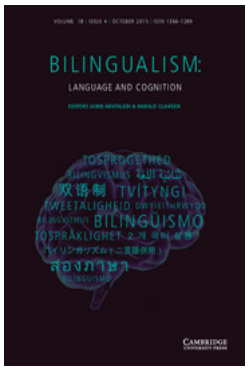

From form to meaning: Stages in the acquisition of second-language vocabulary

ADRIENNE TALAMAS, JUDITH F. KROLL and ROBERT DUFOUR

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From form to meaning: Stages in the acquisition of second-language vocabulary*

ADRIENNE TALAMAS
University of Massachusetts-Amherst
JUDITH F. KROLL
Pennsylvania State University
ROBERT DUFOUR
Swarthmore College

During early stages of second language acquisition adult learners make frequent errors of lexical form. An experiment was performed to examine this effect in the laboratory. More and less fluent bilinguals in English and Spanish performed a translation recognition task in which they decided whether the second of two words was the correct translation of the first. In the critical conditions of the experiment the words were not correct translation equivalents, but related by lexical form (e.g., man-hambre (hunger) instead of man-hombre (man)) or by meaning (e.g., man-mujer (woman) instead of man-hombre (man)). Less fluent participants suffered more interference for form-related than for semantically related words relative to unrelated controls, but the reverse pattern held for more fluent participants. The results support a progression from reliance on word form to reliance on meaning with increasing proficiency in the second language. The performance of the more fluent bilinguals further suggests that the ability to retrieve semantic information directly for second-language words can potentially override some of the costs associated with lexical competition in languages that access shared lexical features.

For some learners, the goal of second-language learning is to achieve a level of proficiency in the second language that is comparable with the first. At the point where an individual becomes a fluent bilingual, he or she should be able to function in the second language (L2) at a level of linguistic complexity and conceptual ease that accommodates most of the functions that the first language (L1) normally performs. However, the experience of many second-language learners who are confined to classroom instruction is that during early stages of learning it is difficult or nearly impossible to reach this goal. Although most individuals appear able to acquire L2 vocabulary, they make errors of lexical form and find themselves unable to use L2 to perform tasks that require conceptual processing. The aim of the present paper is to compare the performance of more and less fluent language learners to examine the changes in lexical and conceptual processing that occur with increasing proficiency in L2.[1]

Research on second-language acquisition suggests that adult second-language learners initially access meaning for second language words through the first language. During early stages of L2 acquisition, the salient form of interconnection between the two languages appears to be lexical; word associations between L1 and L2 mediate second-language performance in tasks such as picture naming and translation (Chen and Leung, 1989; Kroll and Curley, 1988). As the second-language learner becomes more proficient, direct conceptual processing of L2 becomes possible, making L2 functionally similar to L1. At other levels of language processing, there is also evidence that L1 phonology and syntax are active during early stages of L2 learning and that second language learners exhibit significant transfer from the first language to the second (e.g., Hancin-Bhatt and Nagy, 1994; MacWhinney, 1997).

Kroll and Stewart (1994) described a model of bilingual representation that attempts to capture the

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[1] We will use the term bilingual to refer generally to any individual who is engaged in learning a second language and who has achieved some level of fluency. In the present study we will describe two participant groups, one less fluent and the other more fluent in their L2, but technically neither group of participants is balanced in their bilingualism in that they are dominant in English and even the more fluent participants are generally far from having near-native fluency in L2. The less fluent group includes individuals who are second-language learners as well as individuals who were exposed to both languages in early childhood but educated primarily and most recently in English. What is essential for our purposes is not whether the more fluent participants are balanced bilinguals, but rather whether they have passed beyond an early critical stage of second language learning.

Address for correspondence
Judith F. Kroll, Department of Psychology, 641 Moore Building, Pennsylvania State University, University Park, PA 16802, USA
E-mail: jfk7@psu.edu

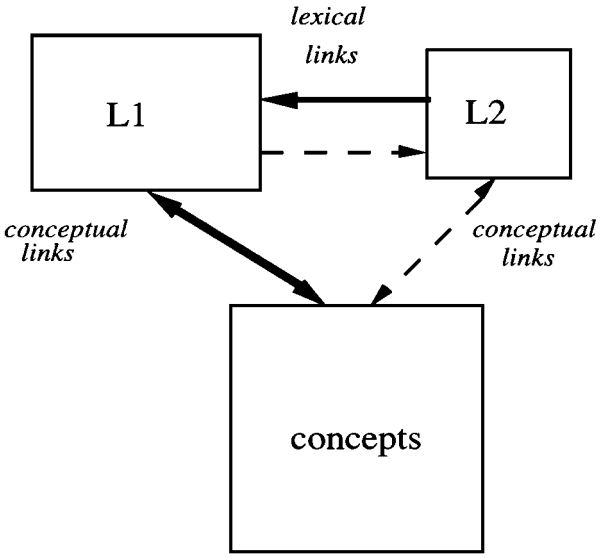

Figure 1. Revised hierarchical model of lexical and conceptual representation in bilingual memory (adapted from Kroll & Stewart, 1994).

consequences of this developmental shift with increasing proficiency in L2 from words to concepts. The model, shown in Figure 1, takes as its basic architecture a hierarchical structure in which representations of lexical form are independent for each language but representations of meaning are assumed to be shared across languages and across modes of perceptual experience (e.g., Potter, 1979; Potter, So, Von Eckardt and Feldman, 1984; Snodgrass, 1984). Because second-language learners initially access meaning for L2 words through L1, the revised hierarchical model hypothesizes that the early dependence on L1 creates an asymmetry in the form of interlanguage connections. Specifically, the model proposes that the early reliance on lexical-level associations between the two languages creates lexical-level connections from L2 to L1 that will be stronger than lexical-level connections from L1 to L2. As second-language learners become more proficient, they will be more likely to conceptually mediate L2 words, but the lexical-level connections between the two languages remain as a form of interlanguage connection. These lexical-level connections may be important, even for relatively fluent bilinguals, because not all words across two languages share precise translation equivalents (see De Groot, 1992, and De Groot, Dannenburg and Van Hell, 1994, for evidence on the translation of abstract nouns). The model also assumes that L1 words have privileged access to meaning; for most bilinguals, associations between L1 words and concepts will be stronger than those for L2 words.

Empirical support for the proposed model comes from the observation of an asymmetry that has been observed in many word translation studies: translation from L2 to L1 can often be performed more rapidly and accurately than translation from L1 to L2, even for relatively fluent bilinguals (Keatley, Spinks and de Gelder, 1992; Kroll and Stewart, 1990, 1994; Sánchez-Casas, Davis and García-Albea, 1992). According to the revised hierarchical model, the translation asymmetry occurs because the two directions of translation reflect two distinct routes to translation; translation from L2 to L1 can be accomplished at a lexical level but translation from L1 to L2 requires concept mediation. Kroll and Stewart (1994) provided empirical support for this claim by showing that translation from L1 to L2 was influenced by the semantic context in which translation was performed, whereas translation from L2 to L1 was not.[2]

A study that examined priming from picture naming to translation provided further support for the claim that the two directions of translation reflect distinct processing routes. Sholl, Sankaranarayanan and Kroll (1995) showed that translation from L1 to L2 was facilitated by earlier picture naming of the same concepts. Although the magnitude of facilitation was greater following picture naming in L2 than in L1, there was significant priming in both conditions, suggesting a conceptual contribution to the effect. In contrast, translation from L2 to L1 was unaffected by prior picture naming in either language, consistent with the proposal that L2 to L1 is primarily lexically mediated, whereas L1 to L2 is conceptually mediated. Because picture naming requires conceptual processing (e.g., Levelt, Schriefers, Vorberg, Meyer, Pechman and Havinga, 1991; Potter and Faulconer, 1975), Sholl et al. argued that selective transfer from picture naming to L1 to L2 translation suggested that only this direction of translation is conceptually mediated.

If second-language learners acquire lexical-level connections from L2 to L1 before they are able to mediate conceptually the second language, then performance during early stages of L2 learning should reflect the salience of lexical-level variables, whereas performance by more fluent bilinguals should be

[2] A number of recent studies (e.g., De Groot & Poot, 1997; La Heij, Kerling & van der Velden, 1996) have reported evidence that appears directly contrary to the predictions of the revised hierarchical model in that either no translation asymmetry was observed, or an asymmetry occurred in the opposite direction, with faster translation from L1 to L2 than L2 to L1. See Kroll and De Groot (1997) and Kroll and Tokowicz (in press) for a discussion of some of the methodological factors that may account for these different results.

influenced by conceptual variables. Indirect evidence to support this hypothesis comes from a study that examined translation performance with increasing L2 expertise (Kroll, Dufour, Sholl and Roufca, 1993). As learners became more proficient in L2, the magnitude of the translation asymmetry diminished, but the change was disproportionately attributable to a change in the speed of translation from L1 to L2, the translation direction hypothesized to be conceptually mediated by the revised hierarchical model. In contrast, translation from L2 to L1, the direction hypothesized to be lexically mediated, changed only slightly with increasing fluency, suggesting that lexical-level connections were in place early in second-language learning. Although it is possible that the dramatic change in translation from L1 to L2 reflects a change in the ability to speak in L2, comparison with a simple naming control in L2 suggests that it is the ability to lexicalize concepts in L2 and not simply L2 production that accounts for the effect.

Additional evidence for a developmental sequence from reliance on word form to reliance on meaning comes from informal observations of classroom performance during second-language learning. In one of the high schools in which the first author has taught Spanish, students were grouped or ''tracked'' into three academic levels which differ in terms of the rate and amount of material covered. Students in basic level classes generally acquired less vocabulary, made less progress with grammar, and demonstrated little fluency with the material. In contrast, students in the enriched-level classes generally acquired the vocabulary and grammar rather thoroughly and demonstrated much greater fluency with the material.

Of interest for present purposes, is that students in the basic class frequently made an error only rarely observed in the enriched class. Students in the basic class often confused Spanish words that had similar spellings. This observation is not particularly peculiar except that the same type of error is only observed in the enriched group when they are presented with relatively unfamiliar vocabulary. What is surprising about these errors is that students make them even when semantic and contextual cues ought to rule them out because the words that are confused share similar form but they have very different meanings. Furthermore, the errors appear to occur in both receptive and productive language tasks. For example, when a student heard, ''Como es la **mujer**?'', which translates as, ''What is the woman like?'', the student responded, ''You want to know about 'mi **mejor** amigo?'' The student clearly mistook what he heard, ''mujer'' which means ''woman'', for ''mejor'' which translates as ''best''. Again, the student made this error when referring to a picture of a woman. Another error of this kind in reception occurred when a student read ''Maria **cuida** a los niños los sábados'', meaning ''Maria takes care of the children on Saturdays''. Checking for meaning the student asked, ''She lives in the city?''. Here the student is mistaking the verb he heard, ''cuidar'', which translates as ''to take care of'', with ''**ciudad**'', which translates as ''city''.

Similar errors appear in production tasks. For example, a student wrote, ''Miguel quiere **llegar** un postre a la cena.'' Here the student is confusing the verb ''llegar'' for the verb ''**llevar**'' attempting to express the idea that Miguel brought a dessert to the dinner. (The student really wanted the verb ''traer''.) A second example in production occurred when describing his morning routine, a student said ''**me pienso**''. ''Pensar'' means ''to think''. The student meant to say ''**me peino**'', which means ''I comb my hair''. ''Pienso'' and ''peino'' are again very similar in form.

A common feature of each of these errors is that lexical form was salient for the students in selecting and interpreting vocabulary, regardless of the meaning of the context. What do these errors imply about how words are stored, or about the effect of familiarity on comprehension? The two groups of students differ in their ability to use the second language vocabulary fluently. This is not to say that the students in the enriched class are fluent in Spanish, but rather that they are fluent with the material covered in the Spanish curriculum. The more fluent students only make errors of lexical form when words are unfamiliar. The less fluent students make frequent errors of lexical form regardless of semantic context.

These anecdotal classroom observations are consistent with the account of L2 development provided by the revised hierarchical model. The less fluent students are likely to be relying on lexical associations from the second language to the first and hence are prone to confusions among words that share close lexical form. The more fluent students appear to be able to conceptually mediate the second language, at least for a portion of the L2 vocabulary with which they are most familiar, and therefore do not commit as many form errors as their less fluent counterparts.

The goal of the present study was to test the developmental sequence predicted by the revised hierarchical model in an experiment in which the critical materials were designed to reflect the natural errors observed in the classroom. We asked a group of bilingual students who differed in their level of L2 fluency in Spanish to perform a translation recogni-

tion task. In translation recognition (De Groot, 1992) the participant sees a word in one language followed by a word in the other language. The task is to decide whether the second word is the correct translation of the first word. In our experiment half of the trials were correct translations (e.g., garlic–ajo). The remaining trials were not correct translations and it is these trials that were of particular interest.

Two types of related, but incorrect, translations were included in the experiment. In the form-related condition, the second word was related in form to the correct translation (e.g., garlic–ojo (eye) instead of garlic–ajo (garlic)). In the semantically related condition, the second word was related in meaning to the correct translation (e.g., garlic–cebolla (onion) instead of garlic–ajo (garlic)). In addition, two control conditions were included in which the second word was completely unrelated to the correct translation but matched in word frequency to the words in the form and semantically related conditions.

If second-language learners pass from a stage of lexical association to eventual concept mediation of L2, we predicted that during the earlier word association stage they will be more sensitive to lexical form than to meaning, but once they become able to conceptually mediate the second language, they will be more sensitive to meaning than to form.[3] Specifically, we predicted that the time to reject false translation pairs in translation recognition would be longer for pairs related by form and meaning than for unrelated control pairs, and that the magnitude of form and meaning interference would be a function of the participant's level of fluency in their second language.[4]

Method

Materials

There were a total of 64 translation sets. Each set included a correct translation which appeared in the order English–Spanish or in the order Spanish–English, and four false or incorrect translation pairs (semantically related, form related, unrelated control for semantic pairs, and unrelated control for form pairs) which also appeared in one language direction or the other. The form-related pairs included words that had similar orthography, similar phonology, or both. The semantically related words included a variety of semantic relations, among them words that were semantically associated or exemplars of the same semantic category. (See the appendix for examples of the material sets.)

The unrelated controls were matched to related conditions as closely as possible on word length in English and Spanish and on English word frequency (Francis and Kucera, 1982). An example of the materials along with length and frequency values for each of these conditions is given in Table 1. In all conditions the Spanish words were slightly, but significantly, longer than the English words. For the correct translation pairs, $t\ (63) = -2.3$, $p < .05$. An analysis of variance on the false translation pairs

Table 1. *Mean word length (number of letters) in English and Spanish, mean word frequency per million in English (Francis and Kucera, 1982) for the 64-item sets used in the 5 conditions of the experiment, and examples of the stimulus materials*

	Measure		
Condition	Word length (English)	Word length (Spanish)	Word frequency
Correct translations (e.g., *garlic–ajo*)	5.27	5.71	241.09 (177.84)[1]
False translations:			
Form pairs:			
Related (e.g., *garlic–ojo* [eye])	5.11	5.70	179.41 (179.92)
Unrelated (e.g., *garlic–grupo* [group])	4.95	5.59	178.47 (178.97)
Semantic pairs:			
Related (e.g., *garlic–cebolla* [onion])	5.29	5.92	587.19 (138.22)
Unrelated (e.g., *garlic–lana* [wool])	5.43	5.63	199.56 (146.22)

[1] It was impossible to match the frequency values in one translation set with particularly high frequency (the target word "but"). These values were recalculated with that one item eliminated and the resulting means are given in parentheses.

[3] Based on our classroom observations, we expected that the more fluent participants would produce greater semantic interference than form interference. Theoretically, however, we might have predicted that more fluent participants would begin to show semantic interference as they begin to conceptually mediate L2, but that the magnitude of form interference would remain constant since other work has suggested that the connections between lexical representations are not lost when concept mediation is achieved (De Groot, 1992; Kroll and Stewart, 1994).

[4] Note that the use of the translation recognition task does not permit precise predictions regarding the effects of direction of translation. Unlike translation production, in translation recognition task words in both languages are presented in rapid succession. Because word recognition and lexical access are likely to be faster for L1 than for L2, even when L1 words are presented following L2 words, L1 may have a disproportionate effect on processing.

revealed the same difference between languages, $F(1,63) = 29.2$, $p < .001$, but no effects of the type of pair (form or semantic) or degree of relatedness (related or unrelated) or interactions between any of the variables. Analyses of variance were performed on word frequency values with the type of pair (form or semantic) and degree of relatedness (related or unrelated) as variables, once with all 64 items and once with 63 items (removing one very high frequency item). In neither case were there any significant main effects or interactions across conditions (all p values > .10).

Different versions of the stimulus materials were constructed so that no words would be repeated within an experimental block for any given participant (e.g., if a given participant saw "man–hombre" then a different participant would see "man–hambre"). An additional practice block was presented at the beginning of the experiment.

Apparatus and procedure

All of the factors in the present experiment were manipulated within participant except the order of the two languages in translation recognition. Each participant was presented with one pair of words from each of the 64 word sets. Half of the participants saw English words followed by Spanish words and the remaining half of the participants saw the Spanish words followed by the English words. A word was presented on the computer screen (in either English or Spanish) for 400 ms, followed by a 100 ms ISI and then by a word in the other language for 500 ms. The participants were instructed to decide whether the second word was the correct translation of the first and to indicate their response by pressing one of two response buttons. Response latencies were recorded to the nearest millisecond from the onset of the second word. At the end of the experimental trials, participants completed a language history questionnaire to assess their fluency and experience in the second language. They were asked to provide information concerning the context in which they acquired the second language and to rate themselves on a 10-point scale indicating their self-perceived ability to speak, write, and converse in their second language.

Participants

The participants were chosen from among 34 English–Spanish and 16 Spanish–English graduate and undergraduate students. The language dominance of the participants was determined by an interview with the experimenter, who was a fluent English–Spanish bilingual, and by the information provided in the language history questionnaire. The language history questionnaire asked participants to rate their written, spoken, and conversational ability in Spanish. However, native Spanish speakers were instructed to rate the language that they considered their second language. One native English-speaking participant and one native Spanish-speaking participant did not complete the questionnaire and were subsequently dropped from the analysis. Only data for participants who met the criteria for English dominance were used in the subsequent analysis. Nine of the remaining 15 native Spanish speakers were eliminated because they were not English dominant (they indicated that they spoke only Spanish at home or that they were enrolled in ESL classes). Of the remaining six native Spanish speakers, three chose to rate Spanish as their second language and were thus English dominant. The remaining three rated their English skills above 9 on a 10-point scale and were categorized as English-dominant by the experimenter. The final sample consisted of 39 participants, all of whom were considered dominant in English.

Results and discussion

Data Analysis

The 39 participants were divided into two Spanish fluency groups according to their overall accuracy in performing the translation recognition task. Of the 39 participants, 17 had an overall accuracy, averaged over both positive and negative trials, equal to or greater than 85 percent. These 17 participants were considered more fluent. The remaining 22 participants had an overall accuracy below 85 percent. These participants were considered less fluent.[5] The mean accuracy for the more fluent group was 90 percent (range: 86 percent–94 percent) and for the less fluent group was 76 percent (range: 64 percent–84 percent). To assess differences in language experience among the two groups, the mean ratings that participants in the two groups assigned themselves in

[5] In De Groot's (1992) original report of performance on the translation recognition task, the average error rate for highly fluent Dutch–English bilinguals on positive trials ranged from approximately 2 per cent to 17 per cent, depending on the word frequency and imagery value of the words. Although differences in materials and L2 fluency make direct comparisons across studies difficult, a criterion of 15 per cent errors (or 85 per cent accuracy) was chosen on this basis as a reasonable expectation for performance by reasonably fluent bilinguals. In addition, 85–90 per cent accuracy on binary decision tasks is commonly adopted in monolingual studies as a basis on which to include or exclude participants.

Table 2. *Mean self-ratings on spoken, written, and conversational proficiency in Spanish. These values include only participants who rated Spanish as their L2. (Each scale was rated from 1 to 10 where 1 was not very fluent and 10 was highly fluent)*

	Bilingual group	
Rating scale	Less fluent (n = 21)	More fluent (n = 15)
Speaking ability	6.9	8.7
Writing ability	7.7	8.3
Conversational ability	6.6	8.2

Spanish were compared. These values are shown in Table 2.[6] The more fluent group rated themselves as more proficient than the less fluent group in their ability to speak Spanish, t (34) = −3.67, $p < .01$, and in their ability to converse in Spanish, t (34) = −2.56, $p < .01$. The difference between the two groups in ratings of the ability to write in Spanish was marginally significant, t (34) = −1.36, $p < .10$.

Because fluency was determined following the assignment of participants to conditions, an additional set of analyses was performed to determine whether the division of participants into more and less fluent bilinguals had any consequence for the between-group manipulation of language order (i.e., English to Spanish vs. Spanish to English). That is, it was essential to establish that the different participant groups were equivalent in all respects other than the intended manipulation. Two-way analyses of variance, with fluency as one factor and language order as the other, were performed on per cent accuracy for yes and no responses, and for the three rating dimensions on the language history questionnaire. In none of these analyses was there any group difference as a function of language order or any significant interactions between fluency groups and language order (in all cases, $p > .10$).

False Translation Pairs

Separate analyses of variance were performed on mean correct response latencies (RTs) and per cent accuracy for false translation pairs (i.e., "no" trials). All analyses were performed using both participants and items as random factors. Data were excluded from trials on which errors were made and trials on which the mean RTs were identified as outliers. A criterion of 2.5 standard deviations above the mean was used to identify outliers for each individual's data.

Response Latencies. The complete results for the false translation trials are shown in Table 3, where response latencies are given for each type of word pair (form and semantically related) in each order of language presentation (English–Spanish and Spanish–English) for less and more fluent bilinguals. What is immediately apparent is that the related false translation pairs produced interference in all but one case. Furthermore, the magnitude of interference was related to the level of fluency. For the less fluent bilinguals, there was more interference for form than for semantic pairs. For more fluent bilinguals, the pattern of interference was more complex, but with more interference overall for semantic than for form pairs.

Analyses of variance were performed on participant and item means to evaluate the reliability of this pattern. The participant analysis included two between-group factors, participant fluency (less or more fluent bilinguals) and order of language presentation in the task (English–Spanish or Spanish–English), and two within-group factors, type of false translation pair (form or semantic) and relatedness (related or unrelated). In the corresponding item analysis, all factors were considered within-item variables. The main effect of relatedness was highly significant for both participants and items: F_1 (1, 35) = 23.32, MSE = 9021.2 $p < .01$; F_2 (1, 63) = 13.31, MSE = 102856.58, $p = < .01$.

Although the analyses did not reveal an overall difference in the speed of translation recognition performance for the less and more fluent groups (F_1 and $F_2 < 1$), the pattern of interference for each type of relation (form or semantic) suggests that the less and more fluent participants were differentially sensitive to the type of false translation. In both analyses of RTs by participant and by item there were significant three-way interactions between fluency, type of pair, and relatedness: F_1 (1, 35) = 5.02, MSE = 14374.2, $p < .05$; F_2 (1, 63) = 5.62, MSE = 84225.9, $p < .025$. Newman-Keuls tests showed that for the less fluent bilinguals, there was significant interference for form-related pairs, q (6, 35) = 5.52, $p < .01$, but not for semantically related pairs, q (2, 35) < 1. For the more fluent bilinguals, there was a large interference effect for the semantically related pairs, q (8, 35) = 6.25, $p < .01$ but a smaller, and nonsigni-

[6] Note that for all but three of the participants, the original L2 ratings were ratings of proficiency in Spanish. The values shown in Table 2 are only for those participants who rated Spanish as their L2. An additional analysis was performed on all ratings of L2 including the data for the three individuals who rated their proficiency in English. The statistical outcomes were identical to those reported for Spanish only.

Table 3. *Mean response latencies (in milliseconds) and per cent accuracy (as shown in parentheses) to make translation recognition judgments for false translation pairs as a function of the language order (English–Spanish [E–S] or Spanish-English [S–E]), type of word pair (form or semantic), relatedness (related or unrelated) and level of fluency (less or more fluent)*

Type of false translation pair	Fluency level					
	Less fluent			More fluent		
Form pairs:	**E–S**	**S–E**	**Mean**	**E–S**	**S–E**	**Mean**
Related	1020 (53%)	924 (62%)	972 (58%)	1043 (79%)	762 (84%)	903 (82%)
Unrelated	868 (82%)	849 (87%)	858 (85%)	914 (100%)	806 (98%)	860 (99%)
Interference	**152 (29%)**	**75 (25%)**	**114 (27%)**	**129 (21%)**	**−44 (14%)**	**43 (17%)**
Semantic pairs:	**E–S**	**S–E**	**Mean**	**E–S**	**S–E**	**Mean**
Related	889 (74%)	907 (71%)	898 (72%)	981 (85%)	953 (86%)	967 (85%)
Unrelated	865 (89%)	892 (91%)	878 (90%)	918 (99%)	768 (98%)	843 (99%)
Interference	**24 (15%)**	**15 (20%)**	**20 (18%)**	**63 (14%)**	**185 (12%)**	**124 (14%)**

ficant interference effect for the form-related pairs, q (4, 35) = 2.5, $p > .05$. The pattern of results thus supports the hypothesis that as second language learners acquire increasing proficiency, they become less sensitive to word form and more sensitive to meaning.

The analyses also revealed a significant three-way interaction between the order of presentation of the two languages, the type of pair, and relatedness: F_1 (1, 35) = 5.32, MSE = 14374.2, $p < .05$; F_2 (1, 63) = 6.47, MSE = 45414.9, $p < .025$. When the language of the first word presented was English, there was a larger form (140 ms) than semantic interference effect (43 ms). When the language of the first word presented was Spanish, there was a larger semantic (100 ms) than form interference effect (16 ms). According to the revised hierarchical model, the direction in which translation takes place determines the degree to which word form and meaning are active. Because the sample of thirty-nine bilinguals in this study were English dominant, these results might be taken as evidence against the predictions of the model; initial presentation of the word in L1 should have produced larger semantic than form effects. However, this pattern of results, which itself did not interact with fluency, is likely to be attributable to the manner in which false translation pairs were constructed. Consider the example of "man–hombre" presented earlier. The form-related substitution for "hombre" was the Spanish word "hambre", which means hunger. In the English to Spanish condition, the word "man" would appear, followed by the word "hambre" and the participant would be expected to respond "no" because the translation was incorrect. However, in the Spanish to English condition, the word "hombre" would appear, followed by the word "hunger", which does not resemble the translation "man" but is simply the translation of the form-related word. The two orders of presentation were thus not equivalent in the degree to which the form relation was salient.[7]

Accuracy. Similar analyses were performed on per cent accuracy. These data are also shown in Table 3. Because the participants were initially assigned to fluency groups according to an accuracy criterion, it is to be expected that there will be an overall differ-

[7] The three-way interactions were not qualified by higher order effects. The four-way interaction between fluency, order of presentation of the two languages, the type of pair, and relatedness was not significant in the analyses by participant or by item: F_1 (1, 35) = 2.12, MSE = 14374.2, $p > .10$; F_2 (1, 63) < 1. The remaining three-way interactions were not reliable in either the analysis by participants or by items (F_1 and $F_2 < 1$). Of the two-way interactions, the interaction of language order and type of pair was significant in the analysis by participants, F_1 (1, 35) = 8.35, MSE = 9691.11, $p < .01$, but not in the analysis by participants, F_2 (1, 63) = 2.71, MSE = 77326.7, $p > .10$. The interaction of fluency and type of pair was not significant in the analysis by participants, F_1 (1, 35) = 2.50, MSE = 9691.1, $p > .10$, but was significant in the analysis by items, F_2 (1, 63) = 7.92, MSE = 42662.0, $p < .01$. None of the remaining two-way interactions was significant in either analysis; for fluency by language order, $F_1 < 1$ and F_2 (1, 63) = 3.22, MSE = 145648.5, $p > .05$, for order by relatedness, F_1 (1, 35) = 1.22, MSE = 9021.1, $p > .10$, and $F_2 < 1$, and for fluency by relatedness and type of pair by relatedness, both F_1 and $F_2 < 1$. The main effect of language order was not significant in the analysis by participants, F_1 (1, 35) = 1.44, MSE = 166124.2, $p > .10$, but was significant in the analysis by items, F_2 (1, 63) = 18.13, MSE = 86403.2, $p < .01$. The main effect of type of pair was not significant in either analysis (F_1 and $F_2 < 1$).

ence in their level of accuracy on the task. However, there were also reliable effects of relatedness, F_1 (1, 35) = 98.89, MSE = .014, $p < .01$, F_2 (1, 63) = 93.23, MSE = .052, $p < .01$, and a significant effect type of pair in the participant analysis, F_1 (1, 35) = 5.80, MSE = .024, $p < .05$, with marginal significance in the item analysis, F_2 (1, 63) = 3.71, MSE = .086, $p < .06$. The interaction between fluency and type of pair was marginally significant in the participant analysis, F_1 (1, 35) = 3.22, MSE = .024, $p < .10$, and significant in the item analysis, F_2 (1, 63) = 4.43, MSE = .065, $p < .05$. There was also a marginally significant interaction between relatedness and fluency, F_1 (1, 35) = 3.75, MSE = .014, $p < .07$, F_2 (1, 63) = 3.96, MSE = .066, $p < .06$. The main result was that less fluent bilinguals were less accurate on related false translation trials than the more fluent bilinguals, regardless of the type of relation. Although the pattern of accuracy shown in Table 3 suggests that the less fluent group was particularly error prone in the form-related condition, the three-way interaction between fluency, type of pair and relatedness was not significant in either the analysis by participants or by items (F_1 and $F_2 < 1$). No other main or higher order effects were significant by participants or by items.

Correct Translation Pairs

The data we have presented thus far have been restricted to the critical false translation trials in which the words in a given pair were not the correct translation equivalents. To examine the performance of the less and more fluent bilingual groups on correct translation trials (i.e., ''yes'' trials), analyses of variance were performed to consider fluency and order of language presentation on RTs and accuracy. These data are shown in Table 4.

Response Latencies. The order of language presentation was marginally significant in the analysis by participants, F_1 (1, 35) = 3.34, MSE = 32586.6, $p < .08$, but highly significant in the analysis by items, F_2 (1, 63) = 36.09, MSE = 38396.0, $p < .01$. Both groups of participants were faster to make translation recognition judgments when the first word appeared in Spanish (L2) and the second word appeared in English (L1) than in the opposite order. Superficially, the difference between the two directions of translation in translation recognition is similar to the observation of a translation asymmetry in translation production: participants are reliably slower to translate from L1 to L2 than from L2 to L1 (Kroll and Stewart, 1994; Sánchez-Casas et al., 1992; Sholl et al., 1995). In translation production the asymmetry has been interpreted to reflect the differential reliance on concept mediation when translating in the L1 to L2 direction and lexical mediation when translating in the L2 to L1 direction. However, unlike the pattern found in translation production, where less fluent participants show a larger translation asymmetry than more fluent participants (Kroll, 1993; Kroll et al., 1993), in translation recognition the less fluent group was not slower on correct translation trials than the more fluent group, and, if anything, the translation asymmetry was larger for the more fluent group, although not significantly so. It is possible that the more directly available form similarity in the English to Spanish order served not only to increase the magnitude of interference for the false translation trials, but also to lengthen the decision process in the correct translation condition. If the problem in translation production for less fluent bilinguals is in using activated conceptual information to retrieve and produce second language words, then in translation recognition, where the lexicalization component of the production process is absent, the differences between the two groups should be reduced, as suggested by the data presented here. No other effects were significant in either the analysis by participants or by items.

Table 4. *Mean response latencies (in milliseconds) and per cent accuracy (as shown in parentheses) to make translation recognition judgments for correct translations as a function of the order of language presentation and level of fluency*

	Fluency level	
Order of language presentation	Less fluent	More fluent
English–Spanish	846 (73%)	849 (86%)
Spanish–English	760 (75%)	720 (85%)

Accuracy. Beyond the expected effect of fluency, there were no significant effects in the analyses on accuracy (all p values > .05).

General discussion

The pattern of RT results for the false translation trials mirrors the classroom observations of beginning and more advanced students. The performance of less fluent bilinguals was impaired by form similarity but less affected by semantic similarity and the reverse was true for more fluent bilinguals. These results are consistent with the claim that less fluent bilinguals rely heavily on information about word

form, whereas more fluent bilinguals are able to access meaning directly for L2 words. Indeed, the more fluent participants not only produced a semantic interference effect, but were also slower than the less fluent participants to respond to the semantically related pairs, suggesting that the ability to conceptually mediate L2 confers a processing cost under these circumstances.

Although the general pattern of interference was consistent with a shift in reliance on form to reliance on meaning with increasing second language proficiency, these effects were not absolute. Less fluent bilinguals produced no observable semantic effect in response latency, but they were less accurate in responding "no" to false translation pairs that were semantically related. Likewise, although the four-way interaction was not significant, the pattern of latency data shown in Table 3 suggests that under some circumstances the more fluent bilinguals are sensitive to form interference, although not to the same degree as the less fluent bilinguals.

The results of the present experiment also differ in some respects from those recently reported by Altarriba and Mathis (1997) using a similar paradigm. Altarriba and Mathis trained a group of monolingual students who did not know any Spanish on a set of Spanish words. They then performed a translation recognition task similar to the one we used and compared performance by the newly trained participants to that of a group of relatively fluent bilinguals. Like the present results, they reported more form interference for the nonfluent participants than for the fluent bilinguals. However, unlike the results of the present study, they found evidence of semantic interference for both groups of participants, regardless of their L2 expertise. On the basis of their results, Altarriba and Mathis argued that even during the earliest phases of second language learning, individuals are capable of conceptually mediating new L2 words.

There are a number of methodological aspects of the Altarriba and Mathis (1997) study that differ from the present work that might account for the different pattern of results. For example, in that study the nonfluent group consisted of monolingual individuals who were trained to a high criterion on a relatively small set of words. It is possible that under these conditions, particularly when testing occurred almost immediately after training and included a direct matching test to the translation equivalent, that even these nonfluent participants show some effects of semantic interference because the semantic distractor itself had been primed by virtue of the semantic conditions used during the training procedure. In the present study, all of the participants were bilingual to some degree and there was no exposure to the stimulus materials immediately preceding the critical trials. The materials in the present study also represented a more extensive range of vocabulary. It is certainly possible that during early stages of learning there might be semantic processing for some restricted portion of the second-language vocabulary (e.g., words with particularly high frequency, by virtue of their use in the language or by the consequence of immediate repetition, or words within a particular semantic category or pocket of expertise). Furthermore, because the form and semantic distractor conditions in the Altarriba and Mathis study were manipulated between participants, the probability of a particular type of related distractor was also higher than in the present study and may have influenced task performance.

The results reported here for the less fluent participants provide mixed support for the role of conceptual processing during early stages of second language learning. Although there was no significant semantic interference effect in the response time measure, there was a significant accuracy effect, suggesting that the less fluent participants were more likely to false alarm to pairs that were semantically related. To examine the effects of semantic interference in more detail, a post hoc analysis was performed in which the semantically related pairs were rated for the degree to which they were semantically similar. Recent work on semantic priming within language in monolinguals (e.g., McRae and Boisvert, 1998) and across languages for bilinguals (e.g., Williams, 1994) suggests that the degree of semantic feature overlap between primes and targets is an important determinant of priming. If individuals who are not yet fluent in a second language have access to some, but not all, semantic information from L2 words (e.g., Dufour and Kroll, 1995), and if the process of concept mediation develops in a gradual manner, then the less fluent participants in the present study might have been more sensitive to semantically related distractors when they were highly similar to the meaning of the target words.

Semantic similarity ratings. Each of the 64 target words was paired with its semantically related distractor and presented, in English, to 32 native English speaking monolingual students to rate for semantic similarity. The 64 word pairs were embedded in a booklet which included a longer list of similar materials that were also rated for semantic similarity. Participants were told to read the first word and to think of what it typically refers to, to then do the same for the second word, and finally to consider the similarity of the two meanings. They were instructed to rate the similarity of the word pair

Table 5. *Mean response latencies (in milliseconds) and per cent accuracy (as shown in parentheses) to make translation recognition judgments for semantically related and unrelated false translation pairs as a function of the level of fluency and the degree of rated semantic similarity*

	Fluency level	
Degree of rated semantic similarity	Less fluent	More fluent
More similar pairs		
Related	942 (60%)	986 (76%)
Unrelated	853 (87%)	879 (98%)
Interference	**89 (27%)**	**107 (22%)**
Less similar pairs		
Related	850 (80%)	923 (92%)
Unrelated	861 (94%)	806 (97%)
Interference	**−11 (14%)**	**117 (5%)**

on a seven-point scale where "1" meant very similar and "7" meant very different.

The word "but" was again dropped from the analysis because of its exceptionally high word frequency relative to the other materials. The remaining 63 word pairs were divided into two groups of items, with those rated less than "6" considered more similar and those rated more than "6" considered less similar.[8] The more similar word pairs had a mean semantic rating of 5.09 (n = 29) and the less similar word pairs had a mean semantic rating of 6.54 (n = 34). To be sure that no confoundings were present across the two groups of items, the resulting groups were compared on measures of target and distractor word frequency in English and on English and Spanish word length. A series of t-tests revealed no significant differences between the groups on any of these measures (all p values > .25).

The mean RTs and per cent accuracy for more and less fluent participants for the semantically related and unrelated conditions of the experiment are broken down by the semantic similarity categories in Table 5. These data show that performance on the translation recognition task was indeed affected by the degree of rated semantic similarity. The most striking result was for the less fluent participants. When the materials were divided up in this way, there was now a semantic interference effect for the less fluent group, but only for the pairs that had been rated as more similar. An analysis of variance on the RT data for the less fluent participants, with type of pair (more or less semantically similar) and relatedness (related or unrelated) as factors revealed a marginally significant interaction of these factors, F (1, 61) = 3.06, MSE = 25716.97, $p < .09$. Subsequent t-tests showed that the effect of semantic relatedness was significant for the more similar pairs, t (28) = 2.93, $p < .01$, but not for the less similar pairs, t (33) = − .25, $p > .10$. Neither of the main effects was significant (for semantic similarity, F (1, 61) = 1.37, MSE = 41309.67, $p > .10$, and for relatedness, F (1, 61) = 1.48, MSE = 25716.97, $p > .10$).[9]

The more fluent group appeared to produce a semantic interference effect in the RT measure regardless of the level of semantic similarity. An analysis of variance on the RT data for this group revealed only a significant main effect of relatedness, F (1, 61) = 12.49, MSE = 31205.85, $p < .001$. The main effect of semantic similarity was marginally significant, F (1, 61) = 2.99, MSE = 47457.35, $p < .09$, and the interaction between semantic similarity and relatedness was not reliable ($F < 1$).

As in the overall analyses, the accuracy data tell a somewhat different story from the RT data. Here, both groups appeared more likely to false alarm to semantically related pairs when the degree of semantic similarity was relatively high. Analyses of variance on the data for the less fluent group revealed significant main effects of semantic similarity and relatedness, F (1, 61) = 8.12, MSE = .07, $p < .01$, and F (1, 61) = 23.04, MSE = .06, $p < .001$, respectively. However, the interaction between semantic similarity and relatedness was not significant ($p > .10$). For the more fluent group, there was a main effect of relatedness, F (1, 61) = 12.92, MSE = .04, $p < .001$, and a significant interaction between semantic similarity and relatedness, F (1, 61) = 5.84, MSE = .04, $p < .025$.

Although the analysis we have described is post hoc and should be treated with some caution, it provides a number of interesting implications for understanding the changes that occur with increase in expertise in L2. First, it suggests that the overall change from reliance on form to reliance on meaning with increasing proficiency in the second language is a matter of degree, not an absolute change in the nature of the information that is accessible to the learner. Second, it is consistent with recent connec-

[8] The semantically related pairs in the present experiment were rated, in absolute terms, at the high end of the scale used in the rating task, indicating that they were perceived to be more different than similar. However, it seems likely that the context in which the critical pairs were embedded may have influenced the way in which the raters used the scale.

[9] The post hoc analysis of semantic similarity was performed on item means.

tionist approaches that claim that featural similarity between words is a critical determinant of access to semantic memory (e.g., McRae and Boisvert, 1998). The fact that the more fluent bilinguals produced semantic interference regardless of similarity but, at the same time, were far less accurate for the more similar pairs, suggests that more fluent bilinguals may be able to access a wider range of semantic information for L2 than the less fluent bilinguals. However, the result that even they can be fooled by similar words demonstrates that the basic mechanism is the same for more and less fluent individuals; it differs in its extent but not in kind.

The post hoc analysis of the effects of semantic similarity also makes the present results more compatible with those reported by Altarriba and Mathis (1997), as it demonstrates that under some circumstances individuals less fluent in their L2 are sensitive to semantic variables. However, even if the two sets of results can be reconciled, there is the remaining question of how to account for the observation that more fluent bilinguals appear to be less sensitive to form similarity than individuals at early stages of L2 acquisition. Unlike the less fluent bilingual, the more fluent bilingual has greater access to conceptual information and can use information available from activated concepts to override form-based competition among lexical candidates. Thus, the more fluent students were less likely to produce form errors in sentence context just as the more fluent participants in the experiment we have reported were less likely to produce form interference in translation recognition.

Lexical competition. Past research on bilingual word recognition has shown that fluent bilinguals do activate related orthographic forms across their two languages, even under conditions of monolingual presentation (Altenberg and Cairns, 1983; Nas, 1983). Recent work on lexical access in highly fluent bilinguals (e.g., Dijkstra and Van Heuven, 1998; Grainger, 1993; Grainger and Dijkstra, 1992; Van Heuven, Dijkstra and Grainger, 1998) suggests that in languages in which aspects of the orthography are shared, lexical neighbors of presented target words are activated in both languages. Depending on the requirements of the processing task, the activation generated by neighbors across the bilingual's two languages will produce either facilitation or interference. When the task requires selection of a single lexical entry, interference is likely to result because lexical activation in both languages will increase competition during the selection process. When the task requires only a judgment of whether lexical information has been activated, the same increased activation is likely to produce facilitation.

The evidence on cross-language lexical activation might have led us to expect similar form interference for more and less fluent bilinguals alike. Although the results we have reported are consistent with the view that even fluent bilinguals activate lexical neighbors with which they share word form, they also suggest that the magnitude of this effect is modulated by the influence of higher-level factors. The data in Table 3 make it clear that the more fluent bilinguals were extremely sensitive to the semantic relatedness of the words to be judged. Because the competition produced by form-related words is unlikely to produce converging competition at the semantic level, distinct patterns of semantic activation may serve to resolve the form interference. In the absence of rapid input from the semantic level, the performance of the less fluent individuals will be determined to a greater extent by form-level competition.

Dijkstra, Van Jaarsveld and Ten Brinke (1998) recently reported a lexical decision experiment which provides some support for the idea that the words with the same level of orthographic overlap can have different consequences depending on the context in which they are processed. The critical materials in the Dijkstra et al. study were interlingual homographs, words that look alike but do not share the same meaning across languages. When fluent Dutch–English bilinguals were asked to make lexical decisions in English, their L2, the presence of words in English that looked like Dutch words had no effect on performance. However, in the same experiment, participants were facilitated for words that were cognates, i.e., that shared meaning as well as form across the two languages, relative to matched controls. Furthermore, when the activation of the first language was increased in a second experiment by including some real Dutch words among the nonword distractors, then the interlingual homographs produced interference relative to matched controls. Dijkstra et al. took this pattern of results as support for the Bilingual Interactive Activation (BIA) model, a model which assumes nonselective access to words in the bilingual's two languages. But most relevant to the present results is the evidence that lexical-level activation can be modulated by the relative activation of the two languages and by the presence of higher-level information about word meaning. If only more fluent bilinguals possess the ability to activate that higher-level information, then only they will be able to reduce the consequences of lower-level competition. The performance of less fluent bilinguals will thus be determined more directly by aspects of the stimulus form rather than its meaning.

The implication of these findings for the interpretation of the present data is that it is likely that the

form-related pairs in translation did produce activation that was potentially hurtful for the more fluent participants. However, because the translation recognition task engages conceptual as well as lexical-level processes (e.g., De Groot and Comijs, 1995), these bilinguals appeared to be able to use higher-level feedback to resolve ambiguities generated at the level of lexical form. If this interpretation is correct, then the form of interaction between conceptual and lexical information will be an essential feature of a model of cognitive change during L2 acquisition.

Models of lexical-conceptual interaction. We have presented the results of a translation recognition experiment that show that less fluent bilinguals are more likely to be influenced by form relations between words whereas more fluent bilinguals are more likely to be influenced by meaning relations. The revised hierarchical model represents the connections between languages as strong at the lexical level and weak at the conceptual level, particularly for the less fluent bilingual. If the less fluent participant does not have direct or strong conceptual representations for form-related neighbors, then he or she cannot use semantic information to resolve competition among lexical alternatives. The selection of a single lexical candidate is thus either random or based on frequency or familiarity of the lexical forms. Indeed, this is precisely the aspect of the classroom observations that we have described that is so surprising, because contextual clues do not appear to eliminate the form-related errors made by beginning students. Instead, the less fluent students apparently use the more frequent or better learned lexical term within a cohort of similar words.

Although the revised hierarchical model can account for the general pattern of differences among the two fluency groups, it cannot, in present form, accommodate the graded effects of semantic similarity described in the post hoc analysis nor does it provide a mechanism for adequately dealing with competition among lexical neighbors. Models in which a distributed representation is assumed at the lexical and/or conceptual levels (e.g., Dell and O'Seaghdha, 1992; Dijkstra and Van Heuven, 1998; Kroll and De Groot, 1997; see also Grosjean, 1997, for a description of a related model for spoken word recognition) may be more successful in accounting for the results. More fluent bilinguals, for whom the mappings between L2 lexical entries and concepts will be relatively strong, will be able to resolve form competition at the lexical level because the lexical alternatives will map to conceptual alternatives that are, for the most part, nonoverlapping. If the process of accessing those conceptual alternatives is slow, as it appears to be for less fluent individuals, then feedback from the conceptual level will not be as available and performance will be determined by the degree of lexical competition.

The post hoc analysis of semantic similarity effects showed that the less fluent participants did produce semantic interference for word pairs that had been rated as relatively more similar. Because the words that comprised the more similar pairs and less similar pairs had been matched on measures of word frequency and length and appeared to include similar types of words (e.g., both concrete and abstract words), it seems unlikely that the effect for the less fluent group can be attributed to concept mediation in L2 for some types of words but not for others. Instead, the result suggests that some degree of conceptual activation was present on all trials and that semantic similarity affected the decision criterion adopted to perform translation recognition. For less fluent individuals, who are likely to have greater uncertainty about their L2 knowledge than more fluent individuals, any significant activation of shared features may present sufficient evidence to respond positively that the pair of words are translation equivalents, regardless of whether or not that is so. Because the more similar semantically related pairs will have a high degree of overlap, like true translation pairs, they will be more likely to generate false alarms and to produce long RTs. By this account, the difference in the performance of the more and less fluent groups is not due to the ability to activate semantic information for L2 words per se, but to the way in which that information is used (see Dufour and Kroll, 1995, for a similar claim about fluency differences in a cross-language categorization task).

Conclusion

The translation recognition experiment we have reported showed that the performance of more and less fluent bilinguals was differentially affected by distractors that were related in word form or meaning to the correct translations of target words. Like observations of errors in reception and production among students at different levels of L2 skill, these results suggest that in the absence of the ability to use L2 to accomplish the full range of conceptual functions available in L1, performance is marked by reliance on word form. With increasing fluency, performance is influenced by meaning to a greater degree. The results also suggest that even less fluent bilinguals are capable, to some extent, of concept mediation in L2. However, their performance is vulnerable to the effects of competition at the form level when higher-level feedback is unavailable within the processing window of the task. We believe that the present

results offer a glimpse into the nature of interactions between lexical and conceptual processes. In future research it will be important to pursue aspects of this work that may allow us further to constrain models of bilingual language processing. At a more applied level, the present study also demonstrates that some of the rich features of classroom observation can be captured and examined in an empirical laboratory study.

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Appendix

An illustration of materials used in the study.

		Distractors			
Target words	Correct translation	Semantically related	Form related	Semantic control	Form control
coins	monedas	billete	moderno	verdad	fuerte
monedas	coins	bill	modern	truth	strong
thinks	piensa	siente	peine	debe	ratón
piensa	thinks	feel	combs	should	rat
garlic	ajo	cebolla	ojo	lana	grupo
ajo	garlic	onion	eye	wool	group
soap	jabón	baña	jamón	cerca	limón
jabón	soap	bathe	ham	nearby	lemon
blind	ciego	sordo	cielo	pela	dueño
ciego	blind	deaf	sky	peel	owner
laugh	ríe	chiste	río	clima	menos
ríe	laugh	joke	river	climate	less
snow	nieve	lluvia	nuevo	comida	viene
nieve	snow	rain	new	meal	come

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