

**BILINGUAL MEMORY: SHARED OR  
SEPARATE SYSTEMS?**

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**CARMEN M. SANCHEZ DE HERRERA**

BILINGUAL MEMORY: SHARED OR SEPARATE SYSTEMS?

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An Abstract

Presented to

the Graduate and Research Council

Austin Peay State University

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In Partial Fulfillment

of the Requirements for the Degree

Master of Arts

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by

Carmen M. Sanchez de Herrera

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## ABSTRACT

The issue of whether bilinguals store information according to the meaning of the words (shared memory hypothesis) or according to the language in which the words were presented (separate memory hypothesis) was the basic concern of this research. Spanish-English bilinguals were shown sentences which they had to identify as true or false as quickly and accurately as they could. Some sentences were presented entirely in one language (either Spanish or English) while in others the languages were mixed. In the mixed language sentences, the number of times a language switched from the one language to the other was varied from one to three. The results indicated that it took the subjects longer to respond to mixed language sentences than to the unilingual sentences and that this difference increased as a function of the number of language switches. These findings appear to support the separate memory hypothesis. However, the possibility that both hypotheses are correct is discussed in the context of a broad theory of semantic memory.

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Carmen M. Sanchez de Herrera

December 1981

To the Graduate and Research Council:

I am submitting herewith a thesis written by Carmen M. Sanchez de Herrera entitled "Bilingual Memory: Shared or Separate Systems?" I recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Arts with a major in Psychology.

Charles R. Yush  
Major Professor

We have read this thesis and  
recommend its acceptance:

Linda Rudolph  
Minor Professor

Harland E. Blair  
Third Committee Member

Accepted for the Council:

William H. Ellis  
Dean of the Graduate School

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## Chapter 1

### INTRODUCTION

An interesting question related to how bilinguals process information is whether the meanings of words in both languages spoken by a bilingual are stored in a single-shared memory system or in two separate memory systems, one for each language. Kolers (1966a) suggests that bilingual speakers process words in terms of their meanings and represent them in a supra-linguistic code which is independent of the language in which the word occurred. In contrast, Macnamara and Kushnir (1971) suggest that there are two separate language-specific storage systems, one for each language. They believe that bilinguals store the meanings of words specifically in the language in which the word appears. The evidence concerning this issue has been contradictory; while much of it supports the separate memory hypothesis, perhaps even more supports the shared memory hypothesis. The purpose of this research is to obtain additional data concerning the issue.

Four different methodologies have been used to investigate this problem. Specifically, researchers have used free recall, word association, priming, and switching paradigms. The research involving each paradigm will be discussed separately.

#### Free Recall Experiments

In the free recall experiments, subjects are asked to study a list of words and then to recall these words in any order they wish. Kolers (1966a) used this paradigm with French-English bilinguals. His lists consisted of 20 English words and 20 French words. The number of times

a word was repeated within the list was varied from one to four times. On some lists the French words were simply the translated equivalents of the English words; on other lists the French and English words were unrelated. If words are stored in a single conceptual store as it has been suggested by the shared memory hypothesis, then presenting an equivalent word in the second language will be perceived as a repetition rather than as a different word and should facilitate recall. In contrast, if words are stored in two separate memory stores as proposed by the separate memory hypothesis, then presenting an equivalent word in the second language will be perceived as a different word rather than a repetition of the word and consequently should not facilitate recall. Kolers found that subjects have higher levels of recall with the bilingual list than with the unilingual list and that the proportion recalled increases approximately linearly with frequency of occurrence of the words within a list. Kolers concluded that "there appears to be an interlingual equivalence of items. This finding would suggest that even in unconnected lists, S stores items in terms of their semantic, not their morphemic properties" (p. 318).

Although similar results using the free recall paradigm are shown by Lambert, Ignatow and Krauthamer (1968), Glanzer and Duarte (1971), Liepmann and Saegert (1974) and Lopez and Young (1974), not all results using the free recall paradigm support the shared memory Hypothesis. Tulving and Colotla (1970) obtained results that support the separate memory hypothesis. In their experiment, they had French-English-Spanish trilingual subjects learn unilingual, bilingual and trilingual lists of words. Their finding showed that subjects' recall was higher with the unilingual list and lowest with the trilingual list. They used these

results to support the separate memory hypothesis on the premise that the presentation of bilingual and trilingual lists interferes with semantic organization. In contrast, the shared memory hypothesis claims these results would not be possible if words had been processed according to meaning alone.

### Word Association Experiments

In a word association task, subjects read a word and are asked to respond with the first word that comes to their mind. For instance, when given the word white, the majority of English speakers will respond with the word black. Kolers (1963) used this paradigm with subjects whose native language was German, Spanish or Thai and had English as a second language. Kolers reasoned that if the shared memory hypothesis was right, then the word given as an association in one language would be equivalent to the word given as an association in the other language because verbally defined experience would be tagged and stored in some supralinguistic form such as "thoughts" or "ideas." In contrast, if the separate memory hypothesis was right, then a word given as an association word in one language would not be necessarily equivalent to the word given as an association in the other language since experiences would be stored separately depending upon the language in which they occur. Kolers' results indicated that very few of the associations given by the subjects to a word presented in one language were the same as those given in response to the equivalent word presented in the other language. In other words, if a Spanish-English bilingual answered white in response to the English word black, it is unlikely that he would also answer with the Spanish equivalent to white (blanco) when shown the Spanish equivalent to black (negro). These results were interpreted to mean that "experiences

and memories of various kinds are not stored in common in some supra-linguistic form but are tagged and stored separately in the language S used to define the experience to himself" (p. 300). Macnamara (1967) used the same paradigm with Irish-English bilinguals and obtained results similar to those of Kolers. The same type of findings were obtained also by Taylor (1971).

### Priming Experiment

In a priming task, subjects typically are asked to classify an item according to a given category and the time take to classify the item is then recorded. One general finding is that when a word being classified (the target) has been preceded by a word from the same category (the prime), the classification usually is faster when the target and prime word are from the same category than when they are from different categories. The rationale behind this paradigm is based on the spreading activation theory of Collins and Loftus (1975). This theory suggests that when a stimulus is processed, its memory representaiton is activated and this activation spreads to similar concepts facilitating a rapid classification (e.g. activation of milk spreads to butter, cheese, ice cream, etc.).

Joan Wolf (1977) using the priming paradigm asked French-English bilinguals to determine if the 24 words presented from a list were related semantically. The words appeared in the same language (e.g. apple - pear) and in different languages (e.g. pomme - pear). Assuming there is one conceptual store for both languages, as has been suggested by the shared memory hypothesis, activation of a concept will spread to similar concepts regardless of language. Consequently, a prime word should produce a priming effect with semantically related targets

whether the prime word is presented in the same language or in a different language. In contrast, if we assume there are two separate memory stores activation would not be expected to spread from one language store to the other. Consequently, a prime word should produce a priming effect with semantically similar words only if the target word is in the same language. Wolf's results supported the shared memory hypothesis. Specifically, priming effects were obtained with semantically related words despite whether the prime and target were presented in the same or different languages.

### Switching Experiments

In switching experiments, subjects are given prose materials to read. In some instances, the materials are presented entirely in one language (unilingual conditions); in others it is switched from one language to the other, typically without warning to the subject (bilingual condition).

Using such a procedure, Kolers (1966b) obtained additional support for the shared memory hypothesis. In this experiment, Kolers had French-English bilinguals silently read paragraphs that were either entirely in one language (unilingual condition) or randomly alternated between languages (bilingual condition). Subjects were tested for their comprehension of the paragraphs. No significant difference was found in the amount of information obtained from the different types of paragraphs suggesting that subjects pay attention directly to the meanings of the words rather than the language in which the words are presented.

Macnamara and Kushnir (1971) in a series of experiments obtained results different from those obtained by Kolers (1966b). In their

first experiment, French-English bilinguals were asked to read silently unilingual and bilingual paragraphs indicating with a pointer the word they were reading. Reading time was measured and the results showed that subjects took longer to read bilingual paragraphs than unilingual paragraphs. In the second experiment, subjects were asked to verify the truthfulness of simple sentences. Some of the sentences were unilingual (either written in French or English); some had one switch, some two switches, and some three switches each (a switch refers to the change from one language to the other). It was found that more time was required to indicate if a sentence was true or false in the bilingual conditions, and the time increased as a function of the number of switches. The third experiment was similar to the second except that half of the switches were made predictable through color cues; that is, red was used for the French words and black for the English words. The other half of the switches were not predictable. Results showed that when subjects knew that a switch would occur, it took them longer to respond than when they could not predict a switch. The fourth experiment was similar to the second. In this case, however, the sentences were presented auditorily rather than visually. The results showed that subjects took longer to tell whether a sentence was true or false when the sentences had three switches, followed by two switches, and finally by one switch. Unilingual sentences were responded to faster than bilingual sentences. Macnamara and Kushnir (1971) argued that these results supported the separate memory hypothesis, for if what is stored is the meaning of the words as the shared memory hypothesis claims, then switching from one language to

the next should not influence the time required for processing. Conversely, their results indicated that when subjects are exposed to bilingual or mixed information, the processing of words belonging to different languages produces an increase in the time needed to respond to them. As Macnamara and Kushnir point out, "The most obvious conclusion from our results is that English and French formed psychologically distinct systems for our Ss. They took a measurable amount of time to pass from one to the other" (p. 485).

### The Problem

Since the evidence regarding bilingual memory has been so contradictory, with perhaps more research supporting the shared memory hypothesis, it would be useful to test both the replicability and generality of the research supporting the separate memory hypothesis. If the results which support the separate memory hypothesis could not be replicated or were found not to apply to other populations, then this would lend further support to the shared memory hypothesis. Alternatively, if the results were replicable and had generality, then they would lend further support to the separate memory hypothesis. Consequently, it was the purpose of this research to test the replicability and generality of some of these results. Specifically, this research replicated Macnamara and Kushnir's (1971) second experiment using Spanish-English bilinguals rather than French-English bilinguals.

## Chapter 2

### METHOD

#### Subjects

The subjects used in this research were 27 bilingual speakers (6 males and 21 females). Twenty-four of the subjects were enrolled at Austin Peay State University at the time the research was done. The remaining subjects were enrolled in the University the prior quarter. The subjects' ages ranged from 19 to 48 years with an average age of 27.7 years. All of the subjects had lived in an English-speaking country for at least one year with the exception of one subject who had lived in an English-speaking country for only half a year. This subject, however, had received 14 years of education in English. The average time spent in an English-speaking country was 14.0 years. Similarly, all of the subjects had lived in a Spanish-speaking country, with the exception of one subject who never had lived in a Spanish-speaking country. This subject, however, was majoring in Spanish and had taken Spanish as a subject for four years. The average time spent in a Spanish-speaking country was 14.4 years. The subjects rated their level of mastery for both Spanish and English from 1 to 5 with 1 being "very poor" and 5 being "very good." The average rating for English and Spanish mastery was 4.15 and 4.40 respectively. Fourteen of the subjects came from Puerto Rico. The remaining came from the United States (other than Puerto Rico), Panama, Ecuador, Honduras, Cuba, and Guatemala. The subjects each received \$5.00 for their participation.

### Design and Materials

In this experiment the primary variable of interest was sentence type. Five types of sentences were used: (a) all English (10 sentences); (b) all Spanish (10 sentences); (c) mixed sentences with one switch (10 sentences); (d) mixed sentences with two switches (10 sentences); and (e) mixed sentences with three switches (10 sentences). Here a switch refers to a change from one language to the second. Half of the sentences in each group were true and half were false with the exception of the sentences written in English and the sentences with three switches. Due to an error on the part of the experimenter, there were four true and six false sentences in the all English condition and six true and four false sentences in the three switches condition. The words used in the sentences were chosen from a pool of the three thousand most frequent words used in both languages (Eaton, 1961). All the sentences were 5-6 words in length and are presented in (Fig. 1).

The subjects in the experiment were divided into three different groups of nine subjects each on the basis of a balance score. The balance score for each subject was calculated by taking the positive difference between the subjects' self-rating of their Spanish competency and their self-rating of their English competency. A balance score close to 0 means that a subject was equally good in both languages. Higher scores mean that a subject was better in one language than in the other. To divide the subjects into the three groups, they were ranked according to their balance score. Subjects with the nine lowest scores were assigned to group I, those with the middle nine scores to group II and those with the highest nine scores to group III. All

## Figure 1

## Sentences Used in the Experiment

English Sentences

1. Birds fly through the air. (T)
2. Teeth grow on your finger. (F)
3. Every student has a car. (F)
4. All people have a name. (T)
5. Horses do not have hair. (F)
6. Some houses are colored white. (T)
7. Coal is a white material. (F)
8. Things are bought with money. (T)
9. Children are older than adults. (F)
10. Coins are made of wood. (F)

Spanish Sentences

1. Todas las personas hablan frances. (F)
2. Un circulo siempre es redondo. (T)
3. El sol calienta la tierra. (T)
4. Cafe es una comida solida. (F)
5. Doce cosas hacen una dozena. (T)
6. Los castillos son edificios modernos. (F)
7. El dia tiene veinticuatro horas. (T)
8. Las minas estan sobre el suelo. (F)
9. Algunos humanos hablan dos lenguages. (T)
10. Una persona hace una muchedumbre. (F)

Sentences With One Switch

1. Milk comes from a vaca. (T)
2. Los puentes son hechos de glass. (F)
3. Potatoes grow in the tierra. (T)
4. Some chairs have blue ojos. (F)
5. La lluvia viene del sky. (T)
6. People cook in the arboles. (F)
7. Los bebe pueden hablar al birth. (F)
8. Una planta es un bird. (F)
9. Schools are places to aprender. (T)
10. Una vaca tiene cuatro legs. (T)

Sentences With Two Switches

1. To sleep es not necessary. (F)
2. A semana has seven days. (T)
3. The periodicos are written yearly. (F)
4. The roca is a hard material. (T)
5. Food es cooked in roofs. (F)
6. All people tienen three arms. (F)
7. Some lions son wild animals. (T)
8. The sun es very hot. (T)
9. The aire is usually clear. (T)
10. Fires son started by rain. (F)

Sentences With Three Switches

1. Los fires son a big danger. (T)
2. Algunas women tienen long hair. (T)

3. Maiz and trigo are clothes. (F)
4. El sun es colored yellow. (T)
5. Algunos birds tiene two colors. (T)
6. Las persons usualmente sleep on beds. (T)
7. Un clock da the time. (T)
8. Los trains corren through the sea. (F)
9. El oro is un cheap metal. (F)
10. Es clear en the night. (F)

subjects in group I had a balance score of zero while subjects in group II had scores ranging from .25 to 1.0 with a mean of .667 and subjects in group III had scores ranging from 1.25 to 2.25 with a mean of 1.80.

The five sentence types, the truthfulness of a sentence (true vs false) and the three groups combined to yield a  $5 \times 2 \times 3$  mixed factor design. The sentence type and the truthfulness of a sentence were manipulated as within subjects variables and groups as a between subjects variable.

### Procedure

The experiment was conducted in two parts. In the first part, subjects were asked to fill out a short questionnaire in which general information such as sex, age, nationality, proficiency in both languages was requested (see Appendix A). In addition all the words that were used in this experiment were shown to each subject. This was done to insure that subjects knew the meaning of all the words. If a subject did not know the meaning of a word, it was explained to him/her at that time. The second part of the experiment was controlled by a Procesor Technology Sol Terminal computer which was programmed to present the sentences, record the time to respond, and record the type of response made (true vs false). Subjects were instructed to indicate if a sentence was true by pushing the key marked true and false by pushing the key marked false. They were told to respond as quickly as possible once a sentence was presented, but cautioned not to respond so quickly that they made errors. Each sentence appeared on the computer screen until the subject had responded. Once a subject had responded there was a five second interval that passed before the next sentence was presented. The sentences were

presented in a random order with the restriction that no more than three true or three false sentences were presented in a row. Six sentences were given as practice to familiarize the subject with the procedure before starting the actual experiment. Fourteen of the subjects operated the key marked true by the left index finger. For the remaining thirteen subjects, the key was operated by the right index finger.

## Chapter 3

### RESULTS

The number of erroneous responses was less than 4 percent. These errors were evenly distributed among the sentences of the experiment with the exception of the Spanish sentence Las minas estan sobre el suelo. Ten out of 27 subjects made errors on this sentence. This suggests that the sentence could not be easily identified as a false sentence; therefore, it was dropped from the analysis. In addition, all other erroneous responses were dropped from the analysis. Consequently, the analyses reported below are based on times for correct responses only.

Since the sentences used in this experiment were not structured according to the number of syllables in a sentence but according to how frequently the words in a sentence occurred in each language, a possibility exists that sentences in some conditions of the experiment had a significantly greater number of syllables. To avoid any possible confoundings involving the number of syllables in a sentence, the same corrective procedures used by Macnamara and Kushnir (1971) were used in the present analysis of the results. First, mean response time per syllable was calculated for the unilingual English and the unilingual Spanish sentences for each subject. Second, a prediction was made about how long it would take each subject to respond to each sentence by multiplying the response time per English syllable times the number of English syllables in the sentence and the response time per Spanish syllable times the number of Spanish syllables in the sentence and then

adding these two products. For example, in the unilingual English sentence Every student has a car there are seven English syllables and zero Spanish syllables. If a subject had reading times of 443 msec. per syllable in English and 257 msec. per syllable in Spanish, it would be predicted that the subject's reading time for that sentence would be  $(443 \text{ msec.} \times 7) + (257 \text{ msec.} \times 0) = 3.101 \text{ sec.}$  Similarly, the bilingual sentence Algunos birds tienen two colors has four English syllables and five Spanish syllables. The predicted time for this sentence would be  $(443 \text{ msec.} \times 4) + (257 \text{ msec.} \times 5) = 3.057 \text{ sec.}$  The predicted time for each sentence was then subtracted from the actual observed time. The difference between the observed times and the predicted times was analyzed.

Figure 2 presents the mean difference between observed and predicted times as a function of sentence type and truthfulness of the sentence. Several important aspects of the results should be noticed. First, Spanish sentences were responded to faster than predicted. Second, sentences with switches in them were responded to more slowly than was predicted. Third, this difference increased as a function of the number of switches. These conclusions are supported by the significant main effect of sentence type,  $F(4, 96) = 24.02, p < .001$ . Fourth, responses to true sentences were consistently faster than responses to false sentences with the exception of English sentences where false sentences were responded to faster than true sentences. This is supported by the significant interaction of sentence type  $\times$  truthfulness of the sentence,  $F(4, 96) = 13.25, p < .001$ . Finally, no significant effect of groups was found  $F(2, 24) < 1$ , nor were any of the other effects statistically significant (see Appendix B).

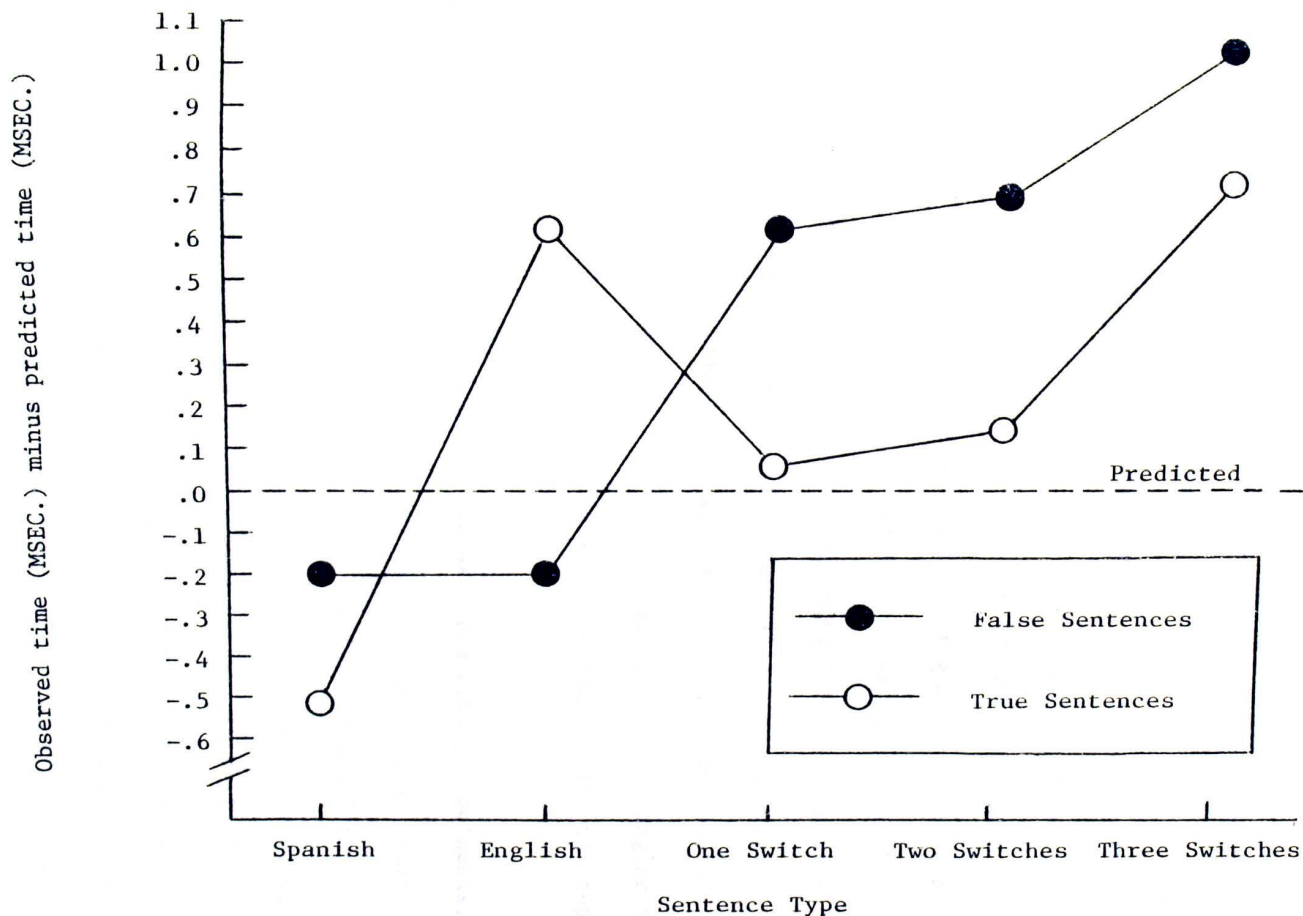


Figure 2. The mean difference between the observed response time and the predicted response time as a function of sentence type and the truthfulness of a sentence.

## Chapter 4

### DISCUSSION

In general, the findings of this experiment were similar to the results obtained by Macnamara and Kushnir (1971). The Spanish-English bilinguals that participated in this research took a longer time to respond to mixed language sentences than to the unilingual sentences. Furthermore, the time taken to respond increased as the number of switches increased. This suggests that both language systems are distinct. If what is stored is the meaning of the words, as the shared memory hypothesis claims, then switching from one language to the next should not influence the time required for processing. However, the results indicated that when subjects are exposed to bilingual or mixed information, the processing of words belonging to different languages produces an increase in the time needed to respond to them.

Although these results support the separate memory hypothesis, they do not reconcile the contradictory results obtained by other researchers. For example, Kolers (1966a) and Tulving and Colotla (1970) using the free recall paradigm obtained contradictory results. Kolers' results supported the shared memory hypothesis while Tulving and Colotla's results supported the separate memory hypothesis. Perhaps both hypotheses are right and not mutually exclusive as has been proposed. Lopez and Young (1974) suggested that the separate memory hypothesis can explain some aspects of language processing more appropriately while the shared memory hypothesis can better explain

other aspects.

The possibility that both hypotheses are correct to some extent can be explained more clearly if one looks at the issue in the context of a complete theory of semantic memory such as that proposed by Collins and Loftus (1975). According to this theory, memory is conceived of as consisting of two structures: a conceptual network which contains the meanings of concepts and a lexicon or "dictionary" which contains the words that represent these concepts. The conceptual network is organized according to the semantic similarity of the concepts. In contrast, the lexicon is organized according to the phonemic and orthographic similarity of the words. The words of the lexicon are linked also to their respective concepts in the conceptual network. The processing of linguistic input involves first identifying a word by locating it in the lexicon, and second determining its meaning by locating its concept in the conceptual network.

It is important to point out that Collins and Loftus' theory of semantic memory was not formulated to explain bilingual memory but can be extended to encompass bilingual memory. In extending their theory to bilinguals it can be assumed that bilinguals have two lexicons - one for each language. In this regard, this aspect of the theory is similar to the separate memory hypothesis. Also, if one accepts the notion of cognitive economy (c.f., Anderson and Bower, 1973; Conrad 1972), then it is reasonable to assume that both lexicons are linked to a common conceptual network. This aspect of the theory then is analogous to the shared memory hypothesis. Translations would occur in this theory by linking a word in one lexicon to the other via the

common conceptual network.

Whether support is found for the shared memory hypothesis as opposed to the separate memory hypothesis would depend upon the extent to which a task involves the lexicons and/or the conceptual network. For example, in the bilingual conditions of the switching experiments, the language in which the materials are presented switches from one language to the other. In the context of the extended theory of Collins and Loftus, this would imply that the subjects had to switch between lexicons whenever they encountered a language switch. When speed is the critical variable as in the present research and that of Macnamara and Kushnir (1971), switching lexicons should increase the time required to respond. When comprehension is involved (e.g., Kolers', 1966b), switching languages should not influence comprehension since both lexicons are linked to the same conceptual store.

Kolers' (1966a) free recall results also can be explained in terms of the extended version of Collins and Loftus' theory if it is reasonable to assume that successful free recall involves the meaningful processing of words (c.f., Craik and Lockhart, 1972). In the context of this theory (Collins and Loftus), meaningful processing would mean that concepts are being activated in the conceptual network. Consequently, it would make no difference in which language a word is presented since equivalent words presented in the two languages would activate the same concept. This should be functionally equivalent to a repetition of the same word; hence, recall would be facilitated when translated equivalents are presented.

Collins and Loftus' theory can also be used to explain Tulving and

Colotla, (1970). In this case, it could be assumed that one of the best strategies to organize information is based on the semantic classification of the words (use of the conceptual network). Since Tulving and Colotla used lists without any obvious semantic categorization, it is likely that subjects were focusing on the lexical differences between languages. The possibility exists then that subjects were attempting to use two competing organizational strategies, one based on information stored in the conceptual network and the other based on the use of the two lexicons. If this is an accurate conceptualization, then one would expect the two organizational strategies to interfere with each other and inhibit recall of the multilingual lists.

Joan Wolf's priming research is easily understood in the context of Collins and Loftus' theory since the logic of her research was based on their theory. Basically, one will expect priming effects, regardless of the language in which target and prime words were presented, because priming involves activation of meanings in the conceptual network.

It is also possible to explain the word association results obtained by Kolers (1963) using Collins and Loftus' theory. According to the theory, when a stimulus word is presented the word will be located in the appropriate lexicon. Its associated concepts then would be activated and this activation would spread to other similar concepts. The subject should respond with the word linked to the first concept activated by this spreading activation. Kolers' results initially might seem contradictory since he found that subjects gave different associates depending on the language used to present the stimulus word. If the same concepts were being activated, then one would expect the subject to

respond with equivalent words. However, it must be pointed out that there is not a strict one-to-one correspondence between words in different languages (Dalrymple-Alford and Aamiry, 1970). Therefore, a concept linked to a word in one language will not necessarily be linked to a word in the other language. To the extent that this kind of concept is activated by spreading activation, then one would not expect equivalent associates to be given when equivalent stimulus words are presented.

In summary, it seems that both hypotheses can be reconciled on the basis of Collins and Loftus theory of semantic memory. Rather than both hypotheses being mutually exclusive as they were originally proposed, a strong possibility exists that they are simply explaining different aspects of bilingual processing.

In addition to the basic findings of the experiment, there are a couple of other results that need to be discussed. One is the lack of influence of the group variable. It would seem reasonable to expect that people who are not really bilingual would have more difficulty in switching between languages than balanced bilinguals. In this regard, it is surprising that no difference was found between the most balanced and least balanced groups. One possible explanation for this is that bilingualism was not varied over a wide enough range. In recruiting bilingual speakers, a possibility exists that only subjects that were reasonably balanced bilinguals were tested. It might be expected that if bilingualism was manipulated over a wider range a different pattern of results would have been obtained. Another possibility is that the degree of bilingualism is not a very important variable.

This possibility has been supported by Macnamara (1967).

Another important finding worth noting is the interaction between sentence type and truthfulness of the sentences. Previous research (Rips, Shoben and Smith, 1973) has shown that true sentences typically are responded to faster than false sentences. This was true in the present experiment with the exception of the English sentences where false sentences were responded to faster than true sentences. This was not expected and may suggest that a unique characteristic of the English sentences used in this research was influencing the results. This problem makes it difficult to interpret the results obtained with the English sentences. An inspection of the English sentences, however, does not reveal any obvious difference with the rest of the sentences of the experiment. Perhaps this finding is simply an anomalous one. Regardless, this finding is difficult to explain and any further discussion without additional research would be premature.

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## APPENDICES

## Personal Background Questionnaire

## Form

1. General information: Age \_\_\_\_\_ Sex \_\_\_\_\_ Nationality \_\_\_\_\_
2. How do you rate yourself in mastering the English language in the following aspects:

Very poor   Poor   Average   Good   Very good

reading	_____	_____	_____	_____	_____
writing	_____	_____	_____	_____	_____
understanding	_____	_____	_____	_____	_____
speaking	_____	_____	_____	_____	_____

3. How do you rate yourself in mastering the Spanish language in the following aspects:

Very poor   Poor   Average   Good   Very good

reading	_____	_____	_____	_____	_____
writing	_____	_____	_____	_____	_____
understanding	_____	_____	_____	_____	_____
speaking	_____	_____	_____	_____	_____

4. How did you learn to speak English:

At home \_\_\_\_\_ At school \_\_\_\_\_

5. How did you learn to speak Spanish:

At home \_\_\_\_\_ At school \_\_\_\_\_

6. How long have you been living in an English-speaking country?

\_\_\_\_\_ years

7. How long have you been receiving educational instruction in English?

\_\_\_\_\_ years

8. How long did you live in a Spanish-speaking country?

\_\_\_\_\_ years

9. How long did you receive educational instruction in Spanish?

\_\_\_\_\_ years

Sentence Type x Truthfulness of the Sentences x Group  
Analysis of Variance

<u>Source</u>	<u>df</u>	<u>SS</u>	<u>MS</u>	<u>F</u>
Total	269	214.063	--	--
Between subjects	26	29.245	--	--
Groups (G)	2	.496	.248	.207
Error <sub>b</sub>	24	28.749	1.198	--
Within subjects	243	184.818	--	--
Truthfulness (T)	1	2.034	2.034	1.639
G x T	2	2.084	1.042	.840
Error <sub>1</sub>	24	29.775	1.241	--
Sentence type (S)	4	44.583	12.146	24.017*
G x S	8	2.681	.335	.662
Error <sub>2</sub>	96	48.549	.506	--
T x S	4	18.344	4.586	13.250*
G x T x S	8	3.541	.443	1.279
Error <sub>3</sub>	96	33.225	.346	--

\* $p < .001$

## Appendix C

Department of Psychology  
Austin Peay State University  
Informed Consent Statement

The purpose of this study is to obtain more knowledge about how bilinguals process information.

Participants in this study will remain anonymous. However, in order to have some statistical information about the participants, each will be asked their age, sex, and nationality. All the information collected in this study will remain confidential. Your participation is completely voluntary and you may choose to stop at any time. You will also receive \$5.00 in payment for your help.

The outcome of this research will be available to you when the results have been tabulated.

Thank you for your cooperation.

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I agree to take part in this study which is being supervised by a faculty member of the Department of Psychology at Austin Peay State University. I have been told about what is involved. I understand that I am free to stop taking part at any time I choose. The purpose or benefits of this study have also been explained to me.

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Student's Name (Please print)

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Student's Signature

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Date