% (80/549 and 72/499, respectively). Their overall distribution among the four conditions was the following: *eE* – 48, *lE* – 67, *eL* – 26, and *lL* – 11.

Discussion

The results of Experiment 2 lend further support to the conceptual identity and the nonselective access hypotheses. Even under the exacting conditions of a 72-item list, cues and targets did not interact in any of the three analyses: for all target words, for recalled target words, and for nonrecalled target words. Note, also, that a differential language cuing effect was absent not only for recently seen targets, but a day later as well. So even after 24 hours different language cues are still equally effective in accessing target words in

episodic memory. Thus, it appears that when bilinguals experience words individually, the corresponding words of different languages, despite their distinct lexical form, manifest a common conceptual core and a mutual openness across the two languages.

An unexpected finding in Experiments 1 and 2 was the greater recall of Lithuanian words during free recall, even when participants judged their English as stronger than Lithuanian. This finding will be explored more closely in the general discussion.

Experiment 3

Experiment 3 was designed to assess contextual encoding of words. Unlike the first two experiments, where participants initially saw individual target words, this time they were first shown intralist cues and target words together. After seeing the cue-target pairs, participants were given a cued-recall test in which half of the targets were tested with the original-language cues (e.g., *bed*-SLEEP, *bed*-____) and half were tested with translated cues (e.g., *bed*-SLEEP, *lova*-____). If cue and target words maintain their conceptual identity and retain their nonselective access, then target recall to original- and cross-language cues should not differ. On the other hand, if cue-target words are encoded in some unique meaningful fashion, then original cues might be more effective than translated cues in aiding the recall of target words.

Method

Participants. Sixteen men and 16 women English-Lithuanian bilinguals participated voluntarily in the experiment. They were all university students in the Chicago, Illinois area. Their bilingual condition was comparable to that of the previous two groups. They too perceived their English as stronger than Lithuanian, $t(31) = 5.68, p < .01$.

Lists. To assess the generality of possible treatment effects, a list consisting of cue-target word pairs was generated that consisted of both strong and weak associates. Specifically, 64 triplets of associatively related words were selected from word-association norms (Palermo & Jenkins, 1964; Postman & Keppel, 1970). Each triplet consisted of a target word and two related cue words. One cue word was a strong associate ($M = 35.18\%$), the other a weak associate ($M = 1.35\%$) of the target word (see Tulving & Thomson, 1973).

Design and procedure. The intralist cue and target words were combined to create four types of word pairs: *English*-ENGLISH (*e*-E), *Lithuanian*-English (*l*-E), *English*-Lithuanian (*e*-L), and *Lithuanian*-LITHUANIAN (*l*-L). These four pairs were crossed with strong and weak-cue associates to produce a total of eight list-presentation conditions that were counterbalanced over the 64 word-pairs.

The individually tested participants were presented the 64 word-pairs on index cards. The lowercase intralist cue appeared above the capitalized target word. The participants were told that they would have to recall the capitalized words but to pay attention to the words in small letters. The participants leafed through a randomized deck of cards at a four-second pace, each time reading the cue and target words. After

solving a series of arithmetic problems, they were given four minutes to recall as many target words as possible.

In cued recall the participants were handed a randomized deck of 64 retrieval cues. Half of the cues were identical in language to the presented intralist cues and half were translations. The two language cues were counterbalanced over the list presentation conditions. After the first self-paced cued-recall session, the participants were given a second one. This time the language of retrieval cues was reversed: *e* cues became *l*, *l* became *e*. A segment of the experimental design and a sample of word-associates are shown in the Appendix.

Following assessment of language ability, participants were questioned about their cued recall experience. Since the participants were presented cue-target word pairs (e.g., *bed* – SLEEP), conceivably they might have translated the cues of a different language (e.g., *lova*) back to the originally seen cue words in their search for target words (e.g., *lova* – *bed* – SLEEP). If this had happened, the intended comparison of original and translated cues would be vitiated. Hence, the participants were asked to answer these two questions: 1. Did anything catch your attention during the experiment? 2. Did you translate the words in small letters as you tried to recall the capitalized words?

Results

Free recall. Even in the more complex setting of word-pair presentation, participants recalled more Lithuanian ($M = 6.25$) than English ($M = 4.12$) target words, $t(31) = 3.49$, $p < .01$. As before, there were very few translations – 1.8%.

Cued recall. Not surprisingly, the degree of associative relatedness had a powerful effect on recall; the means were 22.59 and 14.62 for high and low associates, respectively. However, since relatedness did not interact with other variables, it was pooled in subsequent data analyses. Table 3 shows mean correct cued recall for type of retrieval cue (original vs. translated) and order of testing (first vs. second) in relation to the four cue-target word pairs.

The type of retrieval cue had a powerful effect on cued recall. Significantly, more targets were recalled to original than to translated cues under all three analyses: overall, $F(1, 31) = 15.11$, $p < .001$, $MSE = 16.89$; for recalled target words, $F(1, 15) = 9.93$, $p < .01$, $MSE = 2.64$; and for nonrecalled target words, $F(1, 31) = 13.14$, $p < .001$, $MSE = 8.77$. Even when cued recall was conditionalized for recalled targets, the difference remained significant: .69 and .61 for original and translated, respectively, $t(31) = -2.94$, $p < .01$.

As in Experiments 1 and 2, recall of Lithuanian targets exceeded the recall of English targets for overall cued recall and the cued recall of recalled target words, $F(1, 31) = 9.87$, $p < .01$, $MSE = 15.47$ and $F(1, 15) = 22.65$, $p < .001$, $MSE = 34.52$, respectively. Once cued recall was conditionalized in relation to recalled targets, as before, the difference between the languages disappeared (.66 and .64 for Lithuanian and English words, respectively).

For a closer view of how original and translated cues affected target recall, overall cued recall was partitioned into three kinds of retrieval performance categories in relation

Table 3. Mean Cued Recall as a Function of Cue-Target Study Condition, Type of Cue, and Order of Testing under Three Kinds of Analyses: Overall, Recalled Targets, and Nonrecalled Targets in Experiment 3

	Overall		Recalled targets		Nonrecalled targets	
	Order of testing					
Study condition	First	Second	First	Second	First	Second
	Original cues					
<i>English-ENGLISH</i>	2.16	2.16	.63	.69	1.53	1.47
<i>Lithuanian-ENGLISH</i>	2.66	2.22	.72	.69	1.94	1.53
<i>English-LITHUANIAN</i>	3.16	2.78	1.16	1.19	2.00	1.59
<i>Lithuanian-LITHUANIAN</i>	2.53	2.41	1.00	1.09	1.53	1.31
<i>M</i>	2.63	2.40	.88	.92	1.75	1.48
	Translated cues					
<i>English-ENGLISH</i>	1.63	1.88	.66	.63	.97	1.25
<i>Lithuanian-ENGLISH</i>	2.16	2.38	.66	.63	1.50	1.75
<i>English-LITHUANIAN</i>	2.41	2.72	1.09	1.06	1.31	1.66
<i>Lithuanian-LITHUANIAN</i>	1.87	2.12	.84	.78	1.03	1.34
<i>M</i>	2.02	2.28	.81	.78	1.20	1.50

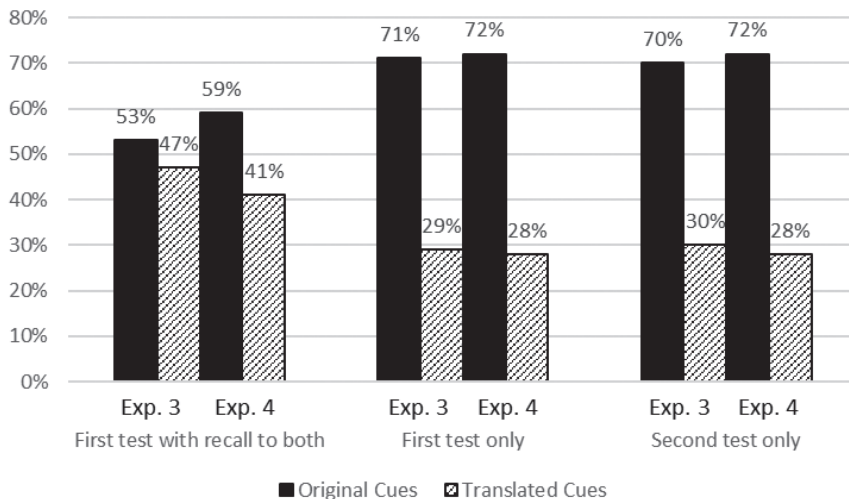


Figure 1. Percentage Cued Recall to Original and Translated Cues in Relation to First and Second Tests in Experiments 3 and 4

to order of testing: successful retrieval on both first and second tests, retrieval on first test only, and retrieval on second test only. The percentages correct for these performance categories are presented in Figure 1 (Exp. 3). Note the first column set shows mean correct cued-recall on the first test for targets recalled across both first and second cued-recall. Although more targets were recalled to original than to translated cues, the difference was not significant, $t(31) = -1.43, p > .10$. However, in the next two categories – cued recall on the first test only and the second test only – the differences were significant, $t(31) = -2.60, p < .05$ and $t(31) = -4.67, p < .01$, respectively.

The total of target translations was 11% (134/1187). They were distributed as follows: *e-E* – 20, *l-E* – 54, *e-L* – 35, *l-L* – 25.

Verbal reports. Two independent judges evaluated the participants' answers to the two questions. Only the second question revealed some translation activity. Overall, translations of cue words were not common. Three participants claimed they translated regularly, seven occasionally; however, their results did not differ from the group. Generally, these findings support Kirsner, Smith, Lockhart, King, and Jain's (1984, p. 526) observation that translation in a bilingual setting "occurs electively rather than automatically."

Discussion

Unlike extralist cuing of single words in Experiments 1 and 2, intralist cuing of relationally encoded cue-target pairs in Experiment 3 revealed a powerful context effect on cued recall: original cues produced much better recall than their translated counterparts. This result held true for various types of comparisons. Apparently, when words are processed in the context of other words, they seem to become language dependent and resist nonselective accessibility.

One might ask at this point, what might be the source of this restriction. Since language harbors a host of features, a change in any one of them may compromise word accessibility. Specifically, Weldon (1991) maintains that words consist of three components: conceptual – meaning, lexical – language specific form, and perceptual – physical appearance (see also Basden, Bonilla-Meeks, & Basden, 1994). As cue words are translated, a change in any one of the components may inhibit target recall. To narrow the possible locus of target recall suppression, the next experiment eliminated perceptual and possibly lexical change by shifting cue modality from the visual at presentation to the auditory at recall. If under these circumstances difficulty in recall should persist, then meaning would become the most likely candidate for closer scrutiny.

Experiment 4

Experiment 4 basically replicated Experiment 3 with one major difference. As before, the participants first looked at cue-target word pairs and then participated in cued recall. However, the cue words this time, instead of being presented visually, were spoken to the participants. Such a change in modality would obviously have the effect of neutralizing

formal (orthographic) differences between original and translated cues. If formal change is responsible for the difference in target recall between original and translated cues, then with its removal the difference in recall should be eliminated.

Method

Eight men and eight women English Lithuanian bilinguals, similar in their bilingual condition to previous groups, participated in the study. They too judged their English to be stronger than Lithuanian, $t(15) = 3.30, p < .01$.

The design and procedure of this experiment was basically identical to Experiment 3, except for changes made in the cued-recall phase. The participants first looked at 64 word pairs that were counterbalanced across targets, cues, and associative relatedness, and afterwards tried to recall as many target words as possible. In cued recall, however, two important changes were introduced. First, instead of reading the original and translated cue words, this time subjects listened to them being spoken by the experimenter as they tried to recall the target words. Second, to enhance the relative sensitivity of the cued-recall test, the second cued-recall session was carried out a day later.

Results and Discussion

As in prior experiments, the recall of Lithuanian words ($M = 5.19$) exceeded recall of English words ($M = 3.25$), $t(15) = 2.28, p < .05$. Again, there were few translations – 2.96%. Since in Experiment 3 the breakdown of cued recall according to recalled and nonrecalled target words had no differential effect on recall performance in relation to type of cue, only overall cued-recall was considered here. The cued recall results, as compared to Experiment 3, were marked by a powerful leveling effect. This time associative relatedness did not affect cued recall, $M = 12.75$ and 13.62 for high and low associates, respectively, $t(15) = 0.51, p > .10$. Hence, cued recall results were collapsed across relatedness and are shown in Table 4. Unlike previous experiments, the cued recall of English and Lithuanian target words, too, did not differ, $F(1,15) = 2.76, p > .05, MSE = 9.76$. There was also no intralist Cue x Target word interaction, $F(1,15) < 1$. The only two main effects showing a significant difference were type of retrieval cue, $F(1,15) = 13.85, p < .01, MSE = 10.56$, with more words recalled to original than to translated cues, and order of testing, $F(1,15) = 17.92, p < .01, MSE = 12.25$, with more targets recalled in first than in second recall. Target word translations in cued recall stood at 17% (73/425) and were distributed as follows: *e-E* – 18, *l-E* – 23, *e-L* – 13, and *l-L* – 19.

Turning to a more analytic assessment of target recall to original and changed language cues, the original language cues dominated, as can be seen in Figure 1 (Exp. 4), in all three performance categories: successful retrieval on the first test of targets recalled across both first and second cued-recall, retrieval on first test only, and retrieval on second test only. The *t*-test results, respectively, were $t(15) = -2.55, p < .05$, $t(15) = -3.48, p < .01$, and $t(15) = -3.34, p < .01$.

Table 4. Mean Cued Recall as a Function of Study Condition, Type of Cue, and Order of Testing in Experiment 4

Study condition	Original		Translated	
	First	Second	First	Second
<i>English-ENGLISH</i>	2.12	.94	1.06	1.25
<i>Lithuanian-ENGLISH</i>	2.25	1.31	1.31	1.37
<i>English-LITHUANIAN</i>	2.56	1.62	1.31	1.88
<i>Lithuanian-LITHUANIAN</i>	2.56	1.44	1.75	1.62
<i>M</i>	2.37	1.33	1.36	1.53

Interestingly, although a shift in modality of cue words from visual to auditory suppressed the effect of certain variables, such as associative relatedness and the language of target words, it had no effect on the superiority of the original retrieval cues in relation to the translated ones.

Discussion

All four experiments show that the type of encounter with bilingual words, individual or relational, can have a powerful impact on cued recall. Individually presented target words, as demonstrated in Experiments 1 and 2, are equally accessible to associatively related extralist cues – be they in the same or a different language. These results support the predictions made by the content retrieval approach that posits the conceptual identity of cross-language words and the latency-based approach that, in addition to positing conceptual identity, assumes nonselective access of bilingual words. The findings converge on the conclusion that corresponding words of different languages are semantically similar and equally accessible.

On the other hand, Experiments 3 and 4 show that if cue-target word pairs are encoded in a relational manner, then target recall to cross-language cues is severely impeded. This result replicates the findings of content retrieval type research that relationally learned materials are language dependent. Clearly, it fails to support an unqualified version of the nonselective accessibility of words.

One may ask at this point: why the difference between extralist versus intralist cues in their ability to retrieve target words? To say that differences in retrieval occur because of language dependency does not suffice. It is still unclear which aspect of language is at play in this case. Experiment 4, for its part, implies that formal changes are not the source of retrieval differences. The more likely hypothetical explanation of these differences in retrieval is that they are a result of changes in word meaning brought about by relational encoding. This interpretation is analogous to Finkbeiner, Forster, Nicol, and Nakamura's (2004) sense hypothesis, which claims that shifts in meaning can affect linguistic performance.

According to Rommetveit (1968), a word consists of a pattern of referential, associative, and emotive components. Furthermore, the relational state the word is in may have important bearing on the kind of meaning it carries. Words that stand alone, in Rommetveit's (1968) view, are experienced in an unmarked sense, with their usual "core potentialities" (p. 178). Morris, Bransford and Franks (1977) refer to such default meaning as "semantic meaning" (p. 530). Thus, a *chair* is an object for sitting. On the other hand, words that appear in context are open, as Rommetveit puts it (1968, p. 178), to a host of "fringe potentialities." Morris et al. (1977) call this kind of situational meaning that expresses some specific interpretation given to the word or some use to which it is put "understood meaning" (p. 530). A *chair*, for instance, might become an "object to stand on" for reaching.

This dynamic view of meaning clearly offers a possible explanation for the difference in recall between the one word and two-word tasks. In Experiments 1 and 2 both target and cue words were presented singly. Accordingly, their meaning should consist of the core semantic components. Furthermore, Szalay and Deese (1978) have shown that equivalent words of various languages have essentially the same meaning. It is not surprising then that research has consistently found equivalent bilingual words to be conceptually similar. Hence, if translated equivalents have the same default meaning, one certainly would expect them to be equally effective in eliciting the recall of an associatively related target word, for example, *chair* and *kédè* cuing TABLE, as was the case.

With Experiments 3 and 4, we obviously have a different situation. Here the participants first see pairs of words that may lend themselves to relational processing. Micco and Masson (1991) maintain that relational processing may prompt an interpretative encoding of words (see also Barsalou, 1982; de Groot, 1992; Hunt & Einstein, 1981). A cue-target pair of words may be given a relational interpretation that contrasts with the usual default interpretation. For example, the flowers we think of upon seeing the word pair *house*-FLOWER might have more to do, as Micco and Masson (1991) put it, "with colorful flowery beds surrounding a house rather than sweet scents or hovering bees" (p. 1107). No doubt the cue-target pairs offered ample opportunity for unique relational encoding. In cases where that happened, it is understandable why a translated cue might fail to operate. Let us assume that the participant sees the cue-target pair: *chair*-CUPBOARD. *Chair* in this case might be interpreted as something "to stand on" to reach something. If at a later encounter the *chair*'s translated equivalent *kédè* still retains its normative sense, then, not surprisingly, the difference in meaning can certainly have a disruptive effect on target recall.

In summary, it was found that bilingual words presented singly or in pairs have different consequences for later accessibility. In the cross-language situation, single words display open (nonselective) accessibility, perhaps driven by an underlying conceptual similarity. Paired- words, on the other hand, show far more selective access: target word retrieval was far more likely to original cues than to their translated equivalents, because of a possible change in meaning.

A plausible theoretical account of the difference in bilingual access is offered by Donelson Dulany's (1997) theoretical view of mental representation that assumes the presence of both evocative and deliberative processing. Within the framework of this

theory, encounters with single words would most likely take place at the *evocative* level. In an immediate sense, words automatically elicit various associatively related features: semantic, formal, and even emotive. As we have seen, translated equivalents typically evoke the same normative semantic features, thus forming the basis for conceptual identity. The latency-based research approach essentially operates at the evocative level. An encounter with paired words is different. The two words may call for interpretation, thus also engaging the *deliberative* mental order. Participants might resort to inferential thinking that gives the two words some unique understanding, foregrounding certain aspects at the expense of others. Thus, the stage is set, based on Tulving's encoding specificity principle (Tulving & Thomson, 1973), for differential target-word retrieval by the same and changed language cues. The translated equivalents still harbor the normative semantic components, but the shift in meaning focus has created a barrier that may be hard for them to cross. Obviously, with respect to the question of word representation, the interface between the evocative and the deliberative aspects of language processing still awaits further research.

A final ad hoc note on a set of unanticipated results that were found in all four experiments, specifically, the better free recall of weaker-language (Lithuanian) words in relation to stronger-language (English) words. The weaker-language superiority effect in free recall is not unusual. Both Nott and Lambert (1968) and Tulving and Colotla (1970) have reported similar results. Analogously, superior recall of uncommon words in relation to common words has been observed under mixed-list conditions (Gregg, Montgomery, & Castano, 1980). For a closer look at this finding, a detailed inspection of free-recall protocols of English and Lithuanian words was carried out across all four experiments. It revealed two consistent findings. First, early recall of words in one language suppressed recall of words in the other language. The two languages are highly symmetrical in this regard. In the following data notice how the proportion of Lithuanian words recalled changes as a function of different initial runs of Lithuanian and English words over the four experiments. For 5 or more Lithuanian words recalled initially, the overall proportion of Lithuanian words recalled was .80, 3 and 4 – .66, 1 and 2 – .59, for 1 and 2 English words – .56, 3 and 4 – .45, 5 or more – .25. Second, Lithuanian words were generally recalled sooner than English words. The actual frequencies for the various initial runs were as follows: 5 or more Lithuanian words recalled initially, total frequency – 14, 3 and 4 – 29, 1 and 2 – 76, 1 and 2 English words – 55, 3 and 4 – 11, 5 or more – 3.

Considering these results, the immediate reason for the dominance of Lithuanian words appears to be retrieval-induced forgetting, a phenomenon in which “the process of retrieving some items has a damaging effect on the retrieval of other items” (Crowder, 1976, p. 347). Hence, early recall of Lithuanian words interfered with later recall of English words. The question to ask, then, is why Lithuanian words are recalled sooner than English words? Possibly, being the weaker language, Lithuanian words stand at a lower resting-level (see Smith, Walters, & Prior, 2017). However, with unexpected activation, their level of activity temporarily outstrips that of the commonly used English words, thus their earlier recall. No doubt, retrieval-induced forgetting needs to be considered when investigating lexical representation in bilinguals.

References

- Barsalou, L. W. (1982). Context-independent and context-dependent information in concepts. *Memory & Cognition*, *10*, 82–93. <https://doi.org/10.3758/bf03197629>.
- Basden, B. H., Bonilla-Meeks, J. L., & Basden, D. R. (1994). Cross-language priming in word-fragment completion. *Journal of Memory and Language*, *33*, 69–82. <https://doi.org/10.1006/jmla.1994.1004>.
- Bilodeau, E. A., & Howell, D. C. (1965). *Free association norms*. (Catalogue No. D210.2: F87). Washington: U.S. Government Printing Office.
- Crowder, R. G. (1976). *Principles of learning and memory*. Hillsdale, NJ: Erlbaum.
- De Groot, A. M. B. (1992). Bilingual Lexical Representation: A Closer Look at Conceptual Representations. In R. Frost & L. Katz (Eds.), *Orthography, Phonology, Morphology, and Meaning* (pp. 389–412). Amsterdam: Elsevier. [https://doi.org/10.1016/s0166-4115\(08\)62805-8](https://doi.org/10.1016/s0166-4115(08)62805-8).
- De Groot, A. M. B., & Poot, R. (1997). Word translation at three levels of proficiency in a second language: The ubiquitous involvement of conceptual memory. *Language Learning*, *47*, 215–264. <https://doi.org/10.1111/0023-8333.71997007>.
- Dijkstra, T. (2009). The Multilingual Lexicon. In D. Sandra, J.-O. Östman, & J. Verschuereen. *Cognition and Pragmatics* (pp. 369–388). Amsterdam: John Benjamins.
- Dimitripoulou, M., Duñabeitia, J. A., & Carreiras, M. (2011). Two words, one meaning: Evidence of automatic co-activation of translation equivalents. *Frontiers in Psychology*, *2*, Article 188. <https://doi.org/10.3389/fpsyg.2011.00188>.
- Dulany, D. E. (1997). Consciousness in the Explicit (Deliberative) and Implicit (Evocative). In J. D. Cohen & J. W. Schooler (Eds.), *Scientific Approaches to Consciousness* (pp. 179–211). Mahwah, NJ: Erlbaum.
- Duyck, W., & Brysbaert, M. (2004). Forward and backward number translation requires conceptual mediation in both balanced and unbalanced bilinguals. *Journal of Experimental Psychology: Human Perception and Performance*, *30*, 889–906. <https://doi.org/10.1037/0096-1523.30.5.889>.
- Finkbeiner, M., Forster, K., Nicol, J., & Nakamura, K. (2004). The role of polysemy in masked semantic and translation priming. *Journal of Memory and Language*, *51*, 1–22. <https://doi.org/10.1016/j.jml.2004.01.004>.
- French, R. M., & Jacquet, M. (2004). Understanding bilingual memory: Models and data. *Trends in Cognitive Science*, *8*, 87–93. <https://doi.org/10.1016/j.tics.2003.12.011>.
- Gregg, V. H., Montgomery, D. C., & Castano, D. (1980). Recall of common and uncommon words from pure and mixed lists. *Journal of Verbal Learning and Verbal Behavior*, *19*, 240–245. [https://doi.org/10.1016/s0022-5371\(80\)90202-9](https://doi.org/10.1016/s0022-5371(80)90202-9).
- Heredia, R. R., & Brown, J. M. (2004). Bilingual Memory. In T. K. Bhatia & W. C. Ritchie (Eds.), *The Handbook of Bilingualism* (pp. 225–249). Malden, MA: Blackwell.
- Hunt, R. R., & Einstein, G. O. (1981). Relational and item-specific information in memory. *Journal of Verbal Learning and Verbal Behavior*, *20*, 497–514. [https://doi.org/10.1016/s0022-5371\(81\)90138-9](https://doi.org/10.1016/s0022-5371(81)90138-9).
- Kirsner, K., Smith, M. C., Lockhart, R. S., King, M. L., & Jain, M. (1984). The bilingual lexicon: Language-specific units in an integrated network. *Journal of Verbal Learning and Verbal Behavior*, *23*, 519–539. [https://doi.org/10.1016/s0022-5371\(84\)90336-0](https://doi.org/10.1016/s0022-5371(84)90336-0).
- Kolers, P. A. (1966). Interlingual facilitation of short-term memory. *Journal of Verbal Learning and Verbal Behavior*, *5*, 314–319. [https://doi.org/10.1016/s0022-5371\(66\)80037-3](https://doi.org/10.1016/s0022-5371(66)80037-3).
- Lambert, W. E. (1956). Developmental aspects of second-language acquisition: I. Associational fluency, stimulus provocativeness, and word-order influence. *Journal of Social Psychology*, *43*, 83–89. <https://doi.org/10.1080/00224545.1956.9919202>.
- Lopez, M., & Young, R. K. (1974). The linguistic interdependence of bilinguals. *Journal of Experimental Psychology*, *102*, 981–983. <https://doi.org/10.1037/h0036544>.
- Macnamara, J. (1967). The linguistic independence of bilinguals. *Journal of Verbal Learning and Verbal Behavior*, *6*, 729–736. [https://doi.org/10.1016/s0022-5371\(67\)80078-1](https://doi.org/10.1016/s0022-5371(67)80078-1).
- Marian, V., & Fausey, C. M. (2006). Language-dependent memory in bilingual learning. *Applied Cognitive Psychology*, *20*, 1025–1047. <https://doi.org/10.1002/acp.1242>.

Marian, V., & Neisser, U. (2000). Language-dependent recall of autobiographical memories. *Journal of Experimental Psychology: General*, *129*, 361–368. <https://doi.org/10.1037//0096-3445.129.3.361>.

Micco, A., & Masson, M. E. J. (1991). Implicit memory for new associations: An interactive process approach. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *17*, 1105–1123. <https://doi.org/10.1037//0278-7393.17.6.1105>.

Morris, C. D., Bransford, J. D., & Franks, J. J. (1977). Level of processing versus transfer appropriate processing. *Journal of Verbal Learning and Verbal Behavior*, *16*, 519–533. [https://doi.org/10.1016/s0022-5371\(77\)80016-9](https://doi.org/10.1016/s0022-5371(77)80016-9).

Nott, C. R., & Lambert, W. E. (1968). Free recall in bilinguals. *Journal of Verbal Learning and Verbal Behavior*, *7*, 1065–1071. [https://doi.org/10.1016/s0022-5371\(68\)80069-6](https://doi.org/10.1016/s0022-5371(68)80069-6).

Palermo, D. S., & Jenkins, J. J. (1964). *Word association norms*. Minneapolis: University of Minneapolis Press.

Postman, L., & Keppel, G. (1970). *Norms of word association*. New York: Academic Press.

Rommetveit, R. (1968). *Words, meanings, and messages*. New York: Academic Press.

Saegert, J., Obermeyer, J., & Kazarian, S. (1973). Organizational factors in free recall of bilingually mixed lists. *Journal of Experimental Psychology*, *97*, 397–399. <https://doi.org/10.1037/h0034104>.

Smith, Y., Walters, J., & Prior, A. (2019). Target accessibility contributes to asymmetric priming in translation and cross-language semantic priming in unbalanced bilinguals. *Bilingualism: Language and Cognition*, *22*, 157–176. <https://doi.org/10.1017/s1366728917000645>.

Szalay, L. B., & Deese, J. (1978). *Subjective meaning and culture: An assessment through word association*. Hillsdale, NJ: Erlbaum.

Tulving, E., & Bower, G. H. (1974). The Logic of Memory Representations. In G. Bower (Ed.), *The Psychology of Learning and Motivation: Advances in Research and Theory* (Vol. 8, pp. 265–301). New York: Academic Press. [https://doi.org/10.1016/s0079-7421\(08\)60457-0](https://doi.org/10.1016/s0079-7421(08)60457-0).

Tulving, E., & Colotla, V. A. (1970). Free recall in trilingual lists. *Cognitive Psychology*, *1*, 86–98. [https://doi.org/10.1016/0010-0285\(70\)90006-x](https://doi.org/10.1016/0010-0285(70)90006-x).

Tulving, E., & Thomson, D. M. (1973). Encoding specificity and retrieval processes in episodic memory. *Psychological Review*, *80*, 352–373. <https://doi.org/10.1037/h0020071>.

Van Assche, E., Duyck, W., & Hartsuiker, R. J. (2012). Bilingual word recognition in a sentence context. *Frontiers in Psychology*, *3*, Article 174. <https://doi.org/10.3389/fpsyg.2012.00174>.

Van Hell, J. G., & De Groot, A. M. B. (2008). Sentence context modulates visual word recognition and translation in bilinguals. *Acta Psychologica*, *128*, 431–451. <https://doi.org/10.1016/j.actpsy.2008.03.010>.

Watkins, M. J., & Gardiner, J. M. (1982). Cued Recall. In C. R. Puff (Ed.), *Handbook of Research Methods in Human Memory and Cognition* (pp. 173–195). New York: Academic Press. <https://doi.org/10.1016/b978-0-12-566760-9.50011-7>.

Weldon, M. S. (1991). Mechanisms underlying priming on perceptual tests. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *17*, 526–541. <https://doi.org/10.1037//0278-7393.17.3.526>.

Author's note

I wish to thank Endel Tulving for his advice with Experiments 1 and 2. I am grateful to Dalia Petreikis, Vita Musonis, and Patricia Smith for their help with data collection and Jeffrey Miller for his help with statistical analysis.

Appendix. A Segment of the Experimental Plan and a Sample of Word Pairs used in Experiment 3

Presented pairs	Retrieval Cues	
	First	Second
<i>e</i> -E (<i>sky</i> -BLUE)	<i>e</i> (<i>sky</i>)	<i>l</i> (<i>dangus</i>)
<i>l</i> -E (<i>pienas</i> -COW)	<i>e</i> (<i>milk</i>)	<i>l</i> (<i>pienas</i>)
<i>e</i> -L (<i>sting</i> -ŠIRŠĒ)	<i>e</i> (<i>sting</i>)	<i>l</i> (<i>gelti</i>)
<i>l</i> -L (<i>dūmai</i> -KAMINAS)	<i>e</i> (<i>smoke</i>)	<i>l</i> (<i>dūmai</i>)
<i>e</i> -E (<i>bed</i> -PILLOW)	<i>l</i> (<i>lova</i>)	<i>e</i> (<i>bed</i>)
<i>l</i> -E (<i>girdėti</i> -EAR)	<i>l</i> (<i>girdėti</i>)	<i>e</i> (<i>hear</i>)
<i>e</i> -L (<i>wet</i> -SAUSAS)	<i>l</i> (<i>šlapias</i>)	<i>e</i> (<i>wet</i>)
<i>l</i> -L (<i>medis</i> -MIŠKAS)	(<i>medis</i>)	<i>e</i> (<i>tree</i>)