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Collocational Links in the L2 Mental Lexicon and the Influence of L1 Intralexical Knowledge

[1,*]BRENT WOLTER and [2,†]HENRIK GYLLSTAD

[1]Department of English and Philosophy, Idaho State University, USA and [2]Centre for Languages and Literature, Lund University, Sweden
*E-mail: woltbren@isu.edu, †henrik.gyllstad@englund.lu.se

This article assesses the influence of L1 intralexical knowledge on the formation of L2 intralexical collocations. Two tests, a primed lexical decision task (LDT) and a test of receptive collocational knowledge, were administered to a group of non-native speakers (NNSs) (L1 Swedish), with native speakers (NSs) of English serving as controls on the LDT. The tests assessed collocations in three critical conditions: (i) collocations with translation equivalents in Swedish and English (L1–L2), (ii) collocations that were acceptable in English but not in Swedish (L2-only), and (iii) unrelated items for baseline data. Our results showed that the L1 may have considerable influence on the development of L2 collocational knowledge. NNSs both processed [with faster reaction times (RTs) on the LDT] and recognized (with higher receptive scores) L1–L2 collocations more effectively than L2-only collocations. However, the results of the LDT also showed considerable variability for the L2-only condition, suggesting that the overall slower RTs in this condition might have been linked more to a lack of priming for individual items rather than slower RTs for this condition as a whole.

INTRODUCTION

It has long been assumed that efficient L2 processing and use are at least partially contingent upon the formation of systematic and meaningful links between words in the L2 lexicon. From a general perspective, Wray (2002: 143), among others, has postulated that knowledge of a language not only presupposes knowledge of the individual words of that language, but also how they fit together. However, any comprehensive account of how L2 words might be linked to each other must also attempt to stipulate what role L1 knowledge plays in the formation of these L2 intralexical links. One such intralexical link that has received particular attention as of late is collocations. Collocations form only one type of link that language users need to develop for an efficient lexical network. Language users also need to form links between semantically related words and between words and underlying concepts (see e.g. Kroll and Stewart 1994). However, there is reason to believe that collocations might warrant special attention, especially where L2 learners are involved.

One reason is that the underlying hierarchical structures that define semantic links (e.g. dog–animal, dog–cat, dog–terrier) are largely conceptual in nature, and are therefore less likely to change from language to language (Viberg 1994; Levelt *et al*. 1999; Wolter 2006). Collocations, on the other hand, have been shown to vary considerably from language to language. Furthermore, this variation sometimes involves a measure of arbitrariness (e.g. Lewis 1997; Nesselhauf 2005). As several researchers have pointed out (e.g. Pawley and Syder 1983; Cruse 1986; Swan 1997) there is often no logical or semantic reason for why different languages use certain lexical patternings at the exclusion of other possibilities, yet they do. Furthermore, studies using learner corpora have empirically demonstrated that even advanced learners often struggle to activate appropriate collocations in productive L2 use (Bahns and Eldaw 1993; Howarth 1996; Granger 1998; Nesselhauf 2005).

Unfortunately, however, there is a lack of research that has explored the psychological reality of collocations in the L2, much less the influence the L1 has on the development of L2 collocations. One possible reason for this is that collocational responses comprise only one of many types of responses that have been investigated on word association tests, which has often been the methodology of choice for applied linguistic researchers exploring the L2 lexicon (e.g. Meara 1982; Söderman 1993; Wolter 2001, 2002; Fitzpatrick 2006, 2007; Zareva 2007). Another reason is that most of the psycholinguistic work to date on bilingual memory has been focused almost exclusively on L1–L2 interlexical and/or lexical-conceptual links, with very little attention given to intralexical links in the L2 [see French and Jacquet (2004) and Kroll and Tokowicz (2005) for overviews].

Nonetheless, the little research that has been done on collocational links in the mental lexicon indicates that they may play an important role in structuring it. Furthermore, collocations might underpin important differences in native speaker (NS) and non-native speaker (NNS) lexical networks. Fitzpatrick (2006), for example, found that although collocations were regularly produced on a word association test by both NSs and (advanced) NNSs, NSs tended to produce them significantly more frequently. From a mental processing perspective, Siyanova and Schmitt (2008), using a subjective familiarity rating task of infrequent and frequent English adjective + noun combinations, found that advanced NNSs rated the infrequent collocations as more familiar than a group of NSs. Conversely, NNSs rated frequent collocations as less familiar than did the group of NSs. They furthermore found that NNSs were slower than NSs in recognizing the presented collocations. Finally, in studies that have investigated collocational priming (i.e. the tendency for an activated word to accelerate subsequent recognition of a collocate), Durrant (2008) found significant priming amongst NSs for prime-target item pairs consisting of adjective + noun and noun + noun (compound) high-frequency collocations when compared with unrelated item pairs. Similarly, Bonk and Healy (2005) (also investigating L1 speakers) found significant priming for collocational items not only in the forward condition (e.g. *hold* → *meeting*), but also in the backward condition (e.g. *meeting* → *hold*) (see also Bonk 2003). In L2 priming research, Frenck-Mestre and Prince (1997) found a limited amount of priming for L2 collocational items, but as these were combined with other types of syntagmatic links, it is impossible to know whether or not the result was significant for collocational priming alone.

Thus, there is evidence that collocational knowledge might perform an important role in structuring the mental lexicon, both in the L1 and the L2. However, there is still a paucity of investigation into whether or not collocational priming occurs, especially in the L2, and whether or not L1 knowledge influences how L2 collocations are processed. Given this lack of research, and the fact that collocational connections seem particularly problematic for L2 learners, it stands to reason that we should want to better understand the potential influence of L1 knowledge on L2 collocations at a psychological level. This was the main aim of this study. Specifically, we wanted to determine if collocations in the L2 that had an equivalent form in the L1 were more readily activated on a primed lexical decision task (LDT) than L2 collocations that had no equivalent form. Furthermore, we sought to determine if both types of collocational links (L1–L2 and L2-only) would be activated more readily than unrelated prime-target pairs that were otherwise matched for word class, frequency, and so forth. One reason for pursuing these issues was to test claims made by Wolter (2006), who suggested that transfer from the L1 to the L2 should be fairly straightforward, but that when the formation of links that do not exist in the L1 becomes necessary, it may require restructuring of the L2 lexical network. In terms of hypotheses, then, we expected the following:

1 For a group of (high proficiency) NNSs, collocational prime-target items that have a translation-equivalent in the L1 will result in a significant priming effect (when compared with a matched set of unrelated items).
2 For the same group of NNSs, collocational prime-target items that do not have a translation equivalent in the L1 will produce significantly less priming than the items that have a translation equivalent (when compared with a matched set of unrelated items).
3 For a group of NSs, both types of items will produce a significant priming effect. However, no significant difference will be found between the two types (as the NSs will be oblivious to the distinction between L1–L2 and L2-only items).

In addition to our main aim of testing these three hypotheses, we also wanted to assess the extent to which the collocations in the two critical conditions listed above (L1–L2 and L2-only) would be identified as acceptable collocations by a group of advanced NNSs.

METHODOLOGY

The LDT

In this study, we used a primed LDT. A primed LDT works by first presenting a test taker with an initial word (the prime) followed by another letter string (the target). Usually, half the targets are real words and the other half are pseudowords (non-words that follow the orthographical and phonological rules of the tested language). The test taker's task is to identify whether or not the target string represents a real word in the specified language, typically by pressing a corresponding key on a keyboard. Although multiple modifications are possible with this basic format, the test taker is normally not asked to attend to the possible connection between the prime and the target. Despite the presumed lack of conscious attention, however, it has been shown consistently and repeatedly that when a prime is followed by a related (real) word, this word will be identified more quickly than if it had been preceded by an unrelated prime. It is widely believed that this priming of the target word occurs due to a process called spreading activation (Collins and Loftus 1975) by which words the test taker perceives as related to the prime receive a residual level of activation prior to actual presentation. More importantly, it is thought that spreading activation provides useful insights into the structure of the mental lexicon.

For the present purposes, we were not centrally concerned with ongoing discussions about whether or not strategic priming has less theoretical value than automatic priming (see Lucas 2000 for an overview).[1] We were interested only in whether or not certain types of connections led to a higher level activation, and in this respect the distinction between automatic and strategic processing was not centrally important. Nonetheless, we decided to take Lucas' view that automatic priming gives a clearer indication of the structure of the lexicon into account along with claims of Frenck-Mestre and Prince (1997) regarding priming for NNSs and the findings of past studies on collocational priming. In respect to the first of these two additional considerations, Frenck-Mestre and Prince (1997) have drawn on other studies to suggest that when NNSs are involved, a stimulus onset asynchrony (SOA: the delay between the initial presentation of the prime and the presentation of the target) of at least 150 ms is needed to obtain a priming effect. As for the second consideration, it was noted earlier that there is not a clear consensus in the literature regarding the existence of a priming effect for collocationally related words. In the study that did report a significant priming effect (Bonk and Healy 2005), however, the SOA was set at 300 ms. With these considerations in mind, we decided to also set our SOA at 300 ms. This mimicked the conditions in Bonk and Healy's study, and clearly incorporated the suggestions of Frenck-Mestre and Prince (1997). Furthermore, it also fit within the upper limits of automatic priming, at least in some researchers' accounts [Hutchison 2003; though see McNamara (2005) and Lucas (2000) who argue for slightly

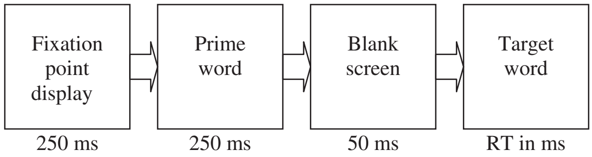

Figure 1: Sequence of presentation for items on the LDT. The fixation point consisted of eight asterisks displayed in the same location as the subsequent prime words and target words

shorter SOAs]. The presentation sequence for the items is shown graphically in Figure 1.

Item development

Since we were specifically concerned with the influence of the L1 intralexical network on the development of L2 intralexical collocations as compared with links that had no L1 equivalent, we needed to isolate both: (i) items that were common collocations in the L1 and the L2, and (ii) items that were collocations only in the L2. This meant working with a NNS population with a common L1. For this study, we used high-proficiency learners of English who spoke Swedish as their first language, so the items were designed with L1 Swedish speakers in mind. Although the decision to work exclusively with L1 Swedish speakers was taken in part with pragmatic considerations in mind (as L1 Swedish speakers were accessible to the second author as participants), there were some theoretical advantages as well. One is that both languages are SVO languages, which was particularly important given the fact that our items consisted of verb primes followed by (object) nouns (see below). This helped to mitigate against possible confounding variables.

There are many ways in which words collocate, but for this study we decided to work exclusively with verb + (object) noun collocations, as it is consistent with the canonical syntax of both languages. Before the item development is described in detail, since conflicting definitions of the term collocation exist in the literature (for overviews, see Nesselhauf 2004; Barfield and Gyllstad 2009), we felt it was necessary here to explicate our view. On the whole, our perspective is one that straddles the views found in the frequency-based and phraseological traditions, in that we believe that both frequency and semantics are important aspects to acknowledge. A collocation is a sequence consisting of two or more words which co-occur more frequently than chance would predict based on the frequency of occurrence of the individual constituent words. In terms of compositionality, we envision collocations residing in the middle ground between free combinations and pure idioms, thus with a varying degree of frozenness.

We began our item development by assembling a list of English 2- and 3-grams (contiguous strings of either two or three words) from the British National Corpus using the 'Phrases in English' interface website.[2] Although we were ultimately interested in testing two-word verb–noun collocations, we also incorporated 3-grams in our search due to the fact that English verb–(object) noun patterns frequently include a determiner between the verb and the object (e.g. *break the law; tell a lie,* etc.). Although there is no agreed-upon standard for what should be considered a 'frequent' *n*-gram in a corpus, we chose to set the minimum frequency of occurrence at 5. This resulted in over 13,500 items that were either verb + noun or verb + determiner + noun sequences, which we felt provided a broad enough range from which to select items. The second author, who is an NS of Swedish with native-like proficiency in English, then worked through the list to extract suitable items. Two types of items were collected. First, sequences which were judged to be lexically congruent (Bahns 1993) with Swedish sequences on a word-by-word basis were chosen. These sequences, where there is a direct translational equivalence between their corresponding elements, were classified as L1–L2 collocations (L1–L2). An example of an L1–L2 item can be found in the English sequence *give an answer* which translates into the felicitous Swedish sequence *ge ett svar*, and where the English verb GIVE has a translation equivalent in the Swedish verb GE, and ANSWER similarly has an equivalent in the Swedish noun SVAR (where italics indicate language forms as they could appear in use and capital letters indicate lemmas). Additionally, the English binary system of the indefinite article form (*a*, *an*) translates into the Swedish binary system of the indefinite article form (*en, ett*). Secondly, English sequences that were analysed as unique and non-congruent vis-à-vis Swedish, in the sense that no word-by-word translation into Swedish would render an idiomatic and acceptable sequence, were classified as L2-only items (L2-only). An example of this is *pay a visit*, where the verb PAY arguably corresponds to the Swedish verb BETALA as its prototypical translation equivalent. This sense cannot, however, be used in an idiomatic translation of *pay a visit* into Swedish, since a sequence like **betala ett besök* would be infelicitous. Rather, an idiomatic translation would entail a delexicalized verb like GÖRA ('make'/'do') or the more formal verb AVLÄGGA ('make'/'give'/'take') as in *göra ett besök* or *avlägga ett besök* (literally 'make a visit' or 'do a visit'). Initially, one list of 40 L1–L2 collocations and another of 40 L2-only collocations items were compiled in this way. In addition, a third list of 40 unrelated verb–(object) noun pairs was assembled to serve as the unrelated baseline condition for calculating the priming effect for the other two conditions.

These three lists were then trimmed down to 33 items each in an effort to ensure comparability by eliminating possible confounding differences in both the primes and the targets. To this end the three lists of primes (the verbs) and the three lists of targets (the object nouns) were matched using data from University of Western Australia MRC Psycholinguistic Database.[3] Specifically, the words in the respective lists were checked to make certain there were no significant differences in respect to the following criteria: number of letters, number of syllables, word frequency counts [from the Thorndike–Lorge (1944) list], and concreteness ratings. It should be noted that in order to assemble lists that were parallel and fulfilled our L1–L2 or L2-only criteria, we sometimes found it necessary to use the same word form two times. In total, there were five words that appeared two times. However, the same form was never used more than once in the same block of items on the test. Furthermore, it also needs to be noted that some of the target words on the test were also cognates. This was potentially a concern, as cognates in particular have been shown (in non-primed LDTs) to elicit faster reaction times (e.g. Lemhöfer and Dijkstra 2004; Lemhöfer *et al.* 2008). Nonetheless, we decided to include these words as it would have otherwise been extremely difficult to assemble a reasonable number of items that included words that were otherwise matched for other variable factors. However, to ensure that these cognates did not have a significant confounding influence, we later ran additional post-hoc analyses to assess priming with the cognate items removed.

In addition to checking individual words, the verb–object noun items for the two collocational conditions (L1–L2 and L2-only) were checked using *t*-score data from the Bank of English corpus (jointly owned by HarperCollins Publishers and the University of Birmingham) to verify that: (i) all items were indeed collocational, from a statistical frequency perspective [using Hunston's (2002) and Barnbrook's (1996) proposed guideline of a *t*-score of at least 2.0] and (ii) no significant differences existed between the lists in terms of the mean collocational strength (as measured by *t*-scores). The *t*-score is a measure of the strength of co-occurrence of words with a node word in a corpus, usually within a span of ±4 words. It tests the null hypothesis by contrasting the observed frequency of co-occurrence in the corpus with the expected frequency of co-occurrence based on random distribution. The formula is $(O-E)/\sqrt{O}$, where O represents the observed frequency of co-occurrence and E represents the expected frequency of co-occurrence. In addition to this association measure, the absolute frequencies of the collocational items (L1–L2 and L2-only) were retrieved from the British National Corpus (BNC) using a lemmatized search where the base form of a verb and all inflected forms were culled together with singular or plural forms of the noun object, in a span of three words to the right of the verb, to allow for articles and premodifying adjectives. In comparing the means based on the lists of frequencies, a *t*-test showed no significant differences. These analyses confirmed the collocational properties of all the pairs as well as the lack of a significant difference between the lists as a whole.

Finally, an additional group of 20 NS university students was administered an additional test to assess subjective familiarity of all the prime-target pairs in the three critical conditions. The two-word items were modified slightly, usually through the insertion of an article, in order to make them grammatically felicitous. Thus, an item that initially appeared as 'pay' (prime)—'VISIT' (target) on the LDT became 'pay a visit' on the familiarity rating task. The items were presented in a random order, and test takers simply had to indicate familiarity using a 6-point Likert scale on which 1 indicated they had never heard the phrase before and 6 indicated they had heard it many times. This test was included to: (i) provide provisional support for the comparability of the items in the two collocational conditions [and dissimilarity for the items in the unrelated (baseline) items], and (ii) identify pairs in the collocational conditions that may have been unfamiliar to NSs (despite their presence in corpora).

Once our list of 99 target items (33 L1–L2 collocational, 33 L2-only collocational, and 33 unrelated items; please see the Appendix available as Supplementary data at *Applied Linguistics* online.) was complete, we assembled an additional list of 121 filler items (again comprised of verbs + nouns) for a total of 220 real-word items. The real-word list was combined with an additional list of 220 items with verb primes and non-word targets, rendering a total of 440 items for the experiment. All non-word targets were phonologically and orthographically legal constructions in English, and were matched on a word-by-word basis to the real word targets in terms of word length. In total, the relatedness proportion (the percentage of related items) on the entire test was 0.15 (66 out of 440 items), which was less than the upper limit of 0.20 suggested by McNamara (2005) for automatic priming studies. Prior to administration, the items were divided into three blocks. One block consisted of 146 items, while the other two consisted of 147. Each block contained 11 L1–L2 items, 11 L2-only items, and 11 unrelated items, with the remaining items consisting of filler and non-word items.

Administration

In addition to 31 L1 Swedish participants, the primed LDT was also administered to a group of 37 NSs of English who served as controls. The L1 English group was also comprised of university students, all of whom were enrolled in either linguistics courses or composition courses at an American university. The test was administrated using DMDX software developed at Monash University and at the University of Arizona by K.I. Forster and J.C. Forster.[4] Prior to testing, computers at both testing sites (in Sweden and in the US) were calibrated to ensure that the timing function on DMDX was consistent. Items within the three blocks were presented in a random order for each participant as determined by DMDX.

The LDT followed the conventional format for primed LDT studies outlined above. Participants were simply asked to press the 'yes' key (right CTRL) on a standard QWERTY keyboard if the target string was a real word, and the 'no' key (left CTRL) if the string was not a real word. No explicit instructions or explanations were given regarding a possible connection between the prime and the target. As with other primed LDTs, the goal here was to explore the possible activation of connections in the mental lexica of our participants.

Table 1: Summary of participants' biographical information

Group	Age[a]	Dexterity (R/L)	Sex (M/F)	NNS self-report proficiency scores[b]			
				Speaking	Listening	Reading	Writing
NS (*N* = 35)	28.4	89/11%	26/74%				
NNS (*N* = 30)	23.4	90/10%	30/70%	6.8	7.4	6.8	6.1

[a]NS range = 18–61 years, NNS range = 19–65 years.
[b]1 = none, 10 = near native-like.

After completing the LDT, participants were also asked to complete a short questionnaire that included questions about vision and dexterity, as well as a self-report test that asked the NNS participants to estimate their ability level in terms of the four skills of speaking, listening, reading, and writing. Details about the participants are presented in Table 1. Finally, the NNS group was also administered a pencil-and-paper yes/no 100-item collocation test format called COLLMATCH (Gyllstad 2007) to gauge the extent of the participants' receptive knowledge of the collocations that appeared in the LDT. The 100 items used in this version of COLLMATCH were those 33 L1–L2 collocational and 33 L2-only collocational items outlined above, together with 34 distractors originally developed for the COLLMATCH test. COLLMATCH uses a format similar to yes/no vocabulary size tests (e.g. Meara and Jones 1990), and simply asks test takers to indicate whether or not presented items represent an acceptable collocation used in the target language. However, as mentioned above, it includes a number of non-collocational distractor items that can be used to adjust scores for test-takers that demonstrate a tendency to overestimate their knowledge.

RESULTS

Before analysing the results, we first of all compared the subjective familiarity ratings for the items in the three critical conditions. This analysis revealed that there were two items in the L2-only condition that were rated as largely unfamiliar by the participants (*jump the queue* and *lay the table*). The mean familiarity rating for these two items was lower than the mean for all the items in the unrelated condition, so these items were excluded from further analysis. With the exclusion of these two items, the familiarity means were as follows (standard deviations in parentheses): L1–L2 = 5.56 (0.44), L2-only = 5.43 (0.55), unrelated = 2.52 (0.95). Additional analysis (a one-way ANOVA using items as cases) revealed a significant difference across the means for the three conditions, $F(2,93) = 199.7$, $p < .001$, $\eta_p^2 = .81$. Post-hoc analyses revealed that this significance was due solely to the difference between the unrelated items and the other two sets of items (L1–L2 and unrelated, $p < .001$); L2-only and unrelated, $p < .001$). The difference between the L1–L2 and L2-only conditions was not significant, $p = .71$. Thus it appears that from the perspective of NSs of English, the two collocational conditions were more or less equivalent.

Next, we checked the biographical information from each of the participants. This revealed the presence of one participant in each group who reported not having normal or corrected to normal vision, so these participants' data were eliminated. In addition, there was one NS participant who arrived late to the testing session and who demonstrated an extraordinarily high error rate (around 50 per cent), so this participant's data were also eliminated. Therefore, the final results were calculated using data from 30 NNS and 35 NS participants. Additionally, it was discovered that a technical error resulted in the presentation of one L1–L2 item two times on the test (once in the first block and once in the third block). Therefore, we eliminated the results of the item from the third block from each participant's data, meaning the ultimate results were based on 32 L1–L2 items, 31 L2-only items, and 33 unrelated items. Following suggestions by Ulrich and Miller (1994) data were minimally trimmed, so the only correct responses that were not included in the final analysis were responses that were faster than 250 ms (which turned out to be only one response out of 6,134 correct responses in the three critical conditions).

The results are shown numerically in Table 2 and graphically in Figure 2. Statistical analyses on the LDT data were done in two main ways. First of all, the response times and error rates for the three main priming conditions between the two groups were compared using a MANOVA test. Somewhat surprisingly, the only differences that were found to be significant between the two groups were the response times for the L2-only collocational priming condition, $F(1, 63) = 5.01$, $p = .029$, $\eta_p^2 = .07$, and the error rate for L1–L2 collocational condition, $F(1, 63) = 4.49$, $p = .038$, $\eta_p^2 = .07$.

For the second analysis, which was more central to the main aims of this study, we used a repeated measures design with pairwise comparisons (including a Bonferroni adjustment for multiple comparisons) for the $F1$

Table 2: Mean response times in milliseconds, standard deviations (parentheses), error rates (square brackets), and priming effects (PE)

	L1–L2	L2-only	Unrelated	L1–L2 PE[a]	L2-only PE[b]
NS ($N = 35$)	661 (114) [0.8%]	665 (129) [1.3%]	719 (159) [1.5%]	58	54
NNS (N = 30)	701 (108) [2.0%]	736 (122) [2.4%]	785 (129) [2.6%]	84	49

[a]Unrelated RT – L1-L2 RT.
[b]Unrelated RT – L2-only RT.

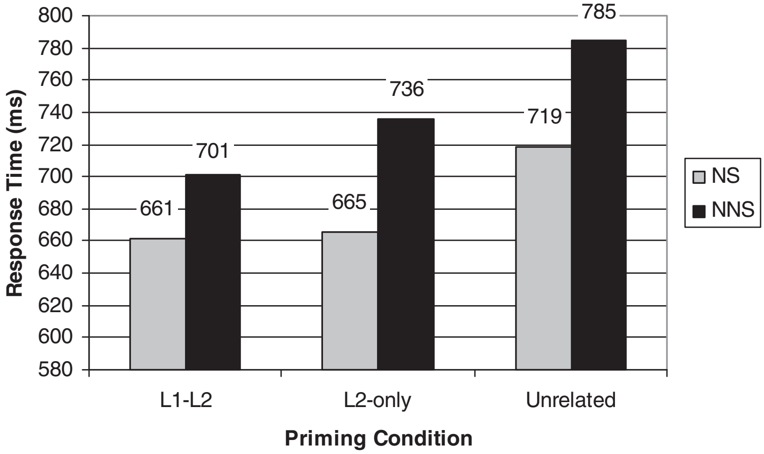

Figure 2: Mean response times (in ms) for L1–L2, L2-only, and unrelated priming conditions

analysis (with subjects as random variables) and a MANOVA for the *F*2 analysis (with items as random variables). This revealed a significant main effect in reaction times (RTs) both for the NS group, $F1(1.4, 47.1)^5 = 19.4$, $p < .001$, $\eta_p^2 = .36$; $F2(2, 93) = 7.3$, $p = .001$, $\eta_p^2 = .14$; and the NNS group, $F1(2, 58) = 35.3$, $p < .001$, $\eta_p^2 = .55$; $F2(2, 93) = 6.5$, $p = .002$, $\eta_p^2 = .13$. A comparison of the error rates across the three conditions revealed no significant differences for either group, $F1_{NS}(2, 68) = 1.2$, $p = .31$, $\eta_p^2 = .03$; $F1_{NNS}(2, 58) = .39$, $p = .68$, $\eta_p^2 = .01$. Pairwise comparisons for the RTs revealed significant differences for the NS group between the L1–L2 condition and the unrelated condition, *F*1 $p < .001$; *F*2 $p = .003$, and the L2-only condition and the unrelated condition, *F*1 $p < .001$; *F*2 $p = .006$, but not between the L1–L2 and the L2-only conditions, *F*1 $p = 1.0$; *F*2 $p = 1.0$). This suggests that there was a priming effect for both collocational conditions for the NS group, but, as expected, there was not a significant difference in how they responded to items in the two priming conditions.

For the NNS group, there were significant differences in priming at all levels of interaction, though there was variation in significance for the *F*1 versus the *F*2 analysis. Only the comparison between the L1–L2 and unrelated conditions showed significance for both the subject analysis and the item analysis, *F*1 $p < .001$; *F*2 $p = .001$. The comparisons between the L2-only and the unrelated conditions, *F*1 $p < .001$; *F*2 $p = .106$, and the L1–L2 and the L2-only conditions, *F*1 $p = .008$; *F*2 $p = .459$ revealed significance for only the *F*1 analysis. This result suggests that the significant *F*1 difference between the L2-only condition and the other two conditions may have been due to a limited number of items, presumably in the L2-only condition, rather than a pattern that was generalizable across all the items in this condition.

To ensure that the observed differences were not due solely to the presence of cognates in our testing conditions, an additional set of analyses were run with the items that contained cognates removed. The main effects from the repeated measures test corroborated the results found with the initial analyses, $F1_{NS}(1.6, 54.9) = 18.7$, $p < .001$, $\eta_p^2 = .35$; $F2_{NS}(2, 80) = 6.3$, $p = .003$, $\eta_p^2 = .14$; $F1_{NNS}(2, 58) = 26.4$, $p < .001$, $\eta_p^2 = .48$; $F2_{NNS}(2, 80) = 4.9$, $p = .01$, $\eta_p^2 = .11$. The pairwise comparisons (Bonferroni) also revealed similar patterns for both groups. The results for the NS group were as follows: L1–L2 and unrelated, $F1$ $p < .001$; $F2$ $p = .006$, L2-only and unrelated, $F1$ $p < .001$; $F2$ $p = .019$, L1–L2 and L2-only, $F1$ $p = .9$; $F2$ $p = 1.0$. For the NNS group, the results were: L1–L2 and unrelated, $F1$ $p < .001$; $F2$ $p = .009$, L2-only and unrelated, $F1$ $p < .001$; $F2$ $p = .22$, L1–L2 and L2-only, $F1$ $p = .036$; $F2$ $p = .67$. These results were in line with the initial results that included the cognate items and thus indicate a negligible impact of the cognates.

A final analysis was done on the data collected through the COLLMATCH test. The COLLMATCH data were scored using a formula called I_{SDT} developed by Huibregtse *et al.* (2002). The formula was designed specifically for yes/no test formats, such as was used for the COLLMATCH test, and uses a series of mathematical computations designed to compensate for guessing strategies (the mean false alarm rate was 5.3 per cent). The correction procedure results in a score of between 0 and 1, with 1 representing a situation in which all actual items and all distractor items are correctly identified as such (i.e. the actual items are marked with a 'yes' response and the distractor items are marked with a 'no' response). We applied this formula to both the L1–L2 and the L2-only items in order to generate separate scores for the two separate conditions. The result was a mean score of .80 (.09) for the L1–L2 collocations, and .59 (.19) for the L2-only collocations, a difference which was shown to be significant, $F(1,29) = 78.95$, $p < .001$, $\eta_p^2 = .73$. This indicated that the differences observed on the LDT between the L1–L2 and the L2-only conditions for the NNS were paralleled by differences in their receptive recognition knowledge of the same collocations when tested in isolation.

DISCUSSION

At the outset of this article, we proposed three hypotheses regarding the priming conditions in this study. In this section we will first discuss our results in light of these initial predictions before considering some of the broader implications of this study. We will also integrate the results of the COLLMATCH test, which was brought in as an additional (receptive) measure of knowledge for items appearing in the L1–L2 and L2-only LDT conditions.

In examining our hypotheses, we will start with the third one, mostly because these results are the most straightforward, and it is probably the least controversial of our claims. The results supported the position that NSs would react to items in the two priming conditions in a nearly identical way. Given the fact that the NSs in this study were unlikely to perceive any differences amongst these items, this result is not surprising. However, it does add a measure of support to the results of the familiarity judgement task, with the combination of these two findings suggesting that the two conditions were (at least from a NS perspective) equivalent. It also provides further evidence that words do indeed prime their collocates (see Bonk and Healy 2005; Durrant 2008).

The negligible differences between the NS RTs in the two collocational conditions also lend indirect support to our second hypothesis, which was that the main difference in processing for the NNS group was due to the different status the items held in the NNSs' L1. However, the results here are less straightforward. In continuing to work backwards through the hypotheses, we can see evidence from the *F*1 analysis that supports the claim that L2-only items would be responded to more slowly than L1–L2 items. However, the results of the *F*2 analysis indicated that these results were not generalizable to items in this condition as a whole. Therefore, it appears that the differences observed in the *F*1 analysis were due to inconsistencies in the priming amongst the items in the L2-only condition; some items likely demonstrated priming while others did not. The COLLMATCH test results also indicate that the L2-only items were less likely to be recognized as collocational by the NNSs. Therefore, it may have been that when the items were recognized as legitimate L2 collocations, priming occurred and these items were processed in a manner that was similar to the items in the L1–L2 condition. When L2-only items were not recognized as collocational, on the other hand, they were processed in a way similar to that of the unrelated items (see also Yamashita and Jiang 2010). In sum, then, what appears to be occurring is a situation in which the L1 provides more ready access to L2 collocations which have an equivalent form in the L1 than collocations which have no equivalent form (either through initial recognition or through online processing). However, once an L2-only collocation is recognized as a legitimate collocation in the L2, it becomes stored as such psychologically and when the first word in the collocation is observed the second word of the collocation is anticipatorily activated. From a language processing perspective, such collocational priming provides some obvious advantages. Perhaps equally important from a theoretical stance, however, is the fact that it appears that the learners seemed fully capable of developing links that were independent of those available through reference to the L1 alone.

This brings us to our last main point, which is connected to the first of our three hypotheses. This hypothesis stated that L2 collocations that had an equivalent form in the L1 would receive significantly more priming than the unrelated items, and the evidence here clearly allows us to reject the null hypothesis. Furthermore, unlike the situation with the second hypothesis, the results are uniform in supporting this claim: both the *F*1 and the *F*2 analyses supported our initial assumption. However, the situation here may be more complicated than it appears at first glance as well. Perhaps the most intriguing aspect of this result is not merely the fact that there was significant priming for this condition for our NNS group, but rather was the strength of the priming. As seen in Table 2, the mean priming effect for the NNSs was 84 ms, 26 ms more than the 58 ms demonstrated by the NS group. An additional independent samples *t*-test revealed that this difference in NNS and NS priming effects was not significant, $t(63) = 1.58$, $p = .12$, $d = .40$. Still, it is an interesting finding and it warrants considering whether there might be something of a 'doubling up' of activation for collocations that have an equivalent form in the L1 and the L2 (see Lemhöfer and Dijkstra 2004). In other words, the higher level of priming might be due to simultaneous spreading activation of the prime occurring in both the L1 and the L2, which ultimately led to the higher level of priming observed in our NNS group. If this were indeed the case, then it would be an informative finding as it would suggest that, even for advanced L2 learners, the L1 continues to be active even when performing tasks entirely in the L2.

At first glance, this last observation appears to have some implications for the ongoing debate between researchers regarding whether or not the bilingual memory consists of separate lexica or an integrated lexicon. On the one hand, there is the view that the L1 and L2 lexica are separate, and that second language access to meaning is (at least initially) mediated through the first language. This view is best captured in the well-known Revised Hierarchical Model (RHM) (Kroll and Stewart 1994; Figure 3). The opposing view is that there is a single, integrated lexicon that stores all of the language user's lexical entries, be they L1 or L2. This view has been professed by researchers Dijkstra and Van Heuven (1998, 2002) and Dijkstra *et al.* (1998) in models such as the bilingual interactive activation model (BIA) and the Bilingual Interactive Activation Plus model (BIA+). As Dijkstra *et al.* (1998: 178) point out, this

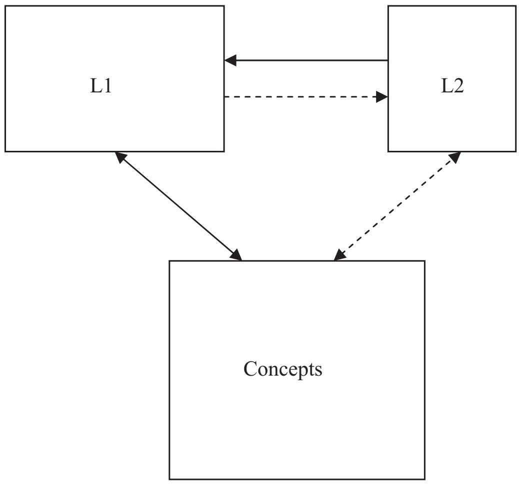

Figure 3: The Revised Hierarchical Model (Kroll and Stewart 1994)

distinction is further linked to 'an analogous contrast . . . between language-selective and nonselective access views'. The key question for this second distinction is the degree to which it is possible to fully suppress the activation of words in one language when dealing with the other language.

Though it is beyond the scope of this article to fully explore the intricacies of this debate, if our assumption that the accelerated priming effect for NNS was due to dual activation is correct, then it would seem to suggest nonselective access. Our findings are consistent with a number of studies indicating nonselective access at the lexical level [see Brysbaert and Duyck (2010) for a detailed overview]. Nonetheless, we see no reason why dual activation could not occur regardless of whether or not we are dealing with a single lexicon or separate lexica. It is possible that even though storage may influence activation, they need not be inextricably intertwined, and indeed pursuing empirical questions of activation in a manner that separates activation from storage may ultimately provide us with more useful insights into the development of bilingual memory than if they are viewed as theoretically inseparable constructs (see also Kroll and Tokowicz 2005). Indeed, the slightly accelerated RT demonstrated by the NNS group to the L1–L2 items in this study can also be accounted for by referring to the RHM if we take into consideration recent evidence indicating cross-language lexical priming even in advanced learners.

In a response to Brysbaert and Duyck's (2010) critical review of the RHM, Kroll et al. (2010) acknowledge that cross-language lexical activation likely occurs even amongst proficient bilinguals (though they dispute the idea that this sort of activation is necessary for accessing meaning for advanced learners). If this is the case, then it leads to a situation in which dual activation could also occur under the RHM. The most plausible scenario under this framework is as follows. When an L2 word is activated, it stimulates not only the L2 word's (known) L2 collocates, but also the L1 translation equivalent and that word's L1 collocates (again, assuming they are known). The subsequent presentation of the target provides four possible scenarios: (i) the word has been primed as an L2 collocate but not an L1 collocate, (ii) the word has been primed as an L1 collocate but not an L2 collocate, (iii) the word has been primed as both an L1 and L2 collocate, and (iv) the word has not been primed (either because it is not an acceptable collocate in the L2 or because it is acceptable but not known). The data in this study tell us nothing conclusive about scenario 2 (though see below), but we can at least draw some tentative conclusions about the other three scenarios. As noted earlier, the L2-only data seem to support the notion that scenarios 1 and 4 are possible, owing to the fact that the L2-only collocations demonstrated significant priming across participants (priming that could not have been assisted by the L1) but not across individual items (the aforementioned difference observed between the *F*1 and the *F*2 results). Scenario 3 seems likely. Our data indicate that L2 priming occurs in the absence of L1 priming, so it is plausible that the priming occurs in both languages simultaneously (as we have argued) and is not merely due to priming in the L1 alone (which would be the case under scenario 2). We have pointed to the stronger priming effect for the NNSs over the NSs as evidence for this dual activation, but this will clearly need further validation.

Along these lines, and in order to get a better handle on how active the L1 is when processing L2 collocations in general, we feel it would be of use in future studies to explore one more condition that was not included in this study. This is the question of whether collocations that are acceptable in the L1 but *not* the L2 would still produce a priming effect when tested solely in the L2 (Wolter and Yamashita, in preparation). If priming were found in such cases, it would provide strong evidence for parallel L1 activation, even when processing intralexical links entirely in the L2. Such a finding would have notable implications for perspectives on second language processing, particularly in respect to the issue of whether or not the L1 loses its influence in L2 processing as the learner gains in proficiency (for various perspectives on this debate see Schwartz and Sprouse 1996; Hawkins and Chan 1997; MacWhinney 1997).

In moving away from these specific hypotheses to a broader view of the implications of this study, the results suggest that the L1 may have a considerable influence on both the development of L2 intralexical links (from the results of the COLLMATCH test) and the online processing of L2 intralexical links (from the LDT). However, there was evidence suggesting that L2 links that had no equivalent form in the L1 could be processed in much the same way as L2 links that had an equivalent form once they were recognized by NNSs as valid L2 collocations. If this description represents an accurate portrayal of L2 collocational development, then some important implications arise. Theoretically speaking, the results seem amenable to the aforementioned models of word recognition and production, but also to claims made by Jiang (2000). Jiang put forth a series of arguments regarding the development of L2 lexical entries. Jiang suggests that lexical information at the lexeme level (which contains 'phonological and orthographic specifications') often consists of information acquired in the L2, while information at the lemma level, which contains semantic and syntactic information (Figure 4), remains restricted by information copied directly from the L1. In Jiang's view, this 'dual language' model of the lexical entries represents the end state for most words in the learner's lexicon. However, Jiang also notes that in some cases the learner may be able to 'escape' this fossilized condition and advance his or her knowledge to a form that is equivalent to that of a NS of the L2, with L2 information at the lemma level as well.

Although Jiang's model refers specifically to individual words, it is adaptable to collocations. It is important to bear in mind that despite the fact that our NNSs were highly proficient and in contact with English everyday in academic settings (and the fact that the collocations we investigated in the critical conditions were matched for things like NS familiarity and frequency) the acquisition (both in terms of development and processing) of the L2-only collocations lagged behind the L1–L2 collocations. Jiang's model provides an explanation for this. If we can assume that combinatorial outcome of

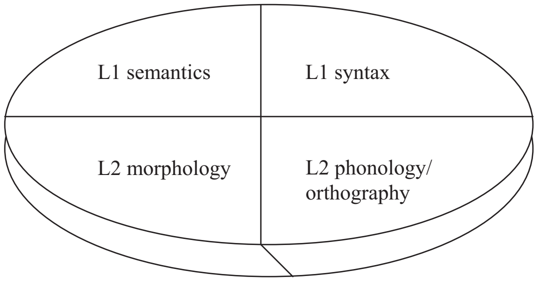

Figure 4: Jiang's model of fossilized L2 lexical knowledge [adapted from Levelt (1989)]

collocations is often a new, unified concept [and not simply the semantic summation of two lexical items; see Hoey (2005); Sinclair (1991, 2004); Wray (2002)], then it means a collocation is usually linked to a single concept. In cases where the fossilized state in Jiang's model is sufficient, the learner will be able to function adequately in the L2 with L1 information stored at the lemma level. In essence, collocational acquisition will simply be a matter of swapping out the L1 words with corresponding L2 words. In cases where the L2 collocation has no translation equivalent, however, the process will be more involved, as it will require the learner to go beyond this fossilized state to reach a state where the L2 information is required at both the lexeme and the lemma level. In cases where the collocational pattern is markedly different from the L1, this might prove to be fairly straightforward (similar to what Jiang envisions for L2 words that have no L1 translation equivalent). Where the patterns are less overtly divergent, however, it may require concerted effort on the part of the learner to develop collocational knowledge that is capable of dealing with the new complexities of the L2 that do not fall under the purview of what is feasible in the L1 (see also Wolter 2006).

Clearly, more research is needed to understand the complexities of L2 collocation acquisition and the role the L1 plays in mediating this process. Nonetheless, if there is one claim we can make without hesitation in light of the results of this study, it is our earlier position that the acquisition of L2-only collocations is not on par with the acquisition of L1–L2 collocations. This is in line with earlier results reported in the literature (Granger 1998; Nesselhauf 2003; Leśniewska and Witalisz 2007). From a teaching and learning perspective, this has some obvious implications. Specifically, it may be useful to give special attention to collocations that have no equivalent form in the learners' L1 (see also Nesselhauf 2003). This would clearly be easier to do in classrooms with a shared L1, but whatever the situation may be it appears we should not leave it to chance and expect L2-only collocations to be acquired through incidental exposure alone. Where L1–L2 collocations are concerned, these appear easier to acquire. Nonetheless, we do not feel that teachers should neglect L1–L2 collocations in their pedagogy. These need attention too. In fact, some studies have shown that learners sometimes reject acceptable L2 collocations even when they have an equivalent form in the L1 (Kellerman 1979; Leśniewska and Witalisz 2007). Therefore, learners need confirmation in such cases that their L1 collocational knowledge is fully transferable. More generally, we feel that collocations need to continue to take a more central position in vocabulary learning and teaching. As complex and unpredictable as they can be at times, they clearly comprise an important part of a well-developed lexical network.

SUPPLEMENTARY DATA

Supplementary data is available at *Applied Linguistics* online.

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NOTES

1 Crudely speaking, strategic priming takes place when test takers have a chance to anticipate a connection between the prime and target, either because the prime is displayed for a comparatively long time and/or there is a high proportion of related items on the test. Automatic priming, on the other hand, is believed to occur when the prime is presented for a short time and the total proportion of related pairs (the relatedness proportion) is low.

2 Available online at http://pie.usna.edu.

3 Available online at http://www.psy.uwa.edu.au/mrcdatabase/uwa_mrc.htm.

4 Available online at http://www.u.arizona.edu/~kforster/dmdx/dmdx.htm.

5 The data for the NS group were not normally distributed, so a Greenhouse–Geisser adjustment was used for the NS data.

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