BILINGUAL MEMORY ORGANIZATION:
TESTING THE INDEPENDENCE MODEL

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In the days before the building of the Tower of Babel, it is said that all men shared a common language. The tower, built to reach the heavens, was felled as a divine punishment towards man. As every stone of the tower separated and fell in its own direction, so did every element of this common tongue, in order that mankind could never unite to rebuild this ill-fated tower.

Men, being ingenious creatures, overcame this inability to communicate by learning each other's languages. Thus we had reached the point where the differences in languages ceased to be barriers in communication. We may now wonder at mankind's ability to have achieved this interlingual communication system and we now seek an understanding of the processes involved.

This paper will examine the memorial aspects of bilingualism. In order to be considered bilingual, a person must have the ability to use two different languages. Memorial organization is a bilingual speaker has been the object of much debate within the last fifteen years. Basically, two viewpoints have emerged, and this paper will review past attempts to resolve the controversy, as well as offer additional evidence in support of one theory. Early research in this area tended to support an independence model of bilingual memory, which held that each language is separately
stored and independent of the bilingual's other language. From later studies in this area emerged the interdependence model of bilingualism, which proposed the concept of a single store memory with dual access routes.

An early twentieth century linguist, Whorf, (1956, Rosch, 1973) shook the foundations of linguistic theory in his proposal of the theory of linguistic relativity. Whorf described language as merely a tool for expressing the relationships between objects or ideas. He asserted that mere knowledge of the vocabulary and grammar of a foreign tongue did not amount to understanding the language. The theory of linguistic relativity proposed that every language represents a unique "world view," that existed independently of the vocabulary and grammatical rules. This "world view" was conceived of as being a supralinguistic organization of the mind that expressed itself through the native language of the people that shared this "world view." Thus, languages were essentially isolated and independent of each other and to apply rules allowing translation between languages was a superficial and futile endeavor. In a monolinguis-
tic society, such as that found in the United States, such a theory has not met with much acceptance. In essence, this theory implies that a person speaking a language different from the language of any other person also perceives the world in a different manner as well.
In accordance with this theory, we can but hope to achieve a superficial understanding of the second language via the translation process. This theory represents the extreme independence model of bilingual memory, as it necessitates separate storage of each language involved.

Rosch (1973) has recently explored the theory of linguistic relativity in detail. Her work points out the difficulty of doing empirical study of this theory. Her work attempts to approach the "world view" from the perspective of natural categories. She felt that certain categories were natural to all humans, regardless of the language they might speak. Naming of colors promised to be a workable concept and she was fortunate to have discovered a contemporary Pre-Stone Age civilization that lacked any terminology for discriminating between colors. This civilization, the Dani tribe of West New Guinea, had but terms for light and dark colors. These terms referred to the brightness of a color, but not the hue itself. Her studies of these people demonstrated that indeed a natural categorization of the color spectrum existed, even if the perceivers of this color lacked an appropriate term in their language. These findings can be used to severely question the validity of Whorf's theory of linguistic relativity in that semantic concepts, in this case colors, existed apart from an appropriate terminology within the perceiver's experience.
The study of the organization of memory was expanded by Tulving (1962). His study analyzed the clustering of unrelated words in a free-recall experiment. Evidence was found for significant, consistent, but idiosyncratic clustering based upon the protocols of the individual subjects.

The study of memory is closely related to the study of organization. Mandler (Melton & Martin, chap. by Mandler, 1972) asserts that the terms "memory" and "organization" may almost be considered equivalents. He argued that in order to recall an item from memory, one must first have organized the item within the memory in some manner to make it retrievable.

Free recall research has served as the original vehicle in verbal learning used to emphasize the role of organization within memory. This task offers the experimenter the opportunity to vary the amount of organization available to the subject during the initial encoding and later compare this organization with that present upon recall. The technique of free recall, using categorized lists, has been used extensively, and while the experimenters have many other possible techniques at their disposal, free recall is one of the most versatile, and thus is applied to the study of related areas, such as bilingualism.
Bilingual memory organization. The bilingual speaker provides a unique subject for the study of memory organization. A bilingual, being fluent in two languages, appears to be able to switch from language to language at no apparent cognitive loss to himself. The question here arises concerning the memory organization present in the bilingual speaker. Does each of the bilingual's languages operate independently of the other, with separate, parallel memory stores, or does the bilingual have but one, shared memory store with dual access routes? In essence, the independence model assumes complete separation of the languages, joined only by translation processes. In comparison, the interdependence model assumes a single, supralinguistic system of organization, yet one capable of processing information in either language. Language becomes but a non-semantic category for the classification of incoming information, superceded by the semantic conceptualization of the item itself. Thus, according to the interdependence theory, words are categorized according to the semantic concept they represent, rather than by the language of presentation. In contrast, the independence model assumes that words are classified according to the language of presentation and remain stored within that distinct categorization. These models are obviously incompatible and much work has been done in the past fifteen years attempting to solve the inde-
pendence-interdependence question. Figure 41 represents graphically the two opposing viewpoints.

The independence-interdependence viewpoints first arose as a result of Kolers' (1963) work on bilingual memory. The independence model found early support, primarily through the work of Kintisch and Kintisch (1969), Kolers (1963, 1965), Lambert, Ignatow, and Krauthamer (1968), Tulving and Colotlia (1970) and others. The interdependence model has found support in recent years from the work of Liepmann and Saegert (1974), Lopez and Young (1974), McCormack and Novell (1975), Rose and Carroll (1974), Saegert, Hamayan, and Ahmar (1975) and others.

The classic empirical data supporting the two models are presented below.

Independence theory. Kolers' (1963) earliest study in this area outlined the original independence-interdependence hypotheses, often referred to as the separate-shared memory store hypotheses as well. Kolers' (1963) experiment consisted of administering a word-association task to three groups of bilingual individuals. The conditions varied from presenting the stimulus word in English and requiring a response in English, or presenting the original stimulus in the native (non-English) language and requiring a native language response. In addition, included were conditions requiring responses in the language other than the one used for the initial stimulus
INTERDEPENDENCE MODEL

INPUT

LANGUAGE 1

T

MEMORY S

LANGUAGE 2

OUTPUT

INDEPENDENCE MODEL

INPUT

LANGUAGE 1

T

M_{L1}

LANGUAGE 2

M_{L2}

OUTPUT

T: TRANSLATION
M_{L1}: MEMORY FOR LANGUAGE 1
M_{L2}: MEMORY FOR LANGUAGE 2
S: SHARED

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presentation. Their results indicated that approximately one-third of the subjects, when in the mixed language condition, gave translated versions of the stimulus word as responses.

Kolers' later work (1966) explored the processes of reading and talking bilingually. Subjects were presented passages that were written in both French and English. Some of the passages mixed languages by alternating sentences of equal length, while other passages consisted of words mixed haphazardly in accordance to language and syntax. The rate and performance of the bilingual subjects reading these passages was compared with their own performances reading passages uniformly written in one language or the other. It was found that the time necessitated by the switching between languages amounted to being approximately .3 to .5 seconds. However, comprehension was only slightly more difficult while reading mixed passages, while reading these passages aloud became increasingly difficult for the subjects.

Quite a number of free recall studies have been run using bilingual subjects. A bilingual subject presents the experimenter with a unique opportunity to study semantic organization following input of linguistic information. The experimenter may vary the language of input, seeking insight as to the form this information takes upon encoding and recall.
A study by Tulving and Colotla (1970) is a classic example. They proceeded to run a series of experiments examining the free recall of unilingual, bilingual and trilingual lists. Their results indicated that recall from primary memory was not affected by language of presentation, but that the recall of material from secondary memory was indeed impeded by lists of words presented in mixed language form. It was undoubtedly easier to recall a list of words presented in a single language as compared to a list of words presented in two or three languages at one time, within one list.

This result, obtained by Tulving & Colotla is in agreement with the work done by Kintsch and Kintsch (1969). Their study examined the free recall of bilingual material by bilingual speakers from material stored in primary memory alone. Subjects were presented with lists of adjectives and later a probe list was given to determine which words were seen previously. Subjects were found to remember the language of presentation of an item, but had difficulty in remembering the semantic content of the items. This was interpreted as the perception of an acoustic component in encoding, rather than a semantic component in primary memory encoding.

Interdependence theory. Rollers, originally the proponent of the independence theory, presented further studies in 1966, which have been interpreted as being supportive
of the interdependence theory. Kolers' study (1966) examined the facilitation effect found in recall of items presented several times within a single long list. The probability of recalling a word within a list increases proportionately with its frequency of occurrence. This facilitation was found by Kolers to occur across languages as well. The probability of recalling a word and its translation when presented n/2 times within a list was found to be approximately equal to presenting a word in one language alone n times.

Tulving and Colotla (1970) argue that this facilitation is due to the well-established habit of translating between languages. This translation would seem most likely in bilinguals who differ in their proficiency in each language (Goggin and Wickins, 1971), whereas a well-balanced bilingual would have no intuitive reason to translate between languages, each language being equally well established.

Lopez and Young (1973) further investigated this translation hypothesis. Bilingual subjects were first familiarized with lists of words in either Spanish or English. This was done by having the subjects simply read their list six times out loud. They were then told that the experiment would begin and were asked to learn a list of words. These words, depending upon the group they were given to, consisted of words that were either
exactly the same as those in the previously seen list, translated equivalents of the previously seen words, or a list of words totally different from those the subjects had seen before. Familiarization effects, similar to those seen in the experiment by Kolers (1966), were found both within and across languages in this experiment. No differences were found in the number of words recalled by either group.

A study by Liepmann and Saegert (1974) investigated the theory of language-tagging as a non-semantic attribute of language storage. They employed a paradigm used by Anderson and Bower (1972), which involved free recall of a series of lists, each of which the subjects had seen but once. However, many of the words were repeated between lists. Anderson & Bower report increasing difficulty in recall of the words as the number of lists presented to the subjects increases. This was attributed to increasing confusion as to the list membership of the words. Liepmann & Saegert altered the paradigm to test the bilingual independence-interdependence hypotheses. Lists were constructed that contained many repeating items across lists, yet many of the repetitions were done in translation of the original presentation. Their data indicated that the subjects experienced greater difficulty in recalling the items as number of lists presented increased. Thus, the subjects experienced increased confusion not
only in relation to list membership, but to language of presentation as well.

The ability to remember language of presentation was studied by Saegert, Hamayan and Ahmar (1975), using a paradigm used by many other experimenters in studying modes of presentations. Bray and Batchelder (1972) studied auditory versus visual modes of presentation, Light, Stansbury, Rubin & Linde (1973) compared pictorial versus verbal presentations of material for recognition, and Kolers (1973) compared normal versus distorted type presentations, among other experimenters. The general procedure involved presenting subjects with word lists presented half in one mode and half in the other mode. Subsequently, they are asked to recognize which of the later presented items were presented previously during the first part of the experiment. The overall results indicated that the subjects revealed a great ability to remember non-semantic attributes of the words presented. The work done by Saegert, Hamayan and Ahmar (1975) indicated that the multilinguals in their studies showed a great ability to remember the language of presentation for linguistically mixed materials, thus extending the list of non-semantic attributes to include language of presentation.

The independence-interdependence issue was also studied using a reaction-time paradigm. This study
(Colletta, 1975), involved a same-different judgement task. The subject was presented two words at once and their task was to judge whether the two items were the same. For the purposes of the experiment, translations of words were to be judged as being the same. Colletta found no significant differences in reaction-time necessary in making a same-different judgement between languages as compared to making the same judgements within languages.

Logic and Design of Present Experiment. In order to further test the independence-interdependence theories, the following experiment was run. The task was one of recalling a series of unilingual lists of words, all taken from a single semantic category. For the control groups, (balanced for language), the language of presentation remained constant. The experimental groups were given a second list to recall consisting of all the words taken from the first list, yet in translation. The controls were presented a second list of words in the same category, but consisting of words totally different from those presented in the first list. According to the extreme independence position, both the controls and the experimental groups should experience equal difficulty in recalling the items, as twenty items stored in one language should be equally difficult to recall as ten words stored in one language in addition to ten words.
stored in another language. The interdependence theory would predict facilitated recall in the experimental groups, as they have simply relearned the same ten semantic concepts a second time, along with the appropriate language tags. In essence, they have but to recall ten semantic concepts, while the control groups, according to this position, must each recall twenty concepts. This theory would predict a high rate of recall from the experimental groups as compared to the recall of the control groups. Figures 2 and 3 graphically describe the conceptions of the experimental and control groups, as would be understood by each viewpoint.
EXPERIMENTAL GROUPS:

**Figure 2**

**INDEPENDENCE MODEL INTERPRETATION**

**INTERDEPENDENCE MODEL INTERPRETATION**

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INDEPENDENCE MODEL INTERPRETATION

INTERDEPENDENCE MODEL INTERPRETATION

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METHOD: Subjects: The subjects were 32 bilingual speakers. Each speaker was fluent in both the Latvian and English language. All were participants in an ethnic seminar that had as a prerequisite fluency in the Latvian language. All subjects were either young Americans or Canadians for whom the everyday language was English.

Assignment of subjects to conditions was done in a random order, depending upon their decision of table at which they had chosen to sit at in the experimental room. No table was more appealing than any other.

Design: On Day One, each group of subjects was given a ten-word list in either Latvian or English. The lists were equivalents of each other. The subjects then proceeded to learn the lists to criterion. On Day Two, the subjects were first asked to recall the list learned on Day One. After completing this task, the subjects were given a second list of ten words to learn to criterion. The "shift in language" groups received the first list in translation, while the "same language throughout" group received a list of words in the same language as they had received on Day One, but consisting of ten totally different words. All the words were taken from the same category, insects. On Day Three, the subjects were asked to recall the list of words learned on Day Two. The experimental design is illustrated in Table #1. One experimenter tested the subjects.

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Materials: The verbal materials used in this study were determined by using the Battig and Montague (1969) norms for word frequency, selecting equally low, medium and high frequency words for all lists involved. The translated lists were examined by several non-speakers of the language in order to avoid words that may be perceived as being similar in sound or orthography to their counterparts in English. The translations were judged as being sufficiently different so as not to provide clues for the translated form of the same word. All words used were of a single semantic category, insects. List A refers to a list of ten semantic concepts, all insects, presented in either Latvian or English. List B refers to another list of ten semantic concepts, all insects, yet none were repeated from List A. List B was also presented in either Latvian or English. The Latvian language is a member of the Indo-European language family, yet it is a rather distant relative of English, being more closely similar to Lithuanian and Sanskrit.

Procedure: Both lists A and B were printed in large block letters on two separate sheets of white paper (standard size). Two sheets of paper were used per list.

On Day One, each subject received several sheets of blank paper on which to record his or her recall lists. All groups were presented with List A (in the appropriate language) and were asked to memorize these words (each subject doing so individually). The lists were then
removed and the subjects were then asked to recall the words, writing them down on their individual sheets of paper. Upon completion of recall, these sheets were removed and this procedure was repeated until criterion (9/10 words) was reached. On Day Two, the subjects were again given several sheets of paper. First, they were asked to recall and record as many of the words learned on the previous day as possible. These sheets were then collected and the second list of ten words were presented. This was either a list of previously unseen words (List B) in either language, or the translated version of List A, given in the language not used for presentation on Day One. The learning procedure was followed as on Day One until this second list was also learned to criterion.

On Day Three, the subjects were given sheets of paper and were asked to recall and record the second list of words they had learned (on Day Two).

This design is illustrated in Table #1.

RESULTS: A one-way analysis of variance was performed on the number of words recalled on Day Three from the second list of words (those learned on Day Two). The experimental groups recalled significantly more words than did either control group; F (1,31) = 4.17, significant at the .05 level. The results are illustrated in Table #2.
<table>
<thead>
<tr>
<th></th>
<th>Experimental</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Day 1</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shift in</td>
<td>Learned</td>
<td>Learned</td>
</tr>
<tr>
<td>language</td>
<td>in Latvian</td>
<td>in English</td>
</tr>
<tr>
<td>Group 1</td>
<td>List A</td>
<td>List A</td>
</tr>
<tr>
<td>Shift in</td>
<td>Learned</td>
<td>Learned</td>
</tr>
<tr>
<td>language</td>
<td>in English</td>
<td>in Latvian</td>
</tr>
<tr>
<td>Group 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Same language</td>
<td>List A</td>
<td>List A</td>
</tr>
<tr>
<td>throughout</td>
<td>in Latvian</td>
<td>in English</td>
</tr>
<tr>
<td>Group 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Day 2</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recall</td>
<td>Recall</td>
<td>Recall</td>
</tr>
<tr>
<td>List A</td>
<td>List A</td>
<td>List A</td>
</tr>
<tr>
<td>in English</td>
<td>Learned</td>
<td>Learned</td>
</tr>
<tr>
<td></td>
<td>in Latvian</td>
<td>in English</td>
</tr>
<tr>
<td><strong>Day 3</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recall</td>
<td>Recall</td>
<td>Recall</td>
</tr>
<tr>
<td>List A</td>
<td>List A</td>
<td>List B</td>
</tr>
<tr>
<td>in English</td>
<td>in Latvian</td>
<td>in English</td>
</tr>
</tbody>
</table>

|               |              |         |
| **Day 4**     |              |         |
|               |              |         |

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<table>
<thead>
<tr>
<th>Shift in language</th>
<th>Subjects per group</th>
<th>Mean recall of second list learned</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1 L₁ to E₁</td>
<td>8</td>
<td>8.25</td>
<td>1.98</td>
</tr>
<tr>
<td>Group 2 E₁ to L₁</td>
<td>7</td>
<td>9.86</td>
<td>0.37</td>
</tr>
<tr>
<td>Same language throughout Group 1 L₁ to L₂</td>
<td>8</td>
<td>6.75</td>
<td>3.24</td>
</tr>
<tr>
<td>Same language throughout Group 2 E₁ to E₂</td>
<td>9</td>
<td>8.11</td>
<td>1.36</td>
</tr>
</tbody>
</table>
DISCUSSION: This experiment was designed to test the extreme independence hypothesis. According to this position, no significant differences were expected to be found between the control and experimental groups, as twenty words presented in one language were expected to be equally difficult to remember as ten words in one language in addition to ten words in another language. The results, however, indicated a significant difference in recall between the experimental groups and the control groups. The interdependence hypothesis would have predicted a facilitation in recall in the experimental groups, as this view argues that those subjects learning ten words in one language and the same ten words in another language are learning but ten concepts, not twenty, as the independence hypothesis upholds. The results support this interpretation of the facilitation found in the recall of the experimental groups.

However, this is not a test of the extreme interdependence theory. Such an experiment could be the basis of further research. In this experiment, only two lists were used, but a test of the interdependence theory could perhaps include a series of ten trials, with subjects learning five lists in one language and the translations of these five lists in the other language, while the controls learned ten lists in one language alone. This experiment was also affected by the ceiling effect.
which could in future studies be raised by increasing the number of items per list or presenting a larger number of lists to learn. In addition, perhaps the use of unrelated items, taken from various categories, could raise the ceiling by increasing the difficulty of recalling the items.

A possible difficulty in the interpretation of these results may arise from the unfortunate oversight in not using the same words during the critical trials during recall. One half of the subjects were recalling List A while the other half recalled List B. While both lists were matched for word frequency, this would have been another appropriate control group to run.

Intuitively, the interdependence model is the better of the two models for describing the storage of several languages by a single bilingual speaker on the grounds that it is a more parsimonious theory. Language of presentation was interpreted by various experimenters to be a non-semantic attribute (Saegert, Hamayan and Ahmar, 1975) and as such was viewed as an abstract representational tag, existing of itself, independent of the word to which it was attached. This view of language tagging was discussed by Hintzman, Block, and Innskeep (1972), who proposed two theoretical alternatives for the encoding of non-semantic attributes. First, these attributes may be encoded as abstract propositions, or secondly, they may
be retained as literal copies of the original attributes. Independence theory suggests that the attribute of language is stored directly in a separate memory store allotted for that specific language, while the interdependence theory separates the language attribute from the item itself, retaining the attribute in an abstract representational form alongside the item in a common memory store. The argument in favor of the interdependence theory rests upon the unlikelihood of one's creating a separate memory store for every non-semantic attribute one might attend to; thus, the likelihood of separate memory stores for each of a bilingual's languages is improbable.

However, Rose, Rose, King and Perez (1975) interpreted the retention of non-semantic language information to be on a continuum, along with the retention of other non-semantic information. Thus, perhaps the actual model may be an interaction model, somewhere to be found between either extreme position. This remains to be explored by further investigations.
REFERENCES:


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