

Lexical and Conceptual Representation in Beginning and Proficient Bilinguals

MARY C. POTTER, KWOK-FAI SO, BARBARA VON ECKARDT, AND LAURIE B. FELDMAN

Massachusetts Institute of Technology

Two hypotheses about the association between the equivalent words in a bilingual's two languages are considered. The *word association* hypothesis proposes that a direct association is established between words in the two languages. During second-language acquisition, that association is used to understand and produce words in the second language by retrieving a word in the first language. The *concept mediation* hypothesis proposes that the only connection between the two languages is via an underlying, amodal conceptual system, one to which pictured objects also have access. The hypotheses make different predictions about the time to name pictures in the second language relative to the time to translate first-language words into the second language. Two experiments are reported, one with proficient Chinese-English bilinguals and the second with nonfluent English-French bilinguals (American high school students). Subjects read words aloud, named pictures, and translated words; one Chinese-English group categorized pictures and words. The results were consistent with the concept mediation hypothesis and contradicted predictions of the word association hypothesis. There was no evidence for a direct association between words in the two languages in either bilingual group.

When a speaker acquires a second language, what pattern of connections is set up between vocabulary items in the two languages? One plausible hypothesis is that new words in the second language (e.g., French) are directly associated with the words in the first language (e.g., English). As long as the second language remains weaker than the first language, this asso-

This work was supported by NIMH Grant MH-27536 and NSF Grant BNS-8015597 to the first author. The second author collaborated on Experiment 1 and the third and fourth authors, on Experiment 2. K.-F. So is now at the Department of Anatomy, University of Hong Kong; B. Von Eckardt is at the Department of Philosophy, Yale University; and L. B. Feldman is at the Department of Psychology, Dartmouth College. We thank R. Friedman for contributions to Experiment 1, M. Garrett and B. Faulstich for collaboration in Experiment 2, and Judith F. Kroll for her comments. We also thank the leaders and members of the Experiment in International Living for their participation in Experiment 2. Requests for reprints should be addressed to the first author at the Department of Psychology, Building E10-032, Massachusetts Institute of Technology, Cambridge, Mass. 02139.

ciation is used in understanding and speaking the second language. We will call this the *word association* hypothesis; it matches the intuitions of many learners.

An alternative hypothesis is that second-language words are not directly associated with first-language words, but instead are associated with the nonlinguistic concept common to the two words. We will call this the *concept mediation* hypothesis.

Both hypotheses are consistent with the assumption that there is a distinction between word representations and their concepts or meanings. This distinction is justified on both logical and empirical grounds (e.g., Anderson & Bower, 1973; Potter, 1979; Snodgrass, 1980), and will be assumed here. An observation consistent with the distinction is the well-known difference in naming time for pictures and written words: words can be named (read) about some 200-300 milliseconds faster than pictures of the same items (Cattell, 1886; Fraisse, 1960; Potter & Faulstich,

1975). Yet in a task such as matching a word or picture to a superordinate category, which requires understanding of the stimulus concept but not overt naming, responses are just as fast (or faster) to pictures as to words (e.g., Banks & Flora, 1977; Rosch, 1975; Smith & Magee, 1980).

This asymmetry between pictures and words in access to a spoken name and to the stimulus meaning suggests a functional division of memory, like that diagrammed in Figure 1. A spoken name is accessed more directly from a written word than from a picture, which must be understood before it can be named. When the task requires understanding but not naming, words and pictures require more nearly equivalent processing. Which type of stimulus will be faster depends on the relative times to activate memory for the surface form in the lexicon or image store, and to retrieve the concept.

If the relations among words, pictures, and concepts are those indicated in Figure 1, how is a second language represented? The two hypotheses described earlier are shown in Figure 2. (The lengths of arrows should be ignored in interpreting this figure.) According to the word association model, access to and from the second-language word (L2) is exclusively via the first-

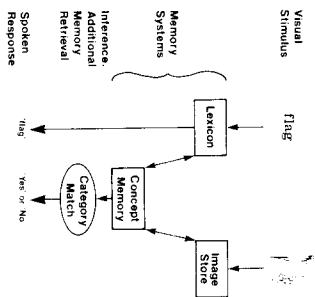


FIG. 1. The major stages and meaning systems engaged in naming or categorizing a picture or word (adapted from Potter, 1979, Fig. 3.2).

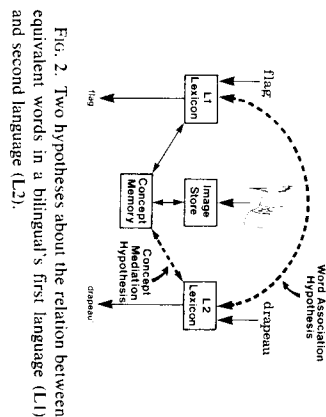


FIG. 2. Two hypotheses about the relation between equivalent words in a bilingual's first language (L1) and second language (L2).

language word (L1), shown by a dashed link between L1 and L2 in Figure 2. According to the concept mediation model, the bilingual's second language is associated directly with the relevant underlying concept and thus is only indirectly associated with the first-language word; the dashed link between the concept and L2 in Figure 2 represents this hypothesis.

One might propose an intermediate model in which second-language learners start out only with lexical associations, but gradually develop direct links between the second-language lexicon and concepts, as in the concept mediation model. In other words, the word association link shown in Figure 2 might eventually be replaced by the concept mediation link.

To test these possibilities, we carried out one experiment on proficient bilinguals (native Chinese speakers currently residing in the United States and studying in English), and a second on relative novices (American high school students who had taken 2 or 3 years of French). In both experiments, we compared times to name (read) written words aloud, to translate these words into the other language, and to name pictures in one or the other language. The critical comparison is that between picture-naming in the second language and translating from the first to the second language. Table 1 and Figure 3 show the steps that each model

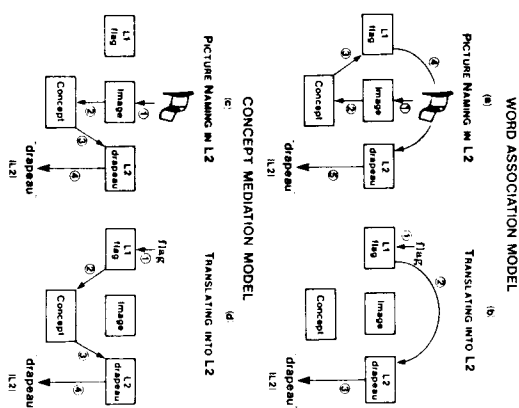


FIG. 3. The processing steps in picture-naming and translating, according to the word association model and the concept mediation model (see Table 1 for descriptions of the numbered processing steps).

hypothesizes, for these two tasks. In all cases, the last step—speaking the L2 word aloud—is identical and can therefore be disregarded. The next-to-last step, retrieval of the lexical entry of the L2 word, is identical for each task within each model, although in the word association model the retrieval route is from L1, whereas in the concept mediation model retrieval is from the concept.

The word association model's prediction for the relative time to perform the two tasks is clear, if it is assumed that picture recognition and word recognition (the first steps) take approximately the same time. (That assumption will be discussed shortly.) Picture-naming in the second language (Figure 3a) should take longer than translating (Figure 3b) because there are two extra steps, retrieving the concept and retrieving the L1 word. These are the same two steps that account for the 200- to 300-

millisecond disparity between first-language naming time for pictures and written words, as diagrammed in Figure 1. Thus, a prediction of the word association model is that a second-language response to a picture will take longer—perhaps 200- to 300 milliseconds longer—than the same response to a first-language word.

The concept mediation model claims that the stages leading to an L2 response are similar for picture-naming and translation (Table 1 and Figures 3c and d). The last two steps are identical in the two tasks, but the first two, although similar, are not identical (concept retrieval is based in one case on image recognition, and in the other case on word recognition). To make a prediction about relative time to perform the two tasks, one needs some evidence about the durations of these two stages. One measure of the first stage, recognition of the picture or word, is duration threshold. Duration threshold as used here is the duration for which a stimulus must be displayed (prior to a visual mask) in order to achieve a 50% probability of recognition. Potter and Faulstich (1975) found that the duration thresholds for pictures and English words like those used in the present experiments were almost identical, for English-speaking subjects. Thus, we can assume provisionally that the duration of the recognition stage is the same for these pictures and words.

As for the second stage, concept retrieval from the image system could well take a longer or shorter time than concept retrieval from the lexical system. If the first stage has been equated as indicated, then the latencies in the category-matching task described earlier allow one to estimate the difference in concept-retrieval time, because all the subsequent steps of category-matching and response are identical (see Figure 1). Potter and Faulstich (1975) obtained a 50-millisecond advantage for pictures over words in the category-matching task, which they interpreted as indicating

TABLE 1
TWO HYPOTHESES ABOUT THE PROCESSING SEQUENCE LEADING TO PRODUCTION OF A SECOND-LANGUAGE WORD
IN RESPONSE TO A PICTURE OR FIRST-LANGUAGE WORD (SEE FIGURE 3)

Word association model		Concept mediation model	
(a)	(b)	(c)	(d)
Picture-naming	Translating	Picture-naming	Translating
(1) Recognize image ↓ (2) Retrieve concept ↓ (3) Retrieve L1 word ↓ (4) Retrieve L2 word ↓ (5) Say L2 word	(1) Recognize L1 word ↓ (2) Retrieve L2 word ↓ (3) Say L2 word	(1) Recognize image ↓ (2) Retrieve concept ↓ (3) Retrieve L2 word ↓ (4) Say L2 word	(1) Recognize L1 word ↓ (2) Retrieve concept ↓ (3) Retrieve L2 word ↓ (4) Say L2 word

that concept retrieval is about 50 milliseconds faster for pictures.¹ In any case, even without equating stimulus types for ease of pattern recognition, one can use the categorization task as an independent measure of the overall difference between pictures and words in the first two stages, together.

In summary, the word association model predicts that translating into L2 from L1 will take substantially less time than picture-naming in L2, for essentially the same reason that naming (reading aloud) a word in L1 takes less time than naming a picture in L1. The concept mediation model predicts little or no difference between pictures and L1 words when the task is to produce L2; the size and direction of the difference (if any) should be consistent with the difference found in the categorization task.

¹ A picture advantage has been reported in a number of other category-matching experiments (Hogaboam & Pellegrino, 1978; Pellegrino, Rosinski, Chesi, & Siegel, 1977; Rosch, 1975; Magee, 1982) as well as in other tasks that require a conceptual response to pictures and words (Banks & Flora, 1977; Pavio, 1975; Porter 1979; Porter, Valian, & Faulcoer, 1977). The picture advantage is not always found (Pavio & Linde, 1980; Smith & Magee, 1980; te Linde, 1982) and varies in magnitude from study to study; a full discussion of these inconsistencies is beyond the scope of this paper.

were from a set used by Potter and Faulcoer (1975). (We will use the term *item* to refer to a given concept regardless of whether it was presented as a picture, English word, or Chinese character. The latter we call *item types*.) The 96 items were members of 29 superordinate categories including food, clothing, animals, household equipment, and the like. An additional 24 items were used for practice, and 30 further items were used in threshold measurement. A mask of lines and letter fragments with a small fixation cross was used in all conditions. The Chinese names consisted of one or two characters; the two-character names were written vertically. All the items had unambiguous and familiar names in both languages and were appropriately illustrated by the picture, as judged by a native Chinese speaker.

Design and procedure. The 96 experimental items were presented in the same order to all subjects, in six blocks of 16 items. The type of item presented in each block—picture, Chinese word, or English word—was counterbalanced across subjects. Each subject saw one block of each type in the first half of the experiment and a second block of each type in the second half. No item was ever repeated in any form. The stimuli were presented for 250 milliseconds, preceded and followed by the mask and fixation point described earlier. Blocks of 16 items of one stimulus type were preceded by 4 practice items of the same type.

Group 1 named or translated the items; for one block of each type of stimulus, the response language was Chinese; for the other block, it was English. The order of stimulus types and response language was counterbalanced so that each item appeared twice in each of the six conditions across the 12 subjects.

Group 2 saw the same items, but the task was to match the item to a superordinate category named by the experimenter 500 milliseconds before the item was presented. The subject responded by saying *yes* or *no* or the Chinese equivalent; half the items in

each block matched the named category. For half the blocks, the language of the category name and the response was English, and for the other half it was Chinese. Thus, the language of the category name and response only matched that of the written words on half the word blocks. All factors—type of stimulus, positive or negative match, and language of the category name and response—were counterbalanced across items and subjects.

After completion of the main part of the experiment, subjects in each group were given a threshold test of 30 new items. Each subject saw a block of 10 items of each type, two of which were practice. Half the items were presented for 45 milliseconds and half for 75 milliseconds, preceded and followed by the mask. The three item types and the two durations were counterbalanced across subjects and items. The task was to name the item; the measure was accuracy of report.

Finally, subjects were unexpectedly asked to recall the items used in the experiment. They were given 5 minutes to write down the names in any order (and in any language). Only recall of the 96 items in the main experiment was scored.

Results and Discussion

The theoretically significant results concern naming a picture in L2 (English, in this case) and translating an L1 word (Chinese) into L2 (English), as contrasted with naming a picture or an L1 word in L1. As shown in Figure 4, there was a marked interaction between stimulus type and the language of response. Whereas in L1 (dashed line) picture-naming was as usual much slower—305 milliseconds slower—than word-naming, in L2 (solid line) pictures were named slightly (but not significantly) faster than L1 words were translated into L2. This is the pattern of results predicated by the concept mediation model.

The mean time for a correct response in each of these conditions for each subject (F_1) or each item (F_2) was entered into anal-

Method
Subjects. The subjects in Experiment 1 were 24 college-age bilinguals whose first language was Chinese and whose second was English. All had lived, during childhood, in Cantonese-speaking countries; they had learned English as a second language in school and had lived and studied in an English-speaking country for one or more years. All were attending or had attended college in the Boston area, but they had continued to read and speak both Chinese and English regularly. They were divided into two groups of 12 subjects each.

Equipment. A Gerbards two-channel mirror tachistoscope was used to present the stimuli; a voice key and clock timer were used to measure time between the onset of the stimulus and onset of the vocal response.

Materials. The stimuli were 96 line drawings of objects and their written names in Chinese and English.² About half the times

² The English stimuli are not directly relevant to the present hypotheses, but the main results for those stimuli are summarized at the end of the Results and Discussion section. English words were included to examine the separate question of whether alphabetic and logographic writing systems differ in relative speed of access to phonological and semantic information. That aspect of the results is discussed in Potter, So, Freedman, and Ng (Note 1).

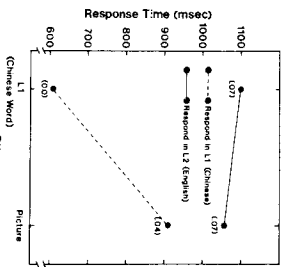


FIG. 4. Experiment 1: Response times in naming or translating Chinese words (L1) and pictured objects (error rates in parentheses).

yses of variance. Responses longer than a given subject's mean plus two standard deviations were replaced by the mean plus two standard deviations. There was a main effect of response language, $\min F(1,19) = 40.9, p < .001$, with Chinese faster than English. There was also an effect of stimulus type, with Chinese words faster than pictures, $\min F(1,44) = 12.5, p < .001$. Stimulus type and response language interacted, $\min F(1,28) = 23.7, p < .001$. A Newman-Keuls test showed that time to translate a Chinese word into English did not differ significantly from time to name a picture in English, but all the other differences were significant, $p < .01$. (The error results, shown in Figure 4, paralleled the reaction time results, although there were two few errors for statistical analysis.) The fact that pictures were named in Chinese significantly faster than in English (a difference of 147 milliseconds) suggests that these proficient bilinguals were nonetheless not quite as fluent in English as in Chinese.

Categoryization. The main purpose of the category-matching task performed by Group 2 was to assess the relative times for completing the recognition-plus-concept-retrieval steps, for pictures and Chinese words. The response times and error rates of Group 2 are shown in Table 2. The main effect of stimulus type was marginally significant, $F(1,11) = 4.76, p < .06; F_2(1,95)$

TABLE 2

EXPERIMENT 1: RESPONSE TIME TO MATCH A CHINESE WORD OR PICTURED OBJECT TO A SUPERORDINATE CATEGORY

Response language	Response	Stimulus ^a	
		Chinese word	Picture
Chinese (L1)	Yes ^b	658 (.03)	665 (.03)
	No	680 (.03)	632 (.00)
	Mean	669 (.03)	649 (.02)
English (L2)	Yes	684 (.03)	623 (.05)
	No	670 (.02)	636 (.01)
	Mean	677 (.03)	629 (.03)

^a Proportions of errors are in parentheses.

^b The response was in Chinese.

$= 10.3, p < .01$, with the response to pictures 34 milliseconds faster than that to Chinese words. This result is consistent with previous evidence that pictures are recognized and understood as rapidly or slightly more rapidly than written English words.

There was no main effect of response type (positive or negative) or response language (which was also the language used by the experimenter to specify the superordinate category on each trial), all F 's less than 1. There was, however, a triple interaction among stimulus type, response language, and positive versus negative response, $F(1,11) = 8.32, p < .05; F_3(1,95) = 4.41, p < .05$. Inspection of Table 2 shows that responses to pictures were faster than those to words except for positive responses in Chinese (we have no explanation for that result). It may seem surprising that it mattered little which language was used in the category-matching task, even when the items to be matched were Chinese words. The result is consistent, however, with the concept-based model shown in Figure 1, in which the match is between two language-free conceptual representations rather than within one or the other language.^{3,4}

³ Caramazza and Brone (1980) had Spanish-English bilinguals categorize words in same-language and mixed-language conditions, and found little or no difference, even when advance translation of the category name was precluded.

TABLE 3
EXPERIMENT 1: PROPORTION OF TRIALS ON WHICH THE STIMULUS WAS CORRECTLY IDENTIFIED IN THE THRESHOLD TASK

Exposure duration	Stimulus		
	Chinese word	Picture	Mean
45 milliseconds	.56	.33	.45
75 milliseconds	.89	.66	.77
Mean	.72	.50	

Threshold measures. The purpose of the threshold measures was to assess possible differences in the recognition time for pictures and Chinese words, among the subjects of Experiment 1. The results for all 24 subjects are shown in Table 3. An analysis of variance showed no significant difference between the naming and categorization groups, $F(1,22) = 1.20$; more accurate report for stimuli presented for 75 milliseconds than for 45 milliseconds, $F(1,22) = 54.1, p < .01$; and more accurate report of Chinese words than pictures, $F(1,22) = 15.6, p < .01$. None of the interactions was significant; group \times exposure duration, $F(1,22) = 3.60, p = .07$; group \times type of stimulus, $F(1,22) = 2.61, p = .12$; type \times duration, $F < 1$; group \times duration \times type, $F(1,22) = 2.65, p = .12$. Linear interpolation gives a 50% threshold of 39 milliseconds for Chinese words and 61 milliseconds for pictures.

Although it is questionable whether one should take these threshold durations as direct estimates of the mean duration of stage one (recognition), they do give an idea of the magnitude of the difference between the two stimulus types: pictures had a 22-millisecond disadvantage. Since the theoretically interesting comparison between the

times to process pictures and words concerns the stages after pattern recognition (see Figures 1-3), it might be appropriate to adjust the response time results for the threshold difference. How would that affect the conclusions already reached?

The picture advantage in L2 naming versus translation into L2, which was a nonsignificant 39 milliseconds (Figure 4), would be increased to 61 milliseconds. Similarly, the marginally significant 34-millisecond picture advantage over Chinese words would be increased to 56 milliseconds. The magnitude of the picture advantage would then be very close to that obtained by Potter and Faulconer (1975) for English words and pictures equated in threshold. These adjusted data are consistent with the concept mediation model.

Recall. The free-recall results for both groups are shown in Table 4. For the naming group, there was a main effect of stimulus type, $F(2,22) = 3.97, p < .05$, no main effect of response language, $F < 1$, and an interaction between stimulus type and response language, $F(2,22) = 8.33, p < .01$.⁵ A Newman-Keuls test showed that recall of Chinese words named in Chinese was significantly poorer than recall in the other three conditions. This pattern of results is what the concept mediation model would predict, if conceptual retrieval implies greater depth of processing than does lexical retrieval (see Durno & Johnson, 1980, and Smith & Magee, 1980, for similar results).

In a separate analysis of the categorizing group, there was a significant effect of stimulus type, $F(2,22) = 5.72, p < .01$, with pictures recalled significantly more often than Chinese words. There was also a marked advantage in recall of positive items (.32) over negative items (.12), $F(1,11) = 58.6, p < .01$, as has been noted by numerous previous investigators: when the superordinate category matches the items. The recall analyses included recall of English words as well as Chinese words and pictures (see footnote 2).

TABLE 4
EXPERIMENT 1: PROPORTION OF ITEMS RECALLED IN EACH CONDITION

Response language	Response	Chinese word	Picture
Group 1 (naming/translating)			
Chinese (L1)		.16	.32
English (L2)		.31	.30
Group 2 (category matching)			
Chinese (L1)	Yes ^a	.31	.41
	No	.08	.19
English (L2)	Mean	.20	.30
	No	.22	.35
	Mean	.07	.18
	Mean	.15	.27

^a The response was in Chinese.

stimulus, a more memorable unit is evidently formed. This effect did not interact significantly with stimulus type, $F < 1$, or with the language of the category name and response, $F(1, 11) = 3.20$, $p = .10$, reinforcing the assumption that the conceptual representation that enters into the matching process is independent of the mode of input and response (as in the model of Figure 1). The main effect of response language was not significant, $F(1, 11) = 3.10$, $p = .11$. No other interactions were significant, F 's < 1 .

The concept mediation model predicts that picture-naming, translation, and category-matching all require concept retrieval, and so all should result in better subsequent recall than simple lexical retrieval in word-naming. Inspection of Table 4 shows that prediction to be a generally accurate characterization of the results, although there was clearly a picture advantage in addition to the predicted concept-retrieval effects and the yes-no differences already alluded to. Paivio and Lambert (1981) used a task like that of the present naming-translation group, with subjects who were balanced in English-French bilinguals, and obtained a similar pattern of recall results. They interpret the results as supporting the dual-coding hypothesis, extended to include each language as a separate code, with the image code as a superior code. This explanation gives a satisfactory alternative account of the recall results. For incidental recall, both the depth of processing elicited

by the task and the surface form of the stimulus seem to be important.

English stimuli. Results for the English stimulus words have not been reported until this point because they are not directly relevant to the contrasted hypotheses (see footnote 2). They were, however, consistent with the concept mediation hypothesis, given that English words were more difficult for these subjects to recognize than pictures or Chinese words. In the threshold test, English words were less accurately reported than either pictures or Chinese words, $p < .01$. At the 45-millisecond duration, .10 of the English words was reported; at 75 milliseconds, .43. Linear extrapolation gives a 50% threshold of 83 milliseconds. (For native English speakers, these English words had approximately the same threshold as the pictures: Potter & Faulconer, 1975.)

The main results of the other conditions were these: Naming the word in English took 744 milliseconds (with .03 errors), which was 135 milliseconds slower, $p < .01$, than naming a Chinese word in Chinese. This difference, which is similar in magnitude to the 147-millisecond difference between naming a picture in English and in Chinese, is a further indication that these bilinguals were somewhat more fluent in Chinese than in English. Translating English words into Chinese took 1079 milliseconds (.07 errors), which is in the range of the other concept-mediated tasks.

Chinese-to-English translation and picture naming. Categorization responses to English words took 736 milliseconds, 80 milliseconds longer than to Chinese words or pictures, $p < .01$. Again, there was no interaction between language of the stimulus and language of the response.

English words named in English were recalled as poorly as Chinese words named in Chinese (.16), and English words named in Chinese were intermediate in recall (.22), between those two conditions on the one hand and the picture-naming and Chinese-to-English conditions on the other. In the category-matching task the corresponding recall proportions were .20 and .23, intermediate between Chinese words (.17) and pictures (.28) and not significantly different from either.

Summary and Conclusions from Experiment 1

For the proficient bilinguals of Experiment 1, the concept mediation hypothesis (Figures 3c and d) correctly predicted that it would take no longer to name a picture in the second language than to translate a written first-language word into the second language. Naming latency in the first language was used as a baseline to assess the time to retrieve the first-language lexical entry, given a written word or picture. As in previous experiments using English words, written Chinese words were named around 305 milliseconds faster than pictures. Contrary to the word association hypothesis, this word advantage in retrieval of L1 did not result in a corresponding advantage in retrieval of L2: a picture was named in L2 slightly *faster* than an L1 word was named in L2.

The results of the category-matching condition verified the assumption of the concept mediation model that the concept of a given object is retrieved at least as rapidly from a picture as from a written L1 word. The 34-millisecond advantage of pictures, in categorization, was close to the (nonsignificant) 39-millisecond picture ad-

vantage as a stimulus for L2 retrieval, just as the concept mediation hypothesis predicts. Threshold measures for the various stimuli indicated that the results were not artifacts of differential discriminability of the stimuli. Finally, the recall results were generally consistent with the claims of the concept mediation model.

An alternative theory not yet considered is that there are two representational systems, verbal and imagistic, but no abstract conceptual system (Paivio, 1971). Paivio and Desrochers (1980) propose that a second language forms a second verbal representation, which has associations between translation equivalents and between each language and the image system. In terms of the model shown in Figure 2, the conceptual system corresponds to the Paivio and Desrochers *imagen*, and both the word association link and the concept (image) links are assumed. A full discussion of the arguments against the dual-coding model is beyond the scope of this paper (but see Potter, 1979). As to the bilingual version, Experiment 1 offered no evidence for the putative association between translation equivalents, in proficient bilinguals.

EXPERIMENT 2

The proficient bilinguals of Experiment 1 gave no evidence of direct word associations between their two languages; instead, translation from the first to the second language appeared to take place via the underlying concept common to the two surface vocabularies. Would that be equally true for nonfluent bilinguals, or would they be more reliant on word associations? As one author puts it: "at lower levels of second language proficiency, [bilinguals] must operate in the second language largely through first language mediation (i.e., by translating first language 'thoughts' into the second language)" (Gekoski, 1980, p. 432). In Experiment 2 we looked at such a nonfluent group. In this case, the first language was English and the second language was French.

Method

Subjects. The volunteer subjects were 28 American high school students who had studied French in school for 2 or 3 years. They were gathered for a few days of orientation prior to spending the summer in France.

Materials. The materials were 96 pictures and their written English names. The items overlapped with those used in Experiment 1, but were selected to have French names we thought would be familiar to relative novices.

Design and procedure. The procedure was similar to that of the naming group in Experiment 1, with the following differences. There were four blocks of 24 trials, each preceded by two practice trials. Two blocks consisted of pictures and two of English words; for two blocks (crossed with stimulus type) the response was in English and for the other two blocks, in French. Thus, the four conditions corresponded to the four main conditions of Experiment 1's naming group, the conditions shown in Figure 4. The order of the 96 items was constant, but the stimulus type (picture or English word) and response language were counterbalanced across subjects and blocks of items, so that each item was presented to seven subjects in each of the four conditions. A given subject saw a particular item only once. Each item was presented for 350 milliseconds, preceded and followed by the mask used in Experiment 1. The subject was instructed to respond as rapidly as possible. After the experiment, a counter-balanced subgroup of eight subjects was unexpectedly asked to recall all the items they could remember, in any order and any language.

Results and Discussion

Exclusion of unfamiliar items. The overall error rate for French naming was .35, and for English naming, .06. Because we had no reliable advance information about the familiarity of the French names

of the 96 items used in the experiment, we planned to discard items which fewer than half the subjects could name correctly in French. The items that failed to meet that criterion were dropped from all four conditions, English as well as French naming. Twenty-five items were eliminated on this basis, plus 7 items randomly selected to equalize the number of items in each block. That left 16 items in each of the four blocks. (For the 32 excluded items, the error rate in French naming was .68 for pictures and .63 for English word stimuli).

Response times. Correct responses longer than the mean plus two standard deviations for a given subject and condition were replaced by that score (about 5% of the correct responses). A subject's mean time for correct responses in each of the four conditions was then obtained and used in the subject analysis (F_2): the item analysis (F_2) was based on the means of the correct responses to each item in each condition. The significant main effects of response language, $\min F(1,67) = 230.1, p < .01$, and stimulus type, $\min F(1,87) = 13.7, p < .01$, were qualified by a significant interaction, $\min F(1,80) = 40.9, p < .01$. This interaction is shown in Figure 5, which may be compared with Figure 4 (Experiment 1). A Newman-Keuls test showed a significant ($p < .05$) 56 millisecond advantage in naming a picture in French, compared with translating an English word into French. The other differences were all significant at $p < .01$.

Errors. The error rates on the included items are shown in Figure 5. An analysis of variance showed that there were fewer errors when the response was in English (.03) than in French (.19), $F(1,27) = 46.7, p < .01$, but no difference between picture and word stimuli, $F < 1$. There was an interaction between response language and stimulus type, $F(1,27) = 8.19, p < .01$, with fewer errors for English words named in English than for pictures named in English, $p < .05$, fewer errors when the response was in English than in French, $p < .01$, and

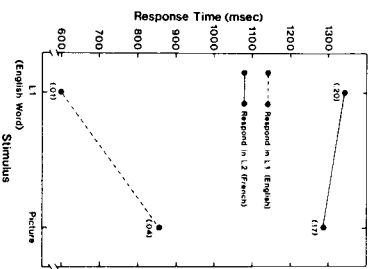


FIG. 5. Experiment 2: Response times in naming or translating English words (L1) and pictured objects (error rates in parentheses).

no difference between the two French conditions.

Recall. Recall results were only available for eight subjects, who formed a counter-balanced set. Recall was scored only for items the subject had named or translated correctly; the proportion of those items recalled in each condition is shown in Table 5. The results may be compared with those of Experiment 1's Group 1 (Table 4). An analysis of variance showed significant main effects of stimulus type, $F(1,7) = 26.2, p < .01$, and response language, $F(1,7) = 8.97, p < .05$, and an interaction, $F(1,7) = 7.1, p < .05$. A Newman-Keuls test showed that recall of English words named in English was significantly worse than the other three conditions, $p < .01$, but the other three conditions did not differ.

TABLE 5
EXPERIMENT 5: PROPORTION OF ITEMS RECALLED IN EACH CONDITION (NAMING OR TRANSLATING)

Response language	English word	Picture
English (L1)	.02	.31
French (L2)	.30	.39

Note. Recall is conditional on correct response to that item; $N = 8$.

This result is consistent with that of Experiment 1, although the very poor recall of English words named in English is surprising.

We instructed subjects to recall in whatever language came to mind; it is of interest that in all conditions (except English words named in English, which were rarely recalled) there was a substantial proportion of recalls in each language. The most interesting case is for named pictures, when only one language, the response language, was involved. Here, recall after French naming was in English 49% of the time; conversely, after English naming, recall was in French 34% of the time. This suggests that initial recall was usually of the underlying concept, not the surface form of the response. Note that since we did not instruct subjects to report the language they had used in responding, the recall language is only suggestive of uncertainty about the response language. We did ask subjects, at the end of recall, to indicate which items had been presented as pictures and which as words; there were only 10% errors, and half of these were made by one of the eight subjects. This ability to retain the surface form of a stimulus is consistent with previous observations (e.g., Potter et al., 1977; Snodgrass & McClure, 1975).

The recall results once more support the assumption of the concept mediation hypothesis that both translation from one language to another and picture-naming require concept mediation, whereas straight word-naming does not.

Conclusions from Experiment 2

The main finding, shown in Figure 5, paralleled that of Experiment 1: subjects named pictures in L2 (here, French) faster by 56 milliseconds than they translated an L1 word there, English) into L2. As in Experiment 1 and in earlier studies, they named L1 words in L1 much faster (257 milliseconds faster) than they named pictures in L1. The results indicate that the nonfluent bilinguals translate from their na-

tive language into the new language via the underlying common concept, not by using a direct association between L1 and L2.

GENERAL DISCUSSION

As expected, the bilinguals of Experiment 2 were clearly less proficient in their second language than the bilinguals of Experiment 1 (compare Figures 4 and 5). Before exclusion of difficult items, the subjects of Experiment 2 made .35 errors in naming or translating into L2, compared to .07 errors for the proficient bilinguals of Experiment 1. Yet, both groups showed the same *relative* difficulty in responding to a picture versus a first-language word when the task was to produce the appropriate second-language word. In both groups there was a slight picture advantage (not significant in Experiment 1 and marginally significant in Experiment 2).

This outcome is just what is predicted by the concept mediation hypothesis, but it is difficult to reconcile with the word association hypothesis (or Paivio & Desrocher's (1980) model). The word association model would predict a more rapid response to a first-language word than to a picture, especially among nonfluent bilinguals such as those in Experiment 2. If, for example, a person had learned *drapeau* only as an associate to *flag*, it would be necessary to name the picture of a flag in English (correctly) before the French word could be activated. In that case, the slower English naming latency for pictures versus words, 257 milliseconds in the present experiment, might be expected to be found in the French responses also. As already stated, however, subjects produced the appropriate French word *more* rapidly in response to a picture than to an English word.

In Experiment 1 there was an independent measure of time to understand each of the stimulus types, using a category-matching task. Pictures were understood slightly faster than Chinese words, which fits with the slightly faster L2 response to

pictures than to L1 words. Both tasks, according to the concept mediation model, require retrieval of the concept common to words and pictures, followed by task-specific processing that is identical whether the input has been a word or a picture.

In Experiment 2, there was no categorization group. Potter and Faulconer (1975), who used a partially overlapping stimulus set with English-speaking subjects, found that pictures were categorized 50 milliseconds faster than words (the same words were named 260 milliseconds faster than pictures, compared to the 257-millisecond difference in Experiment 2). This agrees roughly with the observed magnitude of the picture advantage (56 milliseconds) in triggering a second-language word, in the present Experiment 2.

Comparability of Subjects in Experiments 1 and 2

The subjects in the two experiments differed not only in second-language proficiency, but also in first language (Chinese, English), second language (English, French), age of initial acquisition of L2 (grade school, high school), and age at testing (college, high school, respectively). One might reasonably ask whether any of these other differences could have artifactually produced the similar small advantage shown by the novices and proficient bilinguals in responding to pictures versus L1 words, a result that indicates that neither group made use of direct L1-to-L2 associations. The differences between the two groups would, if anything, have increased the likelihood of finding more lexical associations between translation equivalents in the novice group. English is closer to French than to Chinese in orthography and phonology. Later acquisition would presumably increase dependence of L2 on L1, and so on. Thus, it is unlikely that the similarity of the critical result in the two experiments is spurious. Moreover, we tested five advanced English-French bilinguals in

the course of plotting and carrying out Experiment 2, three of them on the final 96 stimuli and two on a partially overlapping set of materials. They took 551 milliseconds to name English words in English and 825 milliseconds to name pictures in English, a word advantage of 274 milliseconds. Translating an English word into French took 1044 milliseconds; naming a picture in French, 997 milliseconds. This picture advantage of 47 milliseconds was similar to that observed in the novice subjects, even though the absolute latencies were much shorter in the advanced bilinguals.

Word-Naming

In these experiments, naming latency in L1 was used as a baseline to assess time to retrieve an L1 word from two types of stimuli: a written L1 word and a picture. As found here and in earlier work, written words are named (read aloud) very rapidly. It might be argued that that result simply means that "pronunciation" is a special process that does not even require lexical retrieval. In English that argument is somewhat plausible, inasmuch as we can name aloud regularly spelled nonwords such as *mafer*. Even so, there are strong reasons for believing that lexical retrieval guides pronunciation, even in English (e.g., Friesen & Kroll, 1976).⁶

In Chinese, it is plainly necessary that written words be recognized before they can be named. Characters do not follow graphemic-to-phonemic rules, but must be memorized individually. (Even though there is often a part of the character that gives a suggestion that the word sounds like some other word, this cue is not sufficient to allow correct pronunciation of an unfamiliar character.) Hence the word advantage (over pictures) in naming does reflect

a difference in time required to access the lexical entry.

There is still the question of *why* the lexical entry for a word is retrieved so rapidly, compared to the name of a picture. A likely explanation is that a reader must retrieve a word's lexical entry in order to understand it, while objects (or pictures of objects) are probably not named spontaneously in everyday interactions, because they can be understood conceptually, without retrieving a lexical entry.

One versus Two Semantic

Representations

The two hypotheses considered here have both made the assumption that a single conceptual representation is shared by words that are translation equivalents in two different languages. That assumption is consistent with the results of some experiments (e.g., MacLeod, 1976; Meyer & Ruddy, Note 3; Wolf, McCloskey, & Glucksberg, Note 4; see a review by McCormack, 1977), although others have argued in favor of distinct representations of meaning (Kolers, 1963; Kolers & Paradis, 1980). The present results are relevant to the debate about one or two semantic representations in that they indicate that if there is a single representation, it is one shared also by a picture of the referent. That is, the representation that translation equivalents share is not an abstract *linguistic* entity, but rather a conceptual representation.

It has been asserted, in support of the separate-representations claim, that corresponding words in two languages often have somewhat different meanings (e.g., Kolers, 1963). That may be true, especially if one include a word's connotations. For words naming concrete objects, however, the core meaning is more likely to be the same across languages (Taylor, 1976) and between a word and a picture. Furthermore, the materials of the present experi-

⁶ In the still more regular orthography of Serbo-Croatian, one of us has shown that phonological recoding and naming may precede lexical access (Feldman & Turvey, 1983; Feldman, Note 2).

ments were chosen to avoid obvious differences of meaning. Thus the present hypothesis about how translation takes place concerns cases in which there is a single unambiguously equivalent word in the other language. How translators deal with words that do not meet that criterion is a different question. A further issue not addressed by the present models is how the bilingual speaker preferentially accesses one language, in production. That the process is complex is suggested by studies of bilingual aphasics (e.g., Paradis, Goldblum, & Abidi, 1982).

Why, if the concept mediation model is correct, does the word association hypothesis accord with the intuitions of bilinguals whose second language is weak? They have the impression that when they try to name a picture, the first-language word spontaneously comes into awareness and seems to assist recall of the second-language word. A look at Figure 5 shows why people might become aware of the first-language word first, if the two words are retrieved in parallel, since the first-language word has a 431-millisecond advantage. Nonetheless, the pattern of results indicates that the "helping" impression is an illusion. If there were such help, the written L1 word should be a better stimulus than the picture, in this task. It remains to be seen whether there is a stage at the very beginning of second-language learning (before the equivalent of 2 years of high school study) in which direct word associates do play a role in second-language retrieval.

Surface and Underlying Representations

In summary, the results from the two experiments offer no support for the hypothesis that words of a second language are directly associated to corresponding words in the first language, even in nonfluent bilinguals. Rather, words in the two vocabularies are directly associated to concepts that are not linguistic, but amodal. Translation from a word in the first language to

the second language requires one to go through this amodal conceptual system—just as does picture naming. Hence, naming in a second language can be cued directly by pictures that have never been associated with the word. These relationships are embodied in the concept mediation model (Figures 2 and 3).

If the differences among a pictured object and its names in two languages are considered to be surface differences, then it is clear that such surface differences have a massive effect on response time when the task is to produce a spoken word in response to one or another surface form: naming (reading) the word aloud is far faster than translating or picture-naming. The inverse result is observed in incidental recall, with a higher rate of recall for the latter tasks. In contrast, when the task is conceptual or is mediated by a conceptual connection, response times and incidental recall are similar whether the stimuli are pictures or first-language words. That is, the surface difference between pictures and words virtually disappears, when the task is to translate or categorize them.

Scarborough, Gerard, and Cortese (1984) and Kirsner, Smith, Lockhart, King, and Jain (in press) have shown that repetition of a word in a different language has no beneficial effect on lexical decision unless translation occurs at the time of the first presentation. Similarly, Kroll and Potter (1984) found only a minimal effect of cross-modal repetition between pictures and words, in lexical and object decisions. Thus repetition effects, which persist over long lags, appear to be specific to surface forms. In contrast, Vandervort (1984) finds that lexical decisions are primed as effectively by a semantically related picture as by a word, and Kirsner et al. (in press) find that semantic priming occurs about as readily between as within languages. These semantic effects, which are restricted to temporally proximal items, evidently take place in the underlying conceptual representation common to pictures and words in

all one's languages. The pattern of results is consistent with the present evidence that languages come together on a common conceptual ground, not by means of direct associations between lexical pairs.

REFERENCES

- ANDERSON, J. R., & BOWER, G. H. *Human associative memory*. New York: Wiley, 1973.
- BANKS, W. P., & FLOKA, J. Semantic and perceptual processes in symbolic comparisons. *Journal of Experimental Psychology: Human Perception and Performance*, 1977, 3, 278-290.
- CARAMAZZA, A., & BRONES, I. Semantic classification by bilinguals. *Canadian Journal of Psychology*, 1980, 34, 77-81.
- CATTELL, J. M. The time it takes to see and name objects. *Mind*, 1886, 11, 63-65.
- DURSO, F. T., & JOHNSON, M. K. The effects of orienting tasks on recognition, recall, and modality confusion of pictures and words. *Journal of Verbal Learning and Verbal Behavior*, 1980, 19, 416-429.
- FELDMAN, L. B., & TURVEY, M. T. Word recognition in Serbo-Croatian is phonologically analytic. *Journal of Experimental Psychology: Human Perception and Performance*, 1983, 9, 288-298.
- FRANISE, P. Recognition time measured by verbal reaction to figures and words. *Perceptual and Motor Skills*, 1960, 11, 204.
- FREDERIKSEN, J. R., & KROLL, J. F. Spelling and sound: Approaches to the internal lexicon. *Journal of Experimental Psychology: Human Perception and Performance*, 1983, 9, 288-298.
- GEROSKI, W. L. Language acquisition context and language organization in bilinguals. *Journal of Psycholinguistic Research*, 1980, 9, 429-449.
- HODAROVA, T. W., & PELLEGRINO, J. W. Hunting for individual differences in cognitive processes: Verbal ability and semantic processing of pictures and words. *Memory & Cognition*, 1978, 6, 189-193.
- KIRSNER, K., SMITH, M. C., LOCKHART, R. S., KING, M. L., & JAIN, M. The bilingual lexicon: Language specific units in an integrated network. *Journal of Verbal Learning and Verbal Behavior*, in press.
- KOLES, P. A. Interlingual word associations. *Journal of Verbal Learning and Verbal Behavior*, 1963, 2, 291-300.
- KOLES, P. A., & PARADIS, M. Introduction to a special issue on psychological and linguistic studies of bilingualism. *Canadian Journal of Psychology*, 1980, 34, 287-303.
- KROLL, J. F., & POTTER, M. C. Recognizing words, pictures, and concepts: A comparison of lexical, object, and reality decisions. *Journal of Verbal Learning and Verbal Behavior*, 1984, 23, 39-66.
- MACLEOD, C. M. Bilingual episodic memory: Acquisition and forgetting. *Journal of Verbal Learning and Verbal Behavior*, 1976, 15, 347-364.
- MAGEE, L. E. *Pictures, words, and access to information*. Unpublished doctoral dissertation, University of Toronto, 1982.
- MCCORMACK, P. D. Bilingual linguistic memory: The independence—interdependence issue revisited. In P. A. Hornby (Ed.), *Bilingualism: Psychological, social, and educational implications*. New York: Academic Press, 1977.
- PAIVIO, A. *Imagery and verbal processes*. New York: Holt, Rinehart & Winston, 1971.
- PAIVIO, A. Perceptual comparisons through the mind's eye. *Memory & Cognition*, 1975, 3, 635-647.
- PAIVIO, A., & DESROCHERS, A. A dual-coding approach to bilingual memory. *Canadian Journal of Psychology*, 1980, 34, 388-399.
- PAIVIO, A., & LAMBERT, W. Dual coding and bilingual memory. *Journal of Verbal Learning and Verbal Behavior*, 1981, 20, 532-539.
- PAIVIO, A., & TE LINDT, J. Symbolic comparisons of objects on color attributes. *Journal of Experimental Psychology: Human Perception and Performance*, 1980, 6, 652-661.
- PARADIS, M., GOLDBLUM, M.-C., & ABIDI, R. Alternative antagonism with paradoxical translation behavior in two bilingual aphasic patients. *Brain and Language*, 1982, 15, 55-69.
- PELLEGRINO, J. W., ROSSINSKI, R. R., CHESE, H. L., & SIEGEL, A. Picture-word differences in decision latency: An analysis of single and dual memory models. *Memory & Cognition*, 1977, 5, 383-396.
- POTTER, M. C. Mundane symbolism: The relations among objects, names, and ideas. In N. R. Smith and M. B. Franklin (Eds.), *Symbolic functioning in childhood*. Hillsdale, N.J.: Erlbaum, 1979.
- POTTER, M. C., & FAULCONER, B. A. Time to understand pictures and words. *Nature (London)*, 1975, 253, 437-438.
- POTTER, M. C., VALLAN, V. V., & FAULCONER, B. A. Representation of a sentence and its pragmatic implications: Verbal, imagistic, or abstract? *Journal of Verbal Learning and Verbal Behavior*, 1977, 16, 1-12.
- ROSCH, E. Cognitive representations of semantic categories. *Journal of Experimental Psychology: General*, 1975, 104, 192-233.
- SCARBOROUGH, D. L., GIBKARD, L., & CORTSE, C. Independence of lexical access in bilingual word recognition. *Journal of Verbal Learning and Verbal Behavior*, 1984, 23, 84-99.
- SHANNON, B. Identification and classification of words and drawings in two languages. *Quarterly Journal of Experimental Psychology*, 1982, 34A, 135-152.
- SMITH, M. C., & MAGEE, L. E. Tracing the time course of picture-word processing. *Journal of Ex-*

perceptual Psychology: General, 1980, 109, 373-392.

REFERENCE NOTES

1. POTTER, M. C., SO, K.-F., FRIEDMAN, R., and NG, W.-F. *Reading in Chinese and English: Naming versus understanding*. In preparation.
 2. FELDMAN, L. B. *Word recognition in Serbo-Croatian is necessarily phonological* (Status Report on Speech Research, SR-66). New Haven, Conn., 1981.
 3. MEYER, D. E., and RUDDY, M. G. *Bilingual word-recognition: Organization and retrieval of alternative lexical codes*. Paper presented at the meeting of the Eastern Psychological Association, April 1974.
 4. WOLF, J., MCCLOSKEY, M., and GLUCKSBERG, S. *Shared versus separate memory systems: Bilingualism and picture-word processing*. Paper presented at the meeting of the American Psychological Association, Toronto, 1978.
- SNODGRASS, J. G. Towards a model for picture-word processing. In P. A. Kolars, M. E. Wrostad, and H. Bouma (Eds.), *Processing of visible language*. New York: Plenum, 1980, Vol. 2.
- SNODGRASS, J. G., & MCCURE, P. Storage and retrieval properties of dual codes for pictures and words in recognition memory. *Journal of Experimental Psychology: Human Learning and Memory*, 1975, 1, 521-529.
- TAYLOR, I. Similarity between French and English words—A factor to be considered in bilingual language behavior? *Journal of Psycholinguistic Research*, 1976, 5, 85-94.
- TE LINDE, J. Picture-word differences in decision latency: A test of common-coding assumptions. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 1982, 8, 584-598.
- VANDERWART, M. Priming by pictures in lexical decision. *Journal of Verbal Learning and Verbal Behavior*, 1984, 23, 67-83.

(Received June 22, 1982)