A TEST OF THE SINGLE-STORE MODEL FOR LINGUISTIC STORAGE IN BILINGUALS

by

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Introduction

The Importance of Bilingualism

There are approximately 5,000 languages spoken in the world today. Because instant communications and mass mobility are prominent features of today's society, the speakers of these languages come in contact with each other much more often than ever before. They meet in the United Nations, at scientific conferences, in Olympic stadiums and in the world's financial markets. They sell each other weapons and mediate one another's disputes. Education, exploration, invention have all become global undertakings. And so it has become vital that people understand one another. It is in achieving that understanding that bilingualism plays an important role.

The phenomenon of bilingualism also provides psychologists with the means to study more fully certain aspects of human behavior and thought processes, for example concept formation. In a language acquisition study, Ianco-Warrell (1972) played a word substitution game with preschool children. She told them to pretend that "cow" actually meant "dog" and vice versa. When she asked a group of monolinguals if under these new rules, dogs had horns, the answer was generally no; but, when she posed the same question to a group of bilingual children, the answer was generally yes. She maintained that the monolinguals tended to consider the name of an object as part of the object and therefore could not play the game of reversing names. However, the bilinguals, possessing a representation for an object in each of their two lexicons, could play the word game

more successfully because they recognized the symbolic nature of language. Through this study Ianco-Warrell demonstrated that children of preschool age do indeed possess the ability to identify language as a system of manipulable symbols -- symbols which are indepcndent of the things they describe or name.

Assessing Bilingualism

The four skills necessary for the mastery of a language are reading, speaking, writing and listening. A bilingual individual is one who possesses one or more of these skills, even at a rudimentary level, in each of two languages. The term "balanced bilingual" describes the person whose skills in each language are equivalent in all four areas.

Assessment of bilingualism is a comparative process. The task is not to evaluate skills in either language, but to compare skills in one language with the same skills in the other language. This may best be accomplished using indirect measures of degree of bilingualism. These fall into four categories.

A dominance test measures a person's preference for one language over another. Lambert (1955) devised a test in which subjects read words which, in their printed form, could belong to either French or English but are pronounced differently in the two languages. The language whose pronunciations were used most frequently was considered the dominant (or preferred) language. If the number of pronunciations in the two languages was about the same, the subject was considered equally competent in both languages.

A flexibility test measures the relative sophistication of a bilingual's knowledge of his two languages. Macnamara (1969) devised a multiple-choice test in which subjects had to select a word to complete a sentence. In each case, only a secondary meaning of the appropriate word worked. Macnamara called this a Semantic Richness Test. Subjects heard half the items in English and half in French and correct answers in French were subtracted from correct answers in English to yield a difference score. If the difference score was fairly large in favor of one language or the other, that language was considered dominant. If the difference score was small, the subject was considered equally competent in the two languages.

A fluency test measures a bilingual's familiarity with his two languages. Macnamara (1969) administered a speed-of-reading test in which subjects read aloud paragraphs of equal word length in French and English. The readings were timed and a difference score was obtained. Once again, if the difference score was large, the subject was considered more skilled in the language in which he read faster. If the difference score was small, the subject was considered equally competent in both languages.

Self-ratings allow a bilingual to assess his own relative competencies in his two languages. Macnamara (1969) had bilinguals rate themselves in each of their two languages in reading, speaking, writing and listening. Subjects used a seven-point scale. Again difference scores were used to judge a bilingual's relative competence in each of the four skills.

Another form of self-rating is the language background questionnaire (LBQ). Such an instrument is designed to probe a bilingual's linguistic history by asking him questions about his own linguistic preferences and those of his father, mother, siblings and community. Responses to these questions about language usage result in a single score which is taken to indicate the relative competence of a person in each of his two languages. Scores from LBQ's, however, are subject to certain external influences which challenge their validity. In Quebec, for example, where political and social events have made French speakers more intent on perpetuating the French language, tendencies to speak French may be exaggerated, while tendencies to speak English may be deemphasized. Aside from this problem, Macnamara (1969) found LBQ scores to be a weak predictor of bilingual proficiency.

Macnamara (1969) performed a series of regression analyses on 14 indirect measures of bilingualism. He used as criteria the results of 15 language competency tests administered to students in several Montreal schools. These tests measured specific linguistic skills, for instance vocabulary, spelling, phonetics and reading comprehension, in French and English. The regressions were run step-wise. This allowed Macnamara to determine the efficiency with which an indirect measure predicted performance on a language competency test. Macnamara concluded that, since speed-of-reading and self-rating were very powerful predictors, these two tests could be used by psychologists wanting to assess a bilingual's linguistic competencies. Furthermore, should a psychologist need to determine

the degree of relative competency between a bilingual's two languages, Macnamara recommended that the psychologist use the specific indirect measure that tests the skill relevant to his experiment. For example, if the experimental task is oral in nature, the psychologist should rely on the speed-of-reading-aloud test and the sections of the self-rating scale pertaining to speaking and listening skills.

The Compound - Coordinate Distinction

Persons acquire second languages in a variety of ways. Until the early 1970's, foreign language courses were required at nearly all American universities. In several countries, for example Canada and Switzerland, multilingualism is an official state policy; and many citizens learn more than one language in multilingual education programs. A second language is often learned as a part of the process of immigration. If the immigrant wishes to buy goods, find work, converse with his new countrymen, etc. he will learn the indigenous language.

Weinreich (1953) made a fundamental distinction among types of second language acquisition formats. One becomes a compound bilingual if one learns two languages simultaneously or in the same setting. Growing up in a bilingual home is the most common instance of compound bilingualism. Learning a second language through the medium of the first, for example in school, is another. One becomes a coordinate bilingual if one learns one language from birth and acquires a second language, in the context of the culture of the second language, at a later date. The person who speaks English while growing up

where English is the indigenous language and learns Spanish while studying in Spain or Latin America as a teenager is a coordinate bilingual. If the compound-coordinate distinction is observed, it must be assumed that, since the compound bilingual acquires his languages at the same time or in the same setting, the languages share the same underlying semantic system. Since the coordinate bilingual acquires his languages separately and in different settings, each language has its own underlying semantic system. A concrete example used commonly to illustrate this difference is the concept of "wine." To the average American, wine turns an ordinary meal into something special. It is regarded as a dignified drink that one sips slowly. To the Frenchman, however, "vin" (the French translation of "wine") is as commonplace as water might be in this country; it is consumed at most meals by persons of all ages with no particular significance attached to it. A French-English compound bilingual would have a single representation for this concept in his semantic system. Both "vin" and "wine" would carry all the meaning from the culture in which the terms were acquired. However, the coordinate bilingual would perceive of "wine" and "vin" as different constructs, because each concept would be represented in its own separate semantic system.

Evidence supporting the compound-coordinate distinction comes from Lambert and Fillenbaum (1959) who discovered that coordinate bilingual aphasics tended to lose the use of only one language while compound bilingual aphasics tended to lose

at least partial use of both their languages on becoming aphasic.

Lambert, Havelka and Crosby (1958) provided further supportive evidence for the compound-coordinate distinction. They performed an experiment in which they examined the associative dependence of translated words in compound and coordinate bilinguals. In their study, all bilinguals learned a list of 20 English words to a criterion of eight correct answers. Next, some of the coordinate and some of the compound bilinguals were given a list of nonsense syllables while the rest of the coordinate and compound bilinguals were given three learning trials on a list of French translations of the English words. When a final test trial on the 20 English words was administered, Lambert et al discovered that recall was highest for the compound bilinguals learning the French translations. Recall for the coordinate bilinguals learning the French translations did not differ significantly from the recall of those bilinguals who learned the nonsense syllables. This was taken to mean that words in French and English had different meanings when acquired in a compound fashion.

The compound-coordinate distinction seems inadequate to describe all language acquisition contexts, however. One might grow up knowing only English and learning French in school, then move to France and use only French as an adult. Such a person exhibits language acquisition patterns of both compound and coordinate bilinguals. The pure coordinate bilingual in fact does not exist because any person learning a second lan-

guage inevitably uses referents from his first language in establishing second language equivalents.

In fact, not all studies confirm the presence of a compound-coordinate distinction. Kolers (1963), Lambert and Moore (1966), Olton (1960), and Dillon, McCormack, Petrusic, Cook and LaFleur (1973) found no significant differences when analyzing the performance of compound and coordinate bilinguals on word association tasks, galvanic skin responses to translation equivalents of words accompanied by electric shock, and release from proactive inhibition techniques. Since evidence concerning the compound-coordinate distinction is inconclusive, the distinction was not observed in the present study.

Shared vs. Separate Storage

Regardless of whether or not one espouses the compound-coordinate distinction, one can apply the shared versus separate store notion in another way. Are the bilingual's languages functionally separate, or do they share the same cognitive system with respect to the input, comprehension and output of speech?

Penfield and Roberts (1959) argued that when one language was being used for the encoding, comprehension or decoding of a message, the other was compeltely shut down. Macnamara (1967) referred to this notion as a single-switch model. Preston (1965) examined this model, using a variation of the Stroop color word test. Subjects were shown French and English color names printed in ink which was of a different color than the one named by the word. For example the word "red" or its

French translation "rouge", might have appeared in green ink. Subjects then had to name the color of the ink either in French or in English as instructed. In one condition subjects saw English words and had to name the ink color in French; in a second condition they saw English words and had to name the ink color in English; in a third condition they saw French words and had to name the ink color in French; and, in a final condition they saw French words and had to name the ink color in English. The single switch model predicted that reaction times for naming the ink color would have been faster in conditions one and four, because responding in one language would not have been affected by the opposite language word appearing on the card. In conditions two and three, interference would have been maximized by the presence of a word printed in the language of the response. In fact, no significant differences were recorded, and the Penfield and Roberts theory was not supported.

Macnamara (1967) therefore proposed a two-switch model for language switching -- one switch controlling speech production and one for speech input. The first of these switches comes under voluntary control, since a person can consciously select the language in which he wants to speak; the second, however, seems uncontrollable. Treisman (1964) reported that subjects had little difficulty shadowing a message heard in one ear while hearing a second language unknown to them in the other ear. Shadowing was more difficult when subjects heard the same message in the same known language in each ear.

Shadowing was most difficult when subjects heard two different messages in two different languages which were known to him. Apparently, bilinguals cannot ignore one language while decoding in the other. Nevertheless, a two-switch model is more viable than a single-switch model if for no other reason than that a bilingual can easily decode in one language and encode in another simultaneously. Put simply, bilinguals can translate. Several studies have therefore concentrated on either or both switches, with the assumption that switching takes an observable amount of time. Kolers (1966) observed that more time was required when subjects had to read aloud passages containing words from both French and English than passages written entirely in one language or the other. Macnamara (1967) reported that when subjects were asked to name as many words as they could while alternating (not translating) between their two languages, the number of responses was less than the number of responses when subjects named words while remaining within one language or the other. These studies reflect the bilingual's need to keep resetting his linguistic switches.

There is one condition which facilitates reading of mixed-language word lists. Macnamara, Krauthammer and Bolger (1968) showed that reading speed improved when subjects could anticipate the language in which they were to respond. In this experiment, switches could be anticipated because subjects were given a regular switching pattern to follow.

Another place to apply Weinreich's (1953) notion of shared vs. separate linguistic storage is the area of memory. Does

the bilingual have one memory for items from all languages, or does he have a separate memory for each language? If separate, one would expect that a bilingual could remember more words from a mixed list than from a monolingual list. This is not the case, however. Nott and Lambert (1968) and Lambert, Ignatow and Krauthamer (1968) showed no significant differences in the performance of bilinguals in a free-recall task across these two types of lists. In fact, Lambert et al (1968) and Dalrymple-Alford and Aamiry (1969) reported that subjects were actually able to remember more words when they clustered by category than when they clustered by language.

This is not to imply that language does not help one to organize items in a memory task. Kintsch and Kintsch (1969) gave subjects short-term and long-term memory tasks, consisting of verbal monolingual and bilingual word lists. Subjects were then asked to recall as much as possible from the different types of lists. Subjects could easily keep track of items according to language in short-term memory. However, in long-term memory, memory for language decreased sharply. Acoustic properties of a word facilitated recall in short-term memory, and semantic properties prevailed in long-term memory.

Other studies support the notion that semantic features, not linguistic ones, are the basis for organization in memory. Hamers and Lambert (1972) performed an experiment similar to that of Triesman (1964), except that they prepared an auditory analog of the Stroop color word task. Subjects heard high or

low pitched voices saying the words "high" or "low" either in French or in English. They then had to respond either in French or in English whether they heard the high or the low pitched voice. Hamers and Lambert noted that subjects tended to name the word they had heard rather than the correct pitch of the voice; this occurred regardless of the language in which they heard "high" or "low" and regardless of which language they had to use in responding. Hamers (1973) performed the same type of experiments using the words "boy" or "girl" spoken by either a boy or a girl and using either French or English as the language in which the words were spoken and in which the response was to be given. Again it was observed that instead of responding with the correct sex of the speaker, subjects often gave the word that was actually spoken, regardless of the language in which the decoding and encoding took place. These findings strengthen the contention that semantics, not language or phonology, form the underlying organizational network for memory. Also, these findings indicate that bilinguals cannot separate their languages at the input and processing stages, but can do so at the output stage.

Additional supportive evidence is provided by Kolers (1966). Subjects were shown two types of word lists: (1) monolingual lists N words long with each word presented twice; and (2) bilingual lists N words long with each word and its translation presented once. A multi-store model for bilingual memory predicts that subjects would remember more from the monolingual lists because each word in those lists occurred

twice. In bilingual lists, however, a word and its translation are represented in two distinct systems according to a multi-store model. A single-store model for bilingual memory predicts that subjects would do as well on one type of list as on the other, since a word and its translation in the bilingual lists share a common semantic system. Results indicated no difference in performance across list types. It was therefore concluded that words themselves were not stored in memory; rather, words were distilled down to semantic referents which were stored in memory. Kolers (1968) repeated this study presenting lists verbally instead of graphemically. Results were similar to those obtained in the previous study.

In the same study he presented subjects with passages containing randomly ordered French and English phrases to be read silently. Comprehension was measured for such passages and compared with comprehension on monolingual passages in each language; no significant differences were discovered. Kolers concluded that bilinguals are able to extract information from written material, regardless of the ratio of words of one language to words of another. It was observed, however, that no experiment had been done to determine if the same was true of material presented orally.

The Present Study

This study was designed to explore the question of whether or not a bilingual's two languages are separated at the level of comprehension when material is presented orally. The study borrowed some methodology and concepts from the literature on

ambiguous sentence processing and integrated them into a bilingual format in an attempt to resolve this question.

Foss and Jenkins (1973) discovered that when they presented subjects with two kinds of sentences -- ambiguous and unambiguous -- processing for the former was slower than processing for the latter. They defined an ambiguous sentence as one in which one or more words permitted the sentence to be construed in two or more meaningful ways. For example, in the sentence "The soldiers took the port", the word "port" could be construed as meaning harbor or wine. Foss and Jenkins' dependent variable was a phoneme-monitoring task. Before each sentence each subject was told to listen for a specific phoneme and to press a button when he heard it. For the ambiguous sentences the critical phoneme was placed directly after the ambiguous word or phrase. For both the ambiguous sentences and the unambiguous sentence, the critical phoneme occurred at approximately the middle of the sentence. The time elapsing between the occurrence of the phoneme and the pushing of the button was measured and Foss and Jenkins discovered that these elapsed times were significantly faster for unambiguous sentences than they were for ambiguous sentences. They concluded that comprehension of ambiguous material requires an examination of alternative meanings and this process takes time.

A phoneme-monitoring task can be used in a bilingual experiment examining single-store vs. multi-store hypotheses. Since the word order for a given sentence may change from one language to the next and since every language has its own

unique idiomatic speech, the word-for-word translation of a passage from language one to language two can be rendered anomalous or confusing. This study therefore confronted monolingual and bilingual subjects with English sentences containing literal translations of Spanish idioms (a semantic variable) and English sentences containing Spanish word order (a syntactic variable). A group of normal English sentences was used as a control variable. A phoneme-monitoring task was employed in the manner outlined by Foss and Jenkins (1973). For each sentence, regardless of type, the critical phoneme fell in approximately the middle of the sentence. In the case of the experimental sentences the anomalous word or phrase came immediately preceding the critical phoneme.

The notion that a bilingual's two languages share the same semantic system predicts that for the experimental variables, reaction times in the phoneme-monitoring task would be faster for bilinguals than for monolinguals. This is so because, according to such a theory, bilinguals have simultaneous access to both languages. Bilinguals could therefore make use of their knowledge of Spanish idioms and Spanish word orders to unravel an otherwise confusing English sentence. Monolinguals would have no such advantage.

On the other hand, the notion that a bilingual's two languages have separate semantic systems predicts that for the experimental sentences, reaction times in the phoneme-monitoring task would be the same for bilinguals and monolinguals. This is so because, according to such a theory, a bilingual's

two languages are functionally independent. Thus neither monolinguals nor bilinguals would have second language cues to help them comprehend the English sentences.

The results of this study were expected to support the single-store model.

Method

Subjects

Nineteen English monolinguals and 19 Spanish-English bilinguals from the junior and senior classes at Kansas State University participated in the study. Some of the English monolinguals spoke foreign languages other than Spanish, but none had had any exposure to Spanish or any other Romance language. Several had studied German or Russian in high school, but no one who had taken more than three years of an unrelated language in high school, or who had taken any language at the university level, or who had lived in a Spanish-speaking country, was included in the study. In order to be sure that monolinguals met these restrictions, each was asked specifically about his knowledge of Spanish and other Romance languages.

Any knowledge of a language closely related to Spanish might have affected a subject's performance on the experimental tasks. In French, for example, adjectives follow their nouns just as they do in Spanish; and French speakers, even though they may not have known a word of Spanish, may have responded to the noun-adjective reversal items with the same ease as the bilinguals.

Performance on the idiom translation items probably would not have been affected by a knowledge of any language other than Spanish. The idiomatic speech of every language is unique, and the word-for-word translation of a Spanish idiom would make no more sense to a speaker of Italian or French than it would to a speaker of English.

All subjects received $1 each for their participation. The bilingual subjects were individually pretested for degree of bilingualism using a self-rating scale (Appendix A) and a task involving the reading aloud of Spanish and English paragraphs (Appendix B), as described by Macnamara (1969).

The self-rating scale was comprised of eight six-point scales; and subjects rated themselves for their ability to read, write, speak and listen to Spanish and English. The speed-of-reading-aloud task consisted of two paragraphs equal in word length and complexity of sentence structure and vocabulary and having different non-technical subject matter -- one in English and one in Spanish. The time taken by each subject to read each paragraph aloud was recorded on his score sheet. Difference scores were then found by subtracting the time taken to read the Spanish from the time taken to read the English.

All subjects also provided some demographic information (Appendix C) about the countries in which they had lived and all the languages they had encountered. Of the 19 bilingual subjects, seven had learned their Spanish in Puerto Rico; three each in Venezuela and the United States; two each in

Costa Rica and Mexico; and one each in Spain and Bolivia.

Since the primary experimental task involved listening to sentences, only those bilinguals whose self-ratings for ability to listen to English and ability to listen to Spanish differed by two or less were included in the study. Furthermore, only bilinguals whose difference scores in the speed-of-reading-aloud test were less than 60 seconds were included. These criteria were included to establish that the bilinguals had equivalent oral skills in Spanish and English. It was important that the subjects know English well so that they could understand the English sentences. It was important that they know Spanish well, because without a working knowledge of that language they would have no advantage over the monolinguals in processing the test items. For 15 of the 19 bilinguals, Spanish was the native language and English was the second language; for the other four, the situation was reversed. Therefore, since times for Spanish paragraphs were generally shorter than times for English paragraphs, difference scores were usually positive.

Materials

The experimental stimuli were 42 English sentences, each having different subject matter. The sentences were of three types: (1) Fourteen contained literal translations of Spanish idioms. Since the bilinguals in this study came from various Spanish-speaking countries, idioms common in all Spanish-speaking countries were selected. Miller (1972) compiled a list of Spanish idioms in the order of their frequency of

occurrence as rated by several native Spanish speakers from different countries. All idioms used in this study were among the most frequent 5% in Miller's list. A sentence of the idiom translation variety read, Jalopy wants to say car in one form of English slang since the literal translation of "querer decir" is "to want to say." (Appendix D) (2) A group of 14 English sentences was formed reversing the order of a noun and its modifier. In Spanish, adjectives follow their nouns. Therefore, a sentence of the noun-adjective reversal variety read, The swimmer froze in the water icy after diving into the scenic mountain lake. (Appendix E) (3) A final group of 14 control sentences was formed using normal English sentences. Hence, subjects heard sentences like, In many states buying lottery tickets is illegal. (Appendix F). Six of the 42 sentences, two of each type, were used as practice items. The remaining 36 were randomized so that no more than two sentences of the same type were heard consecutively. All subjects heard all sentences in the same order.

Apparatus and Procedure

The experiment required the use of a stereo tape recorder, an electric timer clock, a dual-channel voice key, a set of monaural headphones, and a code button. One channel of a stereo tape contained all 42 practice and test items. Subjects heard these through the headphones, but they could not hear what was in the second channel. The second channel of the tape contained auditory pulses which triggered the voice key. These pulses were patched directly into the first channel of the voice key

and were lined up on the tape to correspond precisely with the onset of the critical phoneme heard in the first channel by the subject. The pulse triggered the voice key which in turn activated the clock which measured the reaction time from the onset of the critical phoneme until the subject pressed the code button which they used to stop the clock. The button was patched into the other channel of the voice key and, when pushed, closed the circuit that stopped the clock. Reaction times were then read in milliseconds and written on the subjects' score sheets.

Hand dominance was taken into account when subjects were seated in front of the code button. If they were left-handed, they were positioned so that they pressed the button with their right hand; if they were right-handed, they were positioned so that they pressed the button with their left hand. This was done to free the dominant hand to perform a written recall task to be described below.

Subjects were told that they would participate in an experiment having to do with sentence processing and were given a set of written instructions explaining the task. (Appendix G). All subjects completed the short demographic survey referred to above, and bilinguals also completed the self-rating form and read the paragraphs in the speed-of-reading-aloud test. Then each subject performed two tasks: (1) During each sentence each subject pressed the code button on hearing a specified phoneme; and (2) After each sentence each subject wrote down as

much of the sentence as he could remember as a short term memory task which was included to force subjects to semantically process what they heard. Had it not been included, subjects might not have attempted to comprehend the sentences, thus rendering the phoneme-monitoring task useless. Elapsed time for each sentence and its corresponding recall period was 45 seconds; elapsed time for the experiment for each subject was approximately 45 minutes.

Task one was a phoneme monitoring task similar to that used by Foss and Jenkins (1973) and described above. Subjects were told before each sentence to listen for a specific phoneme -- /p/ as in Paula, /b/ as in Bill, /d/ as in Doris, /g/ as in Greg, /k/ as in Karen or /t/ as in Thomas. Since one of these sounds, /k/, can be made in English by "c" as in car or "k" as in Karen, subjects were told not to listen for the letters making the sound, rather for the sound itself. The critical phoneme always occurred at the beginning of a word and only occurred once in each sentence. In the idiom translation items the critical phoneme always occurred from one to three syllables after the literal translation of the Spanish idiom. Thus, in the sentence Jalopy wants to say car in one form of English slang, the critical phoneme was /k/. In the noun-adjective reversal items the critical phoneme always occurred from one to three syllables after the adjective. Thus, in the sentence The swimmer froze in the water icy after diving into the scenic mountain lake, the critical phoneme was /d/. In the control items the critical phoneme always occurred at approximately the

middle of the sentence. Thus, in the sentence In many states buying lottery tickets is illegal, the critical phoneme was /b/.

Each sentence consisted of only a single clause; therefore the critical phoneme always occurred in the same clause as the idiom translation or the noun-adjective reversal. This was done because semantic processing seems to be accomplished one clause at a time. If the critical phoneme and the material immediately preceding it came in different clauses, the work load of the preceding mechanism in the mind would, having just completed semantically processing one clause, be considerably lighter at the onset of the critical phoneme than if the phoneme occurred in the same clause as the immediately preceding material. As the amount of energy expended on semantic processing decreases, the energy available for phoneme recognition increases. For the phoneme monitoring task to be effective, subjects must be engaged in semantic processing at the onset of the critical phoneme.

Since the experiment involved the collection of reaction time data, criteria were established to account for outliers, false starts and missing score situations. When subjects pressed the button after the completion of a sentence or when they failed to press the button at all, they were given a score equal to the elapsed time from the onset of the phoneme to the end of that sentence. Such intervals for all items were measured prior to the experiment, and they ranged from 2.002 seconds to 3.300 seconds. All outliers were adjusted before dealing with false starts and missing score situations.

When subjects pressed the button prior to the onset of the critical phoneme (false start) or when the equipment malfunctioned so as not to yield a reaction time (missing score), the median of that subject's remaining scores, adjusted outliers included, was used to fill in the cell.

Results

Table 1 shows the number of outliers, false starts and missing scores for each group of subjects. There was some initial difficulty with the voice key, and since most bilinguals were tested before most monolinguals, there was a greater number of missing scores for bilinguals.

Table 1

Outliers, False Starts and Missing Scores

Subject Group	Total Number of Reaction Times	Outliers	False Starts	Missing Scores
bilingual	684	28	9	36
monolingual	684	19	2	10

For each bilingual and each monolingual subject, reaction time means were obtained for each sentence type, and a two by three analysis of variance was performed on these means. As predicted, the analysis of variance yielded a significant interaction, $F\ (2,72) = 3.91$, $p < .05$. Neither of the main effects, lingual type and sentence type, yielded a significant F. (See Appendix H).

Following the analysis of variance, Tukey's HSD test was used to identify the group means that differed significantly from one another. The critical interval for this test was .126 and reaction time means for the six groups are listed in Table 2.

Table 2

Reaction Time Group Means

Subject Group	Idiom Translations	Noun-Adjective Reversals	Control Sentences
Bilingual	.502	.557	.541
Monolingual	.541	.476	.415

As predicted, there were no significant differences among the three means for the bilinguals. There were, however, three significant differences among the six group means: monolingual control sentence reaction times were significantly faster than monolingual idiom translation sentence reaction times, bilingual control sentence reaction times, and bilingual noun-adjective reversal sentence reaction times. The last of these three compares cells differing along two dimensions and is therefore less clearly interpretable. The other two will be discussed later.

A second analysis of variance was performed using difference scores obtained by subtracting each subject's mean control sentence reaction time from his mean noun-adjective reversal reaction time and his mean idiom translation reaction time.

This yielded a 2 x 2 design in which each subject served as his own control, thus eliminating the base line difference between monolinguals and bilinguals on control sentence reaction time means. This analysis of variance yielded a significant lingual main effect, F (1,36) = 4.27, $p < .05$. Neither the main effect of sentence type nor the interaction of the two main effects was significant. The difference score means for the three groups are listed in Table 3.

Table 3

Difference Score Group Means

Subject Group	Noun-Adjective minus Control Sentence	Idiom Translation minus Control Sentence
Bilingual	.016	-.038
Monolingual	.062	.126

As for sentence recall, this task was subordinate to the reaction time task, and data from it were more difficult to interpret. Since the major task was oral comprehension, bilingual subjects' ability to write English as measured by the self-rating scale was permitted to vary. Thus comparisons normally done on written recall data were confounded by less written recall in the bilingual group.

However, some things may be worth noting. In one informal examination of the data, insertions of the idiomatic meanings of Spanish idioms in the idiom translation items were tabulated

for bilingual and monolingual subjects. An example of such a substitution is the word means for the phrase wants to say in the sentence Jalopy wants to say car in one form of English slang. In 228 sentences for each group -- 12 idiom translation items for each of 19 subjects in a group -- bilinguals made 12 idiomatic meaning substitutions while monolinguals made ten such substitutions. Most of these substitutions came in two sentences. These items were State law says it is necessary to have 18 years in Kansas to buy beer in a restaurant or bar, and The town mayor did the paper of King Lear last month in the church play. In Spanish, to have 18 years actually means "to be 18 years old." Did the paper actually means "played" or "did the part". In the first sentence the actual meaning was substituted six times by bilinguals and six times by monolinguals. In the other sentence the phrase "did the part" was substituted five times by bilinguals and four times by monolinguals.

In a second cursory examination of the data, noun-adjective reversal sentences from three randomly selected bilinguals and three randomly selected monolinguals were scored to determine the order in which nouns and adjectives were recalled. In 36 sentences for each group, adjectives were placed before nouns twice by bilinguals and twice by monolinguals. For the bilinguals, recall was correct in 20 sentences; for the monolinguals, recall was correct in 29 sentences. The remaining noun-adjective pairs were either recalled inaccurately, recalled partially or not recalled at all.

Discussion

The fact that the group means for the bilinguals did not differ significantly from one another in either analysis indicates that the bilinguals' knowledge of Spanish facilitated the understanding of the idiom-translation items and the noun-adjective reversal items. It was for them just as easy to comprehend these sentence types, as measured by the phoneme monitoring task, as it was to comprehend normal English sentences.

Macnamara (1967) demonstrated that translation takes a measurable amount of time. Since reaction times for bilinguals on idiom translation sentences were nonsignificantly faster than on control sentences, it suggests that bilinguals did not use translation as a way of deriving meaning from idiom translation sentences. Rather, meaning was derived without switching between the surface structures of the respective languages.

Although the monolinguals seemed to have no trouble adjusting to sentences containing Spanish word order (the noun-adjective reversal items), their lack of understanding of the idiom translation items inhibited their ability to respond to the onset of phonemes in these sentences. For the monolinguals, the information immediately preceding the critical phoneme was not readily assimilated; thus their response times for this sentence type were significantly longer than for normal English sentences. In other words,

semantic processing for idiom translations was slower than it was for the other two sentence types. This detracted from subjects' capacity to recognize and respond to the critical phoneme.

It might be argued that the knowledge of any second language aided bilinguals in processing the experimental sentences. However, a calculation of the reaction time means for the four monolinguals who had had some exposure to unrelated languages yielded .655 for idiom translation items, .433 for noun-adjective reversals, and .431 for control sentences. The fact that the idiom translation reaction time means and control sentence reaction time means were slower than the corresponding means for the monolingual subject group as a whole indicates that merely knowing another language was not helpful in processing the sentences.

It might further be argued that monolinguals exhibited a significant difference between control sentence and idiom translation reaction times and bilinguals did not, because bilinguals, having read Spanish and rated themselves in Spanish in the pretest, were more aware that Spanish played a role in the experiment. However, monolinguals, having been asked about their knowledge of Spanish when recruited, were also aware that Spanish played a role in the experiment. If bilinguals were more aware than monolinguals of the importance of Spanish to the experiment, bilinguals should have produced similar reaction times in each test condition throughout the experiment while monolingual reaction times should have been

faster for each condition at the end of the experiment than at the beginning. However, an examination of monolingual reaction times for the first six test items as compared with their reaction times on the last six test items showed no practice effect.

The fact that bilingual reaction times for control sentences were marginally significantly longer than monolingual reaction times for control sentences was not in accordance with predictions. It suggests a base-line difference between the two groups of subjects. There are at least two possible explanations for this difference: (1) In 15 of 19 cases, English was a bilingual's second language while Spanish was his native language. Naturally, English was the native language for all 19 monolinguals. This meant that for control sentences monolinguals had the advantage of hearing their native language while most bilinguals heard their second language. Thus, English word patterns and sentence structure were probably more familiar to the monolinguals, facilitating semantic processing and retention and allowing them to concentrate more on phoneme identification on control sentences. (2) There was a limited number of bilingual students from which to recruit subjects, and the author did not have as much flexibility in selecting the most balanced bilinguals as he would have liked. Thus, some bilinguals, even though they had a working knowledge of English, had to concentrate more on the semantic processing and retention of English sentences than did other bilinguals and monolinguals. These two factors probably contributed to

the difference between bilingual and monolingual control sentence reaction times and to the longer bilingual reaction times across all sentence types.

The difference-score analysis of variance shows that monolinguals' reaction times on experimental variables varied more from their control sentence reaction times than bilinguals' reaction times on experimental variables did from their control sentence reaction times. As this difference was significant, it strengthens the contention that, for monolinguals, the processing of sentences complicated by the inclusion of elements of Spanish was not the same as the semantic processing of normal English sentences, while, for bilinguals, processing of experimental sentences was similar to processing of normal English sentences. This was so despite the fact that bilingual control sentence reaction times were significantly slower than monolingual control sentence reaction times.

As stated in the results section, written recall did not yield much interpretable data. The fact that substitutions of idiomatic meanings of Spanish idioms occurred primarily in two of the idiom translation items probably reflects the similarity of the word-for-word translation used in the two items to the direct idiomatic translation of the Spanish idioms. In other words, the phrases to have 18 years and did the paper are not too far removed from "to be 18 years old" and "did the part". This is especially true considering the contexts of the sentences. In the first, the concepts of state law, 18 years and buying beer could easily lead one to substitute "to be 18 years

old" for to have 18 years. In the second, the concepts of King Lear and church play could easily lead one to substitute "did the part" for did the paper. The other idiom translation items did not lend themselves to such substitutions because the word-for-word translations of Spanish idioms which appeared in the sentences did not closely resemble the direct idiomatic translations of the idioms. In the sentence The employees seemed to make good crumbs with their boss at the local chemical factory, the correct translation of to make good crumbs is "to get along well". This correct translation could not have been substituted by monolinguals and was not substituted by bilinguals.

The results of this study gave a clear indication that there is some form of interlingual interaction at the level of comprehension. A knowledge of Spanish contributed to the bilinguals' understanding of test items. Also, the two-switch model proposed by Macnamara (1967) was supported rather than the single-switch model proposed by Penfield and Roberts (1959) because, while hearing sentences spoken in English, bilinguals successfully extracted meaning from the unspoken Spanish counterparts of the anomalous English phrases in the idiom translation items.

The study also provided direct support for the single-store model for bilingual linguistic storage. Except for the initial speed-of-reading-aloud test, bilinguals heard no Spanish during the course of the experiment, nor did they produce any. Yet their underlying semantic structure provided

them with an understanding of the words and phrases in the idiom translation items, which, as spoken in English, were anomalous. This was not the case for the monolinguals, who did not have access to the semantic referents of the idiom. Because the monolinguals took significantly longer in the reaction time task for idiom translation items than for control items and the bilinguals did not, the knowledge of Spanish must have aided the bilinguals in the comprehension of the idiom translation items. Thus, unlike the studies of Nott and Lambert (1968) and Lambert, Ignatow and Krauthamer (1968), which were interpreted as support for the single-store model, the significant interaction obtained in this study made a strong statement in support of the single-store hypothesis.

The study obtained the same kind of results for spoken material as Kolers (1968) obtained for written material. In his study, Kolers (1968) demonstrated that subjects were able to comprehend mixed-language paragraphs just as well as monolingual paragraphs; and the ratio of the number of words in one language to the number of words in a second language had no effect on comprehension. In a sense, the present study, with no words being spoken in Spanish and all words being spoken in English, was an oral counterpart to the study done by Kolers (1968). Even with this severe a ratio, comprehension attributable to a knowledge of Spanish took place.

Although the compound-coordinate distinction was not made among the bilinguals serving in this experiment, the results of the study probably apply to all bilinguals, no matter how they

acquired their second language. If separated linguistic storage occurs in bilinguals, it would be evident in coordinates who have different semantic representations for similar concepts in different languages. Demographic data from the present study indicate that the four English-dominant bilinguals were coordinate, while the 15 Spanish-dominant were compound.

This experiment also showed the phoneme monitoring task to have a wider range of use than previously thought. Whereas Foss and Jenkins (1973) and others used it to measure semantic processing for ambiguous sentences only, it was used in this study to measure semantic processing for a different form of material. In the case of the monolinguals, the idiom translation items required more semantic processing than the control items, and the phoneme monitoring task was sensitive enough to detect the difference. This suggests that the phoneme monitoring task may be useful in measuring changes in the level of semantic processing for many types of verbal material.

To summarize, this experiment provided empirical support for the contention that semantics plays an important part in the underlying organizational network for bilingual memory and cognition. It was the semantic variable, idiom translation, that showed the difference between monolinguals and bilinguals. Aslo, unlike other studies which tested and rejected the multistore hypothesis for linguistic storage, this study tested and supported the single-store hypothesis. A logical extension

of this study would be to test its assertions in a long-term memory task. Monolingual and bilingual subjects could be presented with narrations containing idiom translations, and comprehension for the anomalous material could be measured by having subjects answer specific questions about the meaning of the narrations. Such a study could assume a written or oral form. If bilinguals provided more correct answers to test questions, it might mean that the same principles which govern short-term bilingual linguistic storage apply for long-term linguistic storage as well.

APPENDIX A

Self Rating Scale

Rate your abilities in each of the skills below on a scale from one to seven. A rating of one indicates poor ability and a rating of seven indicates excellent ability.

	Poor						Excellent
Ability to speak English	1	2	3	4	5	6	7
Ability to write English	1	2	3	4	5	6	7
Ability to listen to English	1	2	3	4	5	6	7
Ability to read English	1	2	3	4	5	6	7
Ability to speak Spanish	1	2	3	4	5	6	7
Ability to write Spanish	1	2	3	4	5	6	7
Ability to listen to Spanish	1	2	3	4	5	6	7
Ability to read Spanish	1	2	3	4	5	6	7

APPENDIX B

Speed of Reading Aloud Test

English

The first killing, that of Deacon LeRoy, one of the mob's top lieutenants, went almost unnoticed. The Deacon's last night on earth was spent watching a telecast of the Lottery's grand prize presentation. Now, LeRoy was known to feel that the Lottery was not only unfair competition, but blatantly fixed as well. (And indeed, the recipients of grand prizes were good public relations fodder: mainly sweet white-haired old ladies, black policemen, and young couples just starting out in life.) LeRoy's wife, fearing for his hypertension, had sabotaged the TV that night, but the Deacon stormed down to a bar and ordered the proprietor to turn on the presentation. As fate would have it, the thousand-dollars-a-week prize that night was won by a sweet white-haired black lady whose son, a policeman, had just got married; LeRoy caused a scene before retiring to the men's room, where he was found later, dead of an apparent heart attack. No one thought much about it at the time.

APPENDIX B

Speed of Reading Aloud Test

Spanish

El susto fue general y la alarma llegó a su colmo cuando un surtidor de caldo, impulsado por el furioso animal, inundó mi limpísima camisa.

El trinchador se levantó rápidamente a este punto con la intención de cazar el ave, y al precipitarse sobre ella, una botella que tenía a la derecha, con la que tropieza su brazo, abandonando su posición perpendicular, derrama vino sobre el capón y el mantel. Llueve la sal sobre el vino para salvar el mantel; para salvar la mesa se pone por debajo del mantel una servilleta; y una colina se levanta sobre el teatro de tantas ruinas.

Una criada retira el capón en el plato de su salsa; al pasar sobre mí, hace una pequeña inclinación, y una lluvia de grasa desciende a dejar eternas huellas en mi pantalón color de perla. La angustia de la criada es grande, y al volverse tropieza con la criada que traía una docena de platos limpios, y todo viene al sucio con el más horroroso ruido.

APPENDIX C

Demographic Survey

1. List every country you've lived in since you were three years old and the number of years you've lived in each:

COUNTRY	YEARS LIVED THERE

2. List every language (including your native language) which you have studied in school:_____

_____

3. List each language that you have learned in your home or community:_____

_____

Idiom Translation Items

Subjects heard the English sentences shown below. They did not hear the Spanish idioms or idiomatic translations also shown below.

1. State law says it is necessary to have 18 years in Kansas to buy beer in a restaurant or bar.
   tener. . .anos
   to be 18 years old

2. The teacher told the student to make case to problems on the board at the front of the room.
   hacerle caso a
   pay attention to

3. Astronauts will go to Mars more forward to collect information about its atmosphere.
   mas adelante
   later on

4. The town mayor did the paper of King Lear last month in the church play.
   hacer el papel de
   played (did) the part of

5. George learned to open the hand because of an unusual nightmare.
   abrir la mano
   give generously

6. The justice of the peace came above the delinquent for his first criminal offense.
   venir encima
   reprimanded

7. A good meal values the pain of baking even on an extremely hot day.
   valer la pena de
   is worth the trouble

8. The cowboy drank the winds to get the newborn calf out of the canyon.
   beber los vientos por
   did his utmost

9. 'Jalopy' wants to say 'car' in one form of English slang.
   querir decir
   means

10. The heavy smoker gave a turn to purchase a carton of cigarettes for himself.
    dar una vuelta
    took a stroll

11. The cowgirl is going to the rodeo of all ways between now and the middle of next summer.
    de todas maneras
    no matter what happens

12. The employees seemed to make good crumbs with their boss at the local chemical factory.
    hacer buenas migas
    to get along well together

APPENDIX E

Noun/Adjective Reversal Items

1. The worker dabbed his forehead grimy and took up his shovel with a deep sigh.
2. The room was full of people noisy coming to hear the popular band perform.
3. The swimmer froze in the water icy after diving into the scenic mountain lake.
4. The miners breathed the air foul while tunneling their way slowly through the debris.
5. The man's appearance sloppy bothered the woman conducting the interview.
6. The rats ate the grain ripe kept in the old silo by the stable.
7. The soldiers eyes bloodshot combed the empty night for signs of life.
8. The diplomat's limousine large burned up a lot of expensive gasoline.
9. The author of the story mysterious preferred not to attend the writers' banquet.
10. The woman chose the material sheer tc drape the wall of her formal living room.
11. Hockey is a game brutal played on ice during the winter season.
12. The man ran up the hill steep carrying a heavy load on his shoulders.

APPENDIX F

Control Items

1. Mr. Nixon resigned the presidency in the summer of 1974.
2. People have crossed the Atlantic in small boats just for the sake of adventure.
3. Television has been called the babysitter of today's children.
4. Japan is our biggest international trading partner.
5. The Mustang was a combat airplane used by the Allies in World War II.
6. The F.B.I. publishes crime reports for large cities every year.
7. Dairy products like milk and cheese brought lower prices to farmers last year.
8. Editing a large newspaper can be a full-time job for one man.
9. Scientists are working on a device to capture the energy of ocean waves.
10. In order to save energy Congress lowered speed limits on highways.
11. Finding work is hard because of recent high unemployment.
12. Snowstorms occur frequently during winter months like January.

APPENDIX G

Instructions to Main Experiment

You will hear a series of sentences played from a tape recorder. Before each sentence you will be told to listen for a particular consinant used in the sentence. Push the button in front of you as soon as you hear the consonant. After each sentence, you will have a brief period in which to write down as much of the sentence as you can remember. As soon as you hear the word "Ready" stop writing and listen for the next consonant. There will be six practice items to help you become accustomed to the procedure.

APPENDIX H

Analysis of Variance on Reaction Time Means

Source Table

Source	Error Term	F	Degrees of Freedom	Mean Square
Mean	S(A)	427.6106	1	2.9099
A	S(A)	1.3043	1	.0888
B	BS(A)	1.2521	2	.0219
S(A)			36	.0681
AB	BS(A)	3.9095	2	.0685
BS(A)			72	.0175

$p < .05$

Key

A = lingual variable

B = item type

S = subject

APPENDIX I

Analysis of Variance on Difference Scores

Source Table

Source	Error Term	F	Degrees of Freedom	Mean Square
Mean	S(A)	2.6588	1	.1303
A	S(A)	4.2720	1	.2094
B	BS(A)	0.0246	1	.0005
S(A)			36	.0490
AB	BS(A)	3.5926	1	.0673
BS(A)			36	.0187

$p < .05$

Key

A = lingual variable

B = difference score

S = subject

REFERENCES

Dalrymple-Alford, E.C., Aamiry, A. Language and category clustering in bilingual free recall. Journal of Verbal Learning and Verbal Behavior, 1969, 8, 762-768.

Dillon, R.F., McCormack, P.D., Petrusic, W.M., Cook, M., & LaFleur, L. Release from proactive interference in compound and coordinate bilinguals. Bulletin of the Psychonomic Society, 1973, 2, 293-294.

Foss, D.J., & Jenkins, C.M. Some effects of context on the comprehension of ambiguous sentences. Journal of Verbal Learning and Verbal Behavior, 1973, 12, 577-589.

Hamers, J.F. Interdependent and independent states of the bilinguals' two languages. Ph.D. dissertation, McGill University, 1973.

Hamers, J.F., & Lambert, W.E. Bilingual interdependencies in auditory perception. Journal of Verbal Learning and Verbal Behavior, 1972, 11, 303-310.

Ianco-Warrell, A. Bilingualism and cognitive development. Child Development, 1972, 43, 1390-1400.

Jakobovits, L.A., & Lambert, W.E. Semantic satiation among bilinguals. Journal of Experimental Psychology, 1961, 62, 576-582.

Kintsch, W., & Kintsch, E. Interlingual interference and memory processes. Journal of Verbal Learning and Verbal Behavior, 1969, 8, 16-19.

Kolers, P.A. Reading and talking bilingually. American Journal of Psychology, 1966, 79, 357-376.

Lambert, W.E. Measurement of the linguistic dominance of bilinguals. Journal of Abnormal and Social Psychology, 1955, 50, 197-200.

Lambert, W.E., & Fillenbaum, S. A pilot study of aphasia among bilinguals. Canadian Journal of Psychology, 1959, 13, 28-34.

Lambert, W.E., Havelka, J., & Crosby, C. The influence of language acquisition contexts on bilingualism. Journal of Abnormal and Social Psychology, 1958, 56, 239-244.

Lambert, W.E., Ignatow, M., & Krauthamer, M. Bilingual organization in free recall. Journal of Verbal Learning and Verbal Behavior, 1968, 7, 207-214.

Lambert, W.E., & Moore, N. Word-association responses: Comparisons of American and French monolinguals and bilinguals. Journal of Personality and Social Psychology, 1966, 3, 313-320.

Macnamara, J. The bilingual's linguistic performance -- A psychological overview. Journal of Social Issues, 1967, 23, 58-77.

Macnamara, J. How can one measure the extent of a person's bilingual proficiency? In L.G. Kelly (Ed.), Description and measurement of bilingualism. Toronto: University of Toronto Press, 1969.

Macnamara, J., Krauthamer, M., & Bolgar, M. Language switching in bilinguals as a function of stimulus and response uncertainty, Journal of Experimental Psychology, 1968

Miller, J.D., 1,000 Spanish Idioms. Provo, Utah: Brigham Young University Press, 1972.

Nott, C.R., & Lambert, W.E. Free recall of bilinguals. Journal of Verbal Learning and Verbal Behavior, 1968, 7, 1065-1071.

Olton, R.M. Semantic generalization between languages. M.A. thesis, McGill University, 1960.

Penfield, W., & Roberts, L. Speech and brain-mechanisms. Princeton, New Jersey: Princeton University Press, 1959.

Preston, M.S. Inter-lingual interference in a bilingual version of the Stroop color-word test. Ph.D. Dissertation, McGill University, 1965.

Triesman, A.M. The effect of irrelevant material on the efficiency of selective listening. American Journal of Psychology, 1964, 77, 533-546.

Weinreich, U. Languages in contact. New York: Linguistic Circle of New York, 1953.

A TEST OF THE SINGLE-STORE MODEL FOR LINGUISTIC STORAGE IN BILINGUALS

by

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Abstract

This study was designed to test the single-store model for linguistic storage in bilinguals. Nineteen Spanish-English bilinguals and 19 English monolinguals heard 36 sentences, all spoken in English. Twelve were normal English sentences used as a control variable; 12 contained Spanish word order and served as a syntactic variable; and 12 contained word-for-word translations of Spanish idioms and served as a semantic variable.

The dependent measure was a phoneme monitoring task; thus subjects had to press a button when they heard a particular phoneme within each sentence. The phoneme for which they were to listen was specified at the beginning of each sentence. Also immediately following each sentence, subjects wrote down as much of that sentence as they could recall. This task insured semantic processing by the subjects.

Results showed that bilingual subjects pressed the button equally quickly for all types of sentences, but monolinguals pressed the button significantly faster for control items than for idiom translation items. Also, control items were responded to significantly faster by monolinguals than by bilinguals.

The first of these significant differences was interpreted to mean that a knowledge of Spanish helped the bilinguals in processing the test items semantically, since they seemed to understand all sentence types equally well. It was taken as support for the single-store hypothesis. The second of the significant differences was attributed to the relative familiarity with English of the two groups. English was the second

language for most bilinguals and the native language for all monolinguals. Also, a lack of sufficiently balanced bilinguals could have slowed down reaction times for this group.