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ALTENBERG, EVELYN P.

BILINGUAL LEXICAL RETRIEVAL

City University of New York

PH.D.

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BILINGUAL LEXICAL RETRIEVAL

by

EVELYN P. ALTENBERG

A dissertation submitted to the Graduate Faculty
in Linguistics in partial fulfillment of the
requirements for the degree of Doctor of Philosophy,
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1981

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This manuscript has been read and accepted for the Graduate Faculty in Linguistics in satisfaction of the dissertation requirement for the degree of Doctor of Philosophy.

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Charles E. Cairns
Chairman of Examining Committee

Alan M. Stevens
Executive Officer

Charles E. Cairns

D. Terence Langendoen

Virginia V. Valian
Supervisory Committee

The City University of New York

ABSTRACT

BILINGUAL LEXICAL RETRIEVAL

by

Evelyn P. Altenberg

Adviser: Professor Helen S. Cairns

Two questions about bilingual language processing were investigated: 1) Does the bilingual have one unified language processing system, used for processing in both languages, or two processing systems, one for each language?, and 2) If the bilingual has two language processing systems, is one "shut off" while the other is "on," or are both systems always available and/or operating? These two questions were examined with respect to one aspect of bilingual processing: bilingual lexical retrieval.

It was demonstrated that a monolingual lexical retrieval system must have at least a scanner, containing a knowledge of phonotactic constraints, and a lexicon, containing linguistic tags (words) and their semantic representations. A search model of monolingual lexical retrieval was assumed.

Experiments 1 and 2 investigated the question of whether the bilingual has one or two sets of phonotactic constraints. German-English bilinguals rated the acceptability of visually presented nonwords as new words of German or new words of English. The nonwords were either legal in both languages (e.g., FLESS), illegal in both languages (e.g., TLON), legal only in English (e.g., TWIF), or legal only in German (e.g., ZWOK). It was found that bilinguals rated the last two groups differently, depending on whether the items were rated as potential English or potential German words. It was also found that the bilinguals' ratings in English were the same as the ratings of a monolingual English control group. Thus, the bilingual has a knowledge of two sets of phonotactic constraints, one for each language, and the constraints for English are the same as those of English monolinguals.

Experiments 3 and 4 investigated the question of whether the bilingual's two lexical retrieval systems (i.e., two sets of phonotactic constraints and two lexicons) are always available during processing. The experiments were lexical decision tasks, in which the nonwords were the same four groups used in the rating task. The lexical decision task is sensitive to phonotactic constraints, since monolingual reaction time is faster for illegal nonwords than for legal nonwords.

The major finding was that bilinguals had a different

overall pattern of reaction times to the items than did the monolingual control group. This would not be expected if the bilingual simply "shuts off" the retrieval system of one language while processing in the other. Thus, both lexical retrieval systems must be operating during bilingual lexical retrieval.

Another finding was that there was no difference in overall reaction time between monolinguals and bilinguals. One can thus reject any model of bilingual lexical retrieval which assumes that bilinguals always add an extra step during retrieval, which monolinguals do not. Further, the bilingual must organize the words from both languages into two separate lexicons, rather than one large lexicon, since one large lexicon would incorrectly predict longer bilingual reaction times, due to longer search times.

A number of possible models of how bilingual lexical retrieval might work, if both systems are operating during processing, were examined. It was concluded that a parallel exhaustive model best predicts the results. According to the parallel models, the bilingual has two lexical retrieval systems and both systems are always simultaneously operating during lexical retrieval. Further, according to the parallel exhaustive model, the bilingual does not make a decision in the lexical retrieval task, or during language processing, until input from both lexical retrieval systems has been received.

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Chapter 1

INTRODUCTION

The major focus of this dissertation will be two questions relevant to bilingual language processing. They are: 1) Does the bilingual have one unified language processing system, used for processing both languages, or two processing systems, one for each language? and 2) If the bilingual has two language processing systems, is one "shut off" while the other is "on," or are both systems always available and/or operating? The hypothesis that one system is operating while the other is shut off will be called the monolingual hypothesis, since it assumes that the bilingual processes as a monolingual does. The hypothesis that both systems are used in processing will be called the bilingual hypothesis.

The term bilingual will be used to refer to an individual who is fluent in two languages, with native or near-native ability in both. It will not refer to a language learner, or to an individual who is not proficient in both languages.

Questions 1) and 2) will be examined with respect to

one aspect of bilingual language processing: bilingual lexical retrieval. Lexical retrieval is the process of retrieving words from memory, in order to produce or comprehend spoken or written speech. It will be demonstrated that a monolingual lexical retrieval system must have at least a scanner, containing a knowledge of phonotactic constraints, and a lexicon, containing linguistic tags (words) and their semantic representations. Phonotactic constraints are those rules which indicate, for a given language, which sounds can be combined with which other sounds to form words. With respect to bilingual lexical retrieval, questions 1) and 2) can thus be formulated as follows: 1) Does the bilingual have one set of phonotactic constraints and/or one lexicon, used for lexical retrieval in both languages, or two sets of phonotactic constraints and/or two lexicons, one for each language? and 2) If the bilingual has two sets of phonotactic constraints and/or two lexicons, is one "shut off" while the other is on (the monolingual hypothesis) or are both always available and operating (the bilingual hypothesis)? Five experiments which are relevant to these questions will be described. It will be concluded that the bilingual has two lexical retrieval systems, i.e., two sets of phonotactic constraints and two lexicons, one for each language. It will also be demonstrated that both lexical retrieval systems are always available and operating.

The first section of chapter 2 will discuss the literature relevant to bilingual language processing. It will deal with the question of whether the bilingual has one or two sets of rules for processing, and one or two mental lexicons (question 1). It will be demonstrated that, at the level of sentence processing, much of the experimental evidence is equivocal with respect to question 1, although it will be argued that it is most reasonable to assume that the bilingual has two syntactic processing systems. The literature dealing with the categorical perception of phonemes supports the hypothesis that phonemes are perceived by bilinguals via a unified processing system which is used for processing in both languages. The results of studies dealing with the perception of phonotactic constraints suggest that the bilingual has two sets of phonotactic (or graphemic) constraints, one for each language. (This will be confirmed by experiments 1 and 2, described in chapter 4.) It will also be argued that the bilingual's lexicon contains two sets of semantic representations linked to two sets of linguistic tags, one set from each language.

Assuming that the bilingual has two sets of phonotactic constraints and two sets of linguistic tags, chapter 2 continues with a discussion of the literature relevant to the question of whether the two sets of phonotactic constraints and two sets of linguistic tags are

simultaneously available during processing. This is question 2, the monolingual vs. bilingual hypotheses. The review of the small body of relevant literature suggests that both sets of constraints may be available to the bilingual, supporting the bilingual hypothesis. The final section of chapter 2 will discuss the literature relevant to theories of monolingual lexical retrieval.

Chapter 3 contains a discussion of theories of bilingual lexical retrieval. It then describes the rationale behind the design of the five experiments, and the overall procedure used in running the studies.

Chapter 4 describes experiments 1 and 2, in which monolingual and bilingual subjects rated the acceptability of visually presented nonwords. The results of these experiments are relevant to question 1 because they confirm the existence, for the bilingual, of two sets of phonotactic constraints.

Chapter 5 describes two lexical decision tasks (experiments 3 and 4) which address question 2. The results of these experiments indicate that the bilingual hypothesis most accurately describes bilingual lexical retrieval. That is, the results support the hypothesis that both lexical retrieval systems are simultaneously available to the bilingual. The results also provide evidence for deciding among some of the specific models possible under the bilingual hypothesis. Experiments 3 and 4 also provide

data which shed some light on the operation of the scanner.

In addition, the lexical decision tasks provide evidence indicating that the bilingual's two sets of linguistic tags are stored separately, rather than in one large lexicon. Question 2 is again raised: are these two sets of linguistic tags simultaneously available for accessing, or is one set shut off while the other is on? Experiment 5, discussed in chapter 6, addresses this question. Its results are problematic and cannot be interpreted as support for either position.

Chapter 7 concludes with a brief discussion of the findings and their relevance to a theory of bilingual lexical retrieval.

Chapter 2

LITERATURE DISCUSSION

BILINGUAL LANGUAGE PROCESSING

One vs. Two Language Processing Systems

This section addresses the question of whether the bilingual has one unified system for language perception, used for processing both languages, or two processing systems, one for each language. The discussion of the literature relevant to this question is divided into two parts: the first deals with the bilingual's processing of rules; the second addresses the question of whether the bilingual has one or two lexicons.

One vs. Two Sets of Rules

The following discussion of the literature is organized according to the level of language processing which the studies tap.

Sentence processing. Diller (1974, p. 259) makes an excellent point when he states that it would be impossible for a proficient bilingual to have a merged syntactic system, since "no two languages are grammatically similar enough to be compoundable." Technically, of course,

any two syntactic systems can always be compounded in the sense that there can always be one system containing two sets of rules, one set for each language. However, there would never be any reason to compound two systems in this way. The spirit of Diller's argument remains true, i.e., no two syntactic systems are so similar that the same rules can be used for each language. One can at most suggest that the bilingual has one set of rules for those rules that are the same in both languages, and two separate sets of rules for places in which the syntax of the languages differ.

Taylor (1976) notes that a bilingual may fail to understand a language that is known to him if it is contextually unexpected. This is evidence for two perceptual systems, with one shut off while the other is on.

Macnamara (1967a) assumes that the bilingual has two separate language systems, with an output switch and an input switch.

A bilingual can decide to speak in one language rather than the other independent of his environment, and so he acts as though he had a language switch controlling his language output system. On the other hand, when he sees some print or hears some words in one of his languages he automatically carries out the decoding process in the appropriate language. In this case he acts as though he had a language switch at the beginning of his input or decoding system which is controlled by the environment. (p. 67)

Most of the experiments dealing with sentence processing have been interested in testing whether or not

switching from one language to another takes time. It will be demonstrated that the results of some of the switch experiments conflict with one another. Also, they share a common methodological problem. Further, it will be demonstrated that the switch experiments in general cannot provide direct evidence for question 1 at the level of sentence processing. This is because, if no switch time is found, there could still be two systems which operate simultaneously and speakers require no time to go from one to another. If a switch time is found, the studies described below cannot indicate at which level the switch is being made. That is, the studies cannot indicate whether the switch is occurring at the syntactic, lexical, or phonological/graphemic levels (or at any combination of these).

Kolers (1968) had bilingual subjects read unilingual and bilingual passages aloud and silently. Bilingual passages contain sentences which are made up of some words from one language and some words from another. He found that with silent reading, bilinguals' scores on a comprehension test based on the passages were equal to the scores of monolinguals on the unilingual passages. (The bilinguals had to read the passages in the same amount of time that monolinguals had needed for them.) However, he found that bilingual subjects needed more time to read bilingual passages aloud than to read unilingual passages

aloud. He concludes that reading aloud requires switching while reading silently requires no switching. The difference between reading aloud and reading silently could be due to the fact that reading aloud requires speech production in addition to perception. There may be switching only in production. Further, in reading silently it is possible that no switch was noted because subjects could skip words since context could often supply the needed information. In reading aloud, words could not be skipped.

Macnamara and Kushnir (1971) describe a series of experiments in which bilingual subjects read bilingual and unilingual passages and sentences. Their results conflict with those of Kolers because they found that switching during silent reading of passages took an observable amount of time. Further, they found that when subjects were asked to judge the truth or falsity of sentences they read silently or heard on tape, reaction times increased with the number of language switches in the sentence. Surprisingly, however, they found that providing subjects with visual cues so that they could anticipate the switches slowed them up. They conclude that this is because subjects tried to alert both systems at once. However, if there is a switch here, there is no way of knowing at which level(s) of processing the switch occurs.

Neufeld (1976) attempted to replicate some of Macnamara and Kushnir's findings, with switches limited to

single lexical substitutions. Like Kolers, he found that subjects reading passages and sentences needed no time to switch. When subjects heard sentences on tape and the lexical substitutions occurred randomly, switching took time but when the substitute words were placed at phrase boundaries, switching did not take an observable amount of time. Again, if there was a switch, there is no way of knowing, on the basis of this study, at which level(s) of processing the switch occurred.

Pandi (1975) also had subjects judge sentences as true or false. He found that a sentence was judged as true or false as rapidly if it was preceded by a sentence in the other language as if it was preceded by a sentence in the same language. He suggests, on the basis of the above results, that bilinguals can maintain activity in two sets of language-specific processes and require no time to switch from one set to another. However, he found that mixed sentences which had to be judged true or false took longer to be processed. He attributes this to violations in syntax in the mixed sentences. His results can also be interpreted as support for the position that switching within sentences imposes a burden on processing, while switching between sentences does not. Again, if there is a switch, this study cannot indicate at which level the switch occurs.

Wakefield, Bradley, Yom and Doughtie (1975)

demonstrated that for bilingual subjects sentences in which the language switch occurred within major constituents took more time to process than sentences in which the switch occurred at a major boundary. This fits in with Neufeld's and Pandi's findings and suggests that switching languages imposes a burden and that it is easier to handle this extra burden at certain points during processing than at others. If there were one unified system of processing, switching languages should not impose a burden, and it should be irrelevant where switches occur. The authors' results are supported by Lipski's (1978) finding that bilingual code-switching obeys a rather stringent set of sentential constraints. Again, however, there is no way of knowing whether the switch occurred at the syntactic, lexical or phonological levels.

There is a problem with the Wakefield et al. study. Subjects were divided into a Main group (whose sentences had language switches occurring at the major constituent boundaries) and an Off group (whose sentences had language switches occurring at a point within one of the major constituents). Thus, it was possible for subjects in the Main group to anticipate those points in the sentence where a switch was likely to occur. For example, one of the sentences is, The number of persons who have taken up parachuting as a sport/ está definitivamente aumentando (is definitely increasing). Subjects might anticipate a

switch at that boundary if it had not occurred earlier in the sentence. It would be interesting to compare reaction times when the switch occurred early in the sentence to when it occurred later, as well as to replicate the study with the same subjects getting both Main and Off sentences.

As stated above, the findings of the switch experiments are equivocal. For example, the results of Kolers (1968) and Wakefield et al. (1975) conflict with one another as do the findings of Macnamara and Kushnir (1971) and Neufeld (1976). Further, Neufeld's and Macnamara and Kushnir's and Pandi's results may have been influenced by the fact that some sentences may be harder to judge as true or false than others. Also, as pointed out by Pandi, by interpolating some words from one language onto a passage or sentence from another language, one runs the risk of having syntactically odd sentences. Although the authors attempted to minimize such oddities, it is possible that they were not eliminated entirely. This is a problem for all of the switch experiments. Thus, the findings of Neufeld, Pandi and Wakefield et al., which can be interpreted as suggesting that it is easier for the bilingual to handle a switch at a sentence boundary than within a sentence, can also be due to the fact that putting the switch at a sentence boundary will lead to less violations in syntax than having a switch occur within a sentence. Finally, even if there is a switch, there is no way of knowing, on

the basis of the above experiments, at which level it occurs.

Forster and Clyne (1968) present evidence which supports the view that bilinguals have two sets of processing strategies at the syntactic level. Since they do not use a switch experiment, their results are not subject to the problems of the switch experiments. Bilingual subjects were given a sentence-completion task. Some sentences were right-deleted (the second half of the sentence was deleted) and some were left-deleted. Data with monolinguals indicated that German monolinguals had smaller right-deleted - left-deleted differences than did English monolinguals. The authors found that "the results for bilinguals matched the results obtained for separate groups of German and English speakers, provided that the bilinguals were highly fluent in both languages" (p. 113). They state that "within the terms of sentence-completion experiments, the operating characteristics of the production systems of German and English speakers are comparable to those of bilingual speakers of both languages" (p. 119).

Their results suggest two separate systems at the syntactic level, with no interaction between them during the sentence completion task. Diller's argument that a proficient bilingual must have two sets of rules is thus supported.

Categorical perception of phonemes. The evidence from studies on bilingual categorical perception of phonemes suggests that at this level bilinguals perceive phonemes via a unified processing system used for processing in both languages.

Caramazza, Yeni-Komshian and Zurif (1974) conducted a study of the perception of voice onset time of Canadian French-English bilinguals. They noted that monolingual Canadian French speakers perceive voice onset time (VOT) differently from monolingual Canadian English speakers, specifically that French speakers "show both a wider range of perceptual uncertainty and a different division of the VOT continuum than . . . Canadian English speakers" (p. 312). They prepared stimuli sets consisting of syllables that varied only on VOT. For example, one set was perceived as ranging from /ba/ to /pa/. Bilingual subjects were tested in an English session and in a French session. Subjects were asked to indicate, for each syllable, whether it was the voiced or voiceless consonant of the pair (e.g., whether the syllable represented /pa/ or /ba/). The authors found that there was no significant difference in the perception of the syllables, regardless of language set. That is, the crossover values for the syllables were the same, regardless of language. (The crossover value is the point along the continuum of VOT at which subjects no longer perceive, e.g., /ba/ but rather perceive /pa/.)

The authors found, however, that production of stop consonants was different in the two sessions (i.e., VOT for /p,t,k/ was different, depending on language mode). Thus, although the bilingual subjects produced the consonants differently, they had a unified system of perception, regardless of language set.

A similar test of perception by Albert, Obler, Zurif and Caramazza (described in Albert and Obler, 1978, p. 39) with Hebrew-English bilinguals revealed similar results. "The perceptual performance curves for the bilinguals fell between those of the monolingual groups." Garnes (1977) tested the perception of duration of sounds with Icelandic monolinguals and Icelandic-English bilinguals. She found that bilinguals had less accurate perception than monolinguals, supporting the results of the other studies. Thus, the experimental evidence indicates that bilinguals have one processing system used for the categorical perception of phonemes in both of their languages.

Perception of phonotactic constraints. Phonotactic constraints are those rules which indicate, for a given language, which sounds can be combined with which other sounds. For example, the phonotactic constraints of English must specify that a word in English can begin with the sequence /bl-/. The word initial sequence /bz-/, however, does not meet the phonotactic constraints of English. These constraints have also been called morpheme structure

constraints (Halle, 1959) and have been represented in a competence grammar via lexical redundancy rules (Chomsky and Halle, 1968). A legal sequence in a language is one which meets the phonotactic constraints of that language; an illegal sequence is one which does not meet the phonotactic constraints of the language. A distinction should also be made between graphemic and phonemic legality and illegality. Just as there are constraints on sequences of sounds in a language, there are constraints on sequences of graphemes. Graphemic and phonemic legality may not always be identical. For example, in German the word-initial graphemic sequence CL- is illegal, although a possible pronunciation of this sequence, /kl-/, is phonemically legal. The term phonotactic constraints will be used to refer to either phonemic or graphemic constraints.

Godkewitsch (1972) spelled 80 pentagrams out orally in English to German-English bilinguals and English monolingual subjects. For example, ICHLY would sound like: eye-see-aitch-el-why. Half of the pentagrams were legal only in German and half were legal only in English. Subjects listened to the pentagrams through white noise, and then wrote down the letters. Subjects were scored as to their accuracy in correctly writing down the pentagrams heard through the noise.

Godkewitsch found that bilinguals did better on German than on English pentagrams, and that bilinguals made

more errors on English pentagrams than monolingual subjects. However, his conclusion that "language habits which are not relevant to the task at hand can 'supplement' relevant habits when the stimulus situation becomes more ambiguous" (p. 65), is not justified. Although the author assumes there are two sets of phonotactic constraints which can interact, the study provides no evidence for this, since these subjects were dominant in German, and could have had one set of rules which was more accurate for German than for English. These results also cannot be generalized because even if one assumes two sets of constraints in this case, there was no reason for subjects not to use rules from both of their languages, since subjects were not told the sequences would be from one language or another. There was no reason for them to shut one system off.

Anisfield and Gordon (1971) had one group of subjects which had had a single semester of German, and one group which had had introductory classes in French or Spanish. A tape of 48 nonsense words was played, and subjects had to rate them as potential English words on a scale of 1-5. (1=perfectly acceptable, 5=impossible.) The nonwords were either legal in both English and German (EG), legal in only one of the languages (\overline{EG} or \overline{EG}), or illegal in both ($\overline{\overline{EG}}$). In order to control for possible misperceptions of the nonwords subjects later wrote them down in regular English orthography. The categories \overline{EG} and $\overline{\overline{EG}}$ were so

highly misperceived that not enough items were left for a meaningful analysis of their acceptability.

The only significant difference between the German students and the control group was for the category $\bar{E}G$: German students, $\bar{E}G = .55$; control group, $\bar{E}G = .39$. The authors conclude that "exposure to German sounds improves their perceptibility" (p. 292).

This does not necessarily mean that these subjects had one processing system for both languages. It could simply mean that in a task involving writing down syllables heard on tape, which is not necessarily a language-specific task, subjects used whatever skills they had. The German students had had greater experience than the other students in distinguishing German syllables from English syllables.

The responses of the German students and the control group on the acceptability judgments also suggest that the results do not reflect a single processing system. This is because the responses for the $E\bar{G}$ stimuli are in the reverse direction from what one would expect: German students, $E\bar{G} = 2.42$; control group, $E\bar{G} = 2.69$. If the two systems influence one another in a general way, then illegal L_2 sequences should be less acceptable in L_1 .

It should also be pointed out that whatever conclusions are drawn from this study may apply only to second language learners and not necessarily to those who are

fluent in two languages, and whose grammar(s) are relatively stable.

Anisfeld, Anisfeld and Semogas (1969) played tapes of clusters plus vowel sequences to Lithuanian-English bilinguals. The consonant clusters were of four types: EL, E \bar{L} , $\bar{E}L$, and $\bar{E}\bar{L}$. In experiment I, subjects were asked to estimate for each cluster the number of native speakers of English, and the number of native speakers of Lithuanian, who would accept it as the beginning of a name for a new product. In experiment II, subjects were asked to indicate on a five-point scale ranging from "definitely yes" to "definitely no" whether each cluster actually did occur as the beginning of English words and as the beginning of Lithuanian words.

The authors assume that "If the bilinguals' judgments of acceptability in English were not influenced by their knowledge of Lithuanian, then there should be no difference between EL and E \bar{L} sequences . . . and between $\bar{E}L$ and $\bar{E}\bar{L}$ sequences" (p. 259). Thus, their null hypothesis for English is: $EL + \bar{E}L = E\bar{L} + \bar{E}\bar{L}$, and for Lithuanian is: $EL + E\bar{L} = \bar{E}L + \bar{E}\bar{L}$. Their results for bilinguals cause them to reject this null hypothesis and to conclude that "the two linguistic systems of the bilinguals studied were not tightly sealed off from each other" (p. 261).

However, their null hypothesis assumes that the four groups of consonant clusters are comparable on all factors

except their legal status. As the authors point out, the frequency of occurrence of the consonant clusters was not controlled and this could have been a variable influencing subjects' responses. Also, the degree of markedness of the clusters was not controlled, and this can also play a role, since Pertz and Bever (1975) demonstrated that adolescents and children have an awareness of the degree of markedness of consonant clusters that do not occur in their own language.

An additional problem with the study is that subjects' perception of the syllables was not controlled for, i.e., there is no way of knowing whether the consonant cluster perceived by the subjects was the same as that intended by the authors, since this was an aural task. There is strong evidence from Anisfeld and Gordon (1971), discussed above, that in fact subjects often do not correctly perceive illegal sequences. This receives further support from Cohen, Tucker and Lambert (1967), who demonstrate that French and English monolingual and bilingual subjects are least accurate in perceiving sequences that do not occur in either language, and most accurate in perceiving sequences that occur in both languages.

Also, it is not clear that experiment I taps only subjects' knowledge of phonotactic constraints, since it deals with the syllable's acceptability as the beginning of a name for a new product. Subjects may take factors

other than legality into account in making such a decision.

However, the results of the study suggest that bilingual subjects did not use the same constraints for processing in their two languages, since the results for $\bar{E}L$ and $E\bar{L}$ sequences were different for bilinguals, depending on language set. That is, in both experiments I and II, both older bilinguals and younger bilinguals rated $E\bar{L}$ nonwords as better in the English condition than in the Lithuanian condition, and rated $\bar{E}L$ nonwords as better in the Lithuanian condition than in the English condition.

This tentative conclusion received further support from a pilot study which I conducted with English-German bilinguals. The bilinguals were 50 years old or older. All spoke German natively and had been speaking English for at least 30 years. The monolinguals were 13 Queens College undergraduate students with no more than eight years of study of a language other than English. In no case was that other language German.

The stimuli were 56 nonwords which began with consonant clusters that were either legal in both languages, legal only in one language, or illegal in both languages. The average frequencies of the legal consonant clusters in each group were controlled. However, markedness of the clusters was not controlled. Frequency of the consonant cluster in each language was determined using word count books (Meier, 1964 for German and Kučera and Francis, 1967

for English.) The clusters were followed by either "a" or "i", and either "n", "s", or "t". (These are of high frequency in both English and German.)

Subjects were asked to rate the acceptability of visually presented nonwords as new words of English and as new words of German, where 1=completely acceptable and 5=completely unacceptable. The results are as follows:

	<u>Monolingual Group</u> <u>English (N=13)</u>	<u>Bilingual Group</u> <u>English (N=4)</u>	<u>Bilingual Group</u> <u>German (N=4)</u>
EG	1.96	2.82	3.05
\overline{EG}	2.14	2.75	4.09
\overline{EG}	3.30	3.78	3.07
\overline{EG}	4.26	4.13	4.46

Highest possible score is 5.

Although any comparisons between the monolingual and bilingual groups must be cautious since the groups differed in age (and education), it is clear that the direction of responses was the same. Also, the responses of the bilinguals varied, depending on whether they were asked to rate a nonword as acceptable in German or in English (despite the fact that the same nonwords were used for both the English and German conditions.)

Conclusions. The following question was raised at the beginning of this section: 1) Does the bilingual have one unified system of rules for language perception, used for processing both languages, or are there two processing

systems, one for each language? The answer to this question varies, depending on the level of processing to which one is referring. For those studies in which sentences served as stimuli and in which the functioning of a proposed switch mechanism was investigated, the results are equivocal (for example, the results of Kolers, 1968 and Wakefield et al., 1975 conflict with one another). However, the results of Forster and Clyne (1968) and the arguments of Diller (1974) suggest that the proficient bilingual requires two sets of rules.

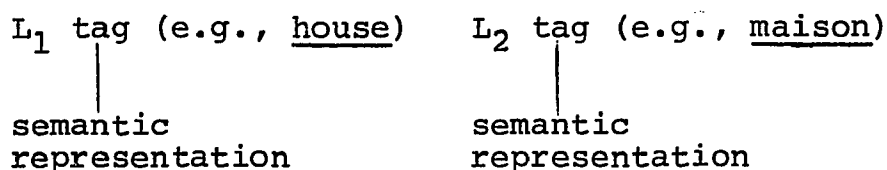
The results of studies dealing with the categorical perception of phonemes indicate that phonemes are perceived by bilinguals via a unified processing system which is used for processing in both languages.

Those studies dealing with the perception of phonotactic constraints suggest that the bilingual has two sets of phonotactic (or graphemic) constraints, one set for each language. In order to confirm this conclusion and begin to address question 2, more extensive studies, using visually presented nonwords, were conducted. The studies (experiments 1 and 2) are described in chapter 4. Chapter 2 will continue the discussion of question 1 by investigating the question of whether the bilingual has one or two lexicons.

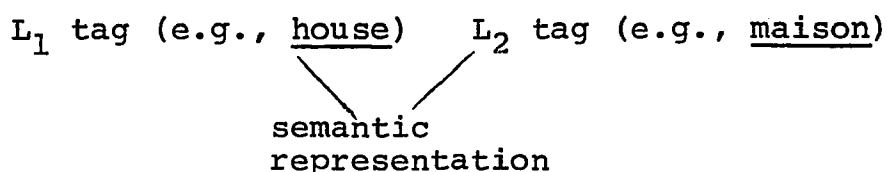
One vs. Two Lexicons

A distinction needs to be made between two parts of the lexicon: the semantic representations and the linguistic tags (words) referring to the representations. A number of questions can be raised about the organization of the tags, the semantic representations, and their relation to one another in the bilingual's lexicon.

The bilingual must have two sets of linguistic tags (two sets of words) for at least most of his/her vocabulary (with the possible exception of cognates and/or homonyms). It is not clear, however, that the bilingual has two sets of semantic representations, and two hypotheses are possible: 1a) the independent hypothesis, according to which there are two sets of semantic representations, one for each language, and 1b) the interdependent hypothesis, according to which there is one set of semantic representations linked to tags from both languages.



The Independent Hypothesis

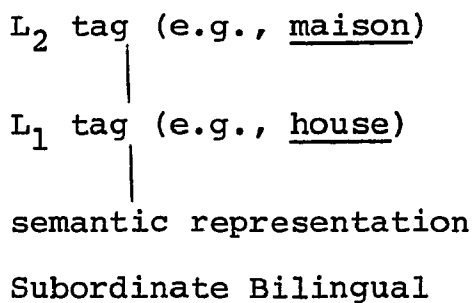


The Interdependent Hypothesis

The question of semantic representations is not necessarily identical to the question of whether the bilingual has one or two memory stores. That is, one can conceive of a bilingual having two separate semantic stores while at the same time having one memory store for things like pictures, events, etc. The question of memory stores will not be discussed.

One can also ask whether the answers to the questions above will vary, depending on the language acquisition background of the bilingual. This question has been extensively discussed in the literature and will be addressed first.

The compound-coordinate distinction. The compound-coordinate distinction was proposed by Weinreich (1953). He suggested that there are compound bilinguals who have two sets of tags with one set of semantic representations (the interdependent hypothesis above), and coordinate bilinguals, who have two sets of tags and two sets of semantic representations (the independent hypothesis). He also suggested that there are subordinate bilinguals, for whom the semantic representation of one of the languages is mediated via the other.



The original proposal was that an individual would likely be a compound bilingual if the two languages had been learned at the same time and in the same environment, for example if both were used interchangeably in the home. An individual would likely be a coordinate bilingual if the two languages were learned in different environments, e.g., one at home and one at school. An individual would be a subordinate bilingual if the second language was learned through the medium of the first, for example, in a classroom by learning words and their translation equivalents. A subordinate would not be a balanced bilingual and would always need to translate from the second language to the first, in order to comprehend an utterance.

There are a number of problems with the compound-coordinate-subordinate distinctions as discussed, among others, by Diller (1974) and Beardsmore (1974). There are problems with the definitions of the terms as well as with the experimental evidence which attempts to support the distinctions.

Ervin and Osgood (1954) revised the definitions of Weinreich, collapsing the compound/subordinate distinction. According to their definitions, if someone learned a second language through the medium of his/her first language (e.g., in school), or if someone learned the two languages in the same environment, they would both be compound bilinguals. On the other hand, someone who learned

English as a child at home, and French as a child at school and from his/her peers would be a coordinate bilingual, but so would someone who learned English as a child in England and French as an adult in France, because both had learned the two languages in separate environments.

Beardsmore points out that although cases can exist where both languages are used interchangeably by the same person, it is more common to find early specialization in language usage in infant bilinguals (e.g., one person, one language), even if both parents are bilingual. Further, even given cases where both parents use both languages, each language may still be used in different contexts, to discuss different topics, etc.

Lambert and Rawlings (1969) use the terms in a different way. They state that a coordinate bilingual is one who has learned the second language after the age of six, while a compound bilingual is one who has learned both languages before the age of six. Lambert (1969) and Genesee, Hamers, Lambert, Monomen, Seitz and Starck (1978) use age ten as the cut-off point. Dillon, McCormack, Petrusic, Cook, and Lafleur (1973) define compound bilinguals as those who learned both languages simultaneously; coordinate bilinguals are those who learned one language after the other.

Further, most authors agree that the compound/coordinate distinction is a relative one, representing a

continuum, so that it is only with individuals at the extreme ends of the continuum that the distinctions among individuals are clear.

Thus, a certain amount of confusion has arisen about the definitions of the terms. However, most of the earlier work uses the Ervin and Osgood definitions, while later works often use the Lambert definitions.

There are also problems with the experimental evidence. Lambert, Havelka and Crosby (1958) found that coordinate bilinguals had greater semantic differences between translation equivalents, as measured by semantic rating scales, than did compound bilinguals. However, Diller suggests that the cultural environment of language learning, rather than the manner of language learning, may be responsible for this effect. Differences were found, for example, among bilinguals who learned French in Paris and English in Montreal and those who learned both languages in Montreal. A similar argument can be made with respect to Gekoski's (1970) finding that compound bilinguals had a greater average percentage of response equivalence than coordinate bilinguals in intralingual and interlingual free association tasks.

Lambert et al. also conducted a recall task with French-English bilinguals. Subjects learned a list of English words, followed by three presentations of a list of nonsense words. Subjects' retention of the English

list was then measured. Subjects then learned a second list of English words, followed by three presentations of the French equivalents of the English list. Retention of the second English list was measured. It was found that compound bilinguals benefited from interpolation of the French word lists, while for coordinate bilinguals, interpolation of the French list had about the same effect on recall as interpolation of the nonsense words.

Jakobovits and Lambert (1961) also show a greater influence of translation equivalents on the performance of compound than coordinate bilinguals. They found that, for compound bilinguals, semantic satiation for words in one language caused satiation of their translation equivalents. Coordinates did not show such effects.

Lambert (1969) reports on a bilingual version of the Stroop task. In the Stroop task, words are printed in different color inks, and subjects are asked to name the color, not the word. Greatest interference occurs when the word is a different color from the ink color, e.g., the word red printed in yellow ink. In the bilingual version, some of the color words are in the language of naming, and some in the other language. Lambert found that coordinates had less interference from color words in the non-response language than did compounds.

It should be noted that the above experiments do not necessarily support the interdependent hypothesis. An

alternative interpretation of the results would be that compounds also have two sets of semantic representations, but with closer associations between translation equivalents.

Lambert (1969) discusses a free recall experiment in which subjects had to recall bilingual lists with ten examples of four different categories (e.g., ten types of fish, ten male first names, etc.). In one kind of bilingual list the categories and languages were concordant (e.g., ten types of fish in English, ten male first names in French, etc.). In another kind of bilingual list, each of the categories contained equal numbers of English and French examples (e.g., five fish in English and five in French). He predicted that coordinates should do better on the concordant list than compounds, while coordinates should do worse than compounds on the discordant list. His results confirm these predictions, which do not rely on an association only among translation equivalents.

In Lambert and Rawlings (1969) bilingual subjects are given a mixed-language list of associations and instructed to find the word that triggered them, e.g., given chair, food, desk, wood, subjects have to come up with table. They found that coordinate subjects made more errors than did compounds. They suggest that coordinates had difficulty dealing with a mixed list because they have two separate systems. It is possible, however,

that compounds have two systems and due to their background have had greater practice in switching from one to the other. Or, compounds have two systems which are organized more similarly than those of coordinates, facilitating success in this task. This will be discussed further below.

Genesee et al. (1978) also found differences among compounds and coordinates, using age of acquisition (age ten) as the determining factor in defining the groups. Subjects heard English words and their translation equivalents on tape and pushed an English key or a French key, depending on the language of the word they heard. Although they found no difference in reaction time among the groups, they found a difference in the subjects' averaged electroencephalic responses, which were also being measured. They conclude that compound bilinguals were prone to adopt a left-hemisphere biased strategy, and coordinate bilinguals to adopt a more right-hemisphere biased strategy. However, it is not clear that the task involved lexical retrieval at all. Subjects may have been using only phonological cues to make their decision. Thus, although the results suggest differences in processing depending on age of acquisition, it is not clear that they say anything about semantic representations.

Vaid and Lambert (1978) use an auditory version of the Stroop task to evaluate cerebral hemispheric involvement in early bilinguals (bilingual before age 5) and late

bilinguals (bilingual after age 10). In this auditory version of the Stroop task, subjects heard the words "high" or "haute" spoken in a high or low pitch, and the words "low" or "basse" spoken in a high or low pitch. In one condition, subjects indicated whether the word was spoken in a high or low pitch. In a second condition, subjects responded only to word meaning. The authors tentatively conclude that "age of onset of bilingualism is an important factor influencing not only one's characteristic mode of approach to verbal information, but also the relative degree of involvement of the two cerebral hemispheres" (p. 25).

Dillon et al. (1973) found no difference between compound and coordinate bilinguals in a release from proactive interference task. Triads of words were presented visually, followed by distractor tasks, followed by subjects writing down the triad. One group had a shift in language after trial four, another group did not. On trial four, the language shift group recalled more than the non-language-shift group. The authors had expected that coordinate bilinguals would benefit more from a language switch than compounds, but no such difference among bilinguals was found. Arkwright and Viau (1974) also found no difference between compound and coordinate bilinguals in an adaptation of the Lambert and Rawlings association study.

Olton (1960, as cited in Macnamara, 1967a) had bilingual subjects read a list of English and French words,

some of which signalled an electric shock. He then presented them with a new list in which some words were translations of the signal words. He found no difference between compounds and coordinates in their responses to the translations.

Walters and Zatorre (1978) use a tachistoscope presentation of four-letter nouns. Their subjects show a word identification advantage in the right visual field. They conclude that, regardless of which language was learned first, there is a left hemisphere advantage for processing of both languages. Although their task is not identical to that of Genesee et al. it should be noted that the two studies reach different conclusions about which hemisphere is involved in processing.

The experimental evidence supporting the compound-coordinate distinction is far from compelling and there is no clear support for the notion that the organization of the bilingual's lexicon will vary depending on the language acquisition background of the individual. The focus of the following discussion will therefore shift from attempts to prove the validity of the compound-coordinate distinction, to attempts to describe the bilingual's lexicon. The compound-coordinate distinction will no longer be considered except to note that it is important to control for the language acquisition background of bilingual subjects as much as possible, and to realize that all

conclusions drawn from studies may be limited by the language background of the subjects.

The independent-interdependent hypothesis. 1a) the independent hypothesis and 1b) the interdependent hypothesis of the bilingual's semantic representations will now be examined. Diller (1974) suggests that it is impossible for a proficient bilingual to have merged linguistic systems. With regard to vocabulary, "a glance through a good bilingual dictionary should show the impossibility of a compounded vocabulary. The vast majority of words in French, for example, have to be defined by at least two English words, and vice versa. . . . No two languages are similar enough to allow morpheme-by-morpheme correspondences" (pp. 259-260). Despite the force of this argument, numerous experiments have been conducted which attempt to decide between the independent and interdependent hypotheses. The results of most of these studies have been interpreted as supporting the interdependent hypothesis. However, it will be demonstrated, in the discussion of the literature which follows, that the results of most of the experiments can be interpreted in other ways as well.

For example, some experiments (e.g., Kolers, 1966, Kintsch, 1970) can be interpreted as supporting only the hypothesis that there are connections between translation equivalents in the bilingual's two languages. Other experiments (e.g., Liepmann and Saegert, 1974, Dalton, 1971)

are not clear as to whether they are testing the existence of two sets of semantic representations or verifying the existence of two sets of linguistic tags. Most importantly, the results of some of the studies (e.g., Taylor, 1971, Nott and Lambert, 1968) can be interpreted as supporting either the interdependent hypothesis, or the revised independent hypothesis. The term "revised independent hypothesis" will be used to refer to the hypothesis that the bilingual has two sets of semantic representations (with connections between and within languages, e.g., between translation equivalents), and that both sets of semantic representations are simultaneously available to the bilingual, such that no difficulty is experienced in going from one set to the other. The following discussion of the studies will be organized according to the experimental task used.

1. The association task. In the association task subjects respond to a stimulus word by saying or writing down whatever word(s) it brings to mind. Bilingual versions of the task have been used in at least two ways: a) to note the nature of the response, depending on language of response (e.g., Kolers, 1968, Lambert and Moore, 1966) and b) to note the number of responses, under various conditions (e.g., Taylor, 1971, Macnamara 1967b). Experiments examining the nature of the response will be discussed first.

Kolers (1968) gave non-balanced bilinguals word association tasks in English and in their native language (either Spanish, German or Thai) and found that for concrete words, subjects responded similarly in both of their languages. For abstract words, subjects' associations were less likely to be the same in the two languages. For example, subjects are more likely to give the same association in their two languages to a concrete word like tree than to a more abstract word like freedom. Kolers concludes that "some information can be stored in such a way that it is readily accessible in either of two languages. Other information is, in terms of its accessibility, closely bound to the language by which it was stored in the mind" (p. 82).

Lambert and Moore (1966) developed word-association norms for groups of English and French Canadian monolinguals, and Canadian English-French bilinguals. The bilinguals responded once in English and once in French. The authors found that the bilinguals responded in each of their languages with associations comparable to those of the corresponding monolingual subjects.

French (1975) used an association task with Japanese-English bilinguals which measured the affective meaning of translation equivalents using rating scales. She found that words in the mother tongue had greater emotional value than words in the other language.

However, none of the association tasks described above can be used as evidence for either the independent or interdependent hypotheses. This is because, if the bilingual produces the same associations to translation equivalents, this does not necessarily reflect an interdependent system. There could be two sets of semantic representations which are organized similarly. And if the bilingual produces different associations to translation equivalents, this does not necessarily reflect two independent systems. There could be one set of semantic representations but the words used may not have been perfect translation equivalents. This is supported by Kolers' finding with concrete and abstract words. As he suggests, the concrete words, such as tree-Baum, may be more nearly equivalent in meaning in the two languages than more abstract words like freedom-Freiheit.

Macnamara (1967b) administered four tests to Irish-English bilinguals. The tests were a) word-naming in Irish (saying as many single words as possible in Irish, in three minutes, given three Irish stimulus words), b) word-naming in English, c) language switching (saying as many different words as possible in one minute, alternating from one language to the other, without translating, e.g., plume-table-maison-run . . .) and d) translating (saying first a word in one language and then its equivalent in the other, e.g., plume-pen-pli-fold).

Macnamara concludes in favor of the independent hypothesis on the basis of his results that the number of responses in the switching and translating conditions (where plume-pen are counted as one response) are fewer than the number of responses in the word-naming conditions. However, once translation pairs are counted as one response, translation scores are no longer comparable to word-naming scores, since one would have to say twice as many words in the translation task in order to get a score equal to that in the word-naming task. Also, in the switching and translation tasks subjects had to bear in mind which language they were up to at the same time that they were trying to think of responses. Thus, the reduced number of responses may be due to the extra burden that these tasks place on memory. Macnamara also failed to control for this extra burden on memory in a revised version of the task.

Even if Macnamara's results were valid, they need not necessarily support the independence hypothesis. There could be one set of semantic representations, but these would have to be related to two sets of linguistic tags and subjects may require time to switch from using one set of linguistic tags (and one set of phonological rules) to using the other.

Taylor (1971) asked English-dominant French speakers to write down associations to a written word under

various conditions: a) change from one language to the other was permitted whenever subjects wanted, b) language switch was required every fifth item, c) language switch was required every third item, d) language switch was required every second item, and e) subjects were required to use only one language. The number of associations for conditions a) and b) was not significantly different from the number for condition e). However, for conditions c) and d), the number of associations dropped. As Albert and Obler (1978, p. 56) point out, this may be due to the fact that "obligatory frequent switch interferes with production of associations, perhaps by unnaturally requiring attention to the language of response." The fact that conditions a) and b) were the same as condition e) supports either the interdependent hypothesis or the revised independent hypothesis.

The results of Růke-Dravina (1971) can be interpreted in the same two ways. In an association task where subjects were told they could respond in either language, she found that subjects whose first contact with a second language had been at the school or university level switched from one language to another, but usually responded with a translation equivalent, e.g., rot-red. Subjects who had been speaking one or more languages fluently since childhood or early youth also gave translations, but frequently also continued the association chain, e.g., rot-apple.

2. Stroop task. Dalrymple-Alford (1968), Dyer (1971), and Lambert and Preston (1967), using the bilingual Stroop test, and also Hamers and Lambert (1972), in an auditory version of the bilingual Stroop test, demonstrate that bilingual subjects are adversely affected on this task whether the stimulus word is in the language of response or in the other language. It should be noted that it is the second language's semantic representation, not just its tag, that is accessed and causing interference. This claim can be made because Dalrymple-Alford reports that bilinguals had longer reaction times to color words (e.g., green) than to non-color words (e.g., book), in the Stroop task. Thus, the meaning of the word must be accessed. (However, he fails to indicate whether or not the color and non-color words were equated in terms of frequency, number of letters, etc.). The results can be interpreted as support for the interdependent hypothesis or for the revised independent hypothesis. That is, both sets of semantic representations may be automatically accessible to the bilingual. These studies can also be interpreted as support for the notion that there are two sets of semantic representations, with connections between translation equivalents. Lambert (1969) presents some support for this in his finding that "bilinguals can gate out the other language distractors better than same language distractors when the color words (and color names) of the

two languages are phonemically dissimilar" (p. 107). This suggests that the strength of the association between the translation equivalents determines the degree of interference.

3. Recall tasks. There are numerous studies which use tasks in which subjects are instructed to recall lists of words in one or both of their languages. Some of these will now be described. Almost all of them have been interpreted as supporting the interdependent hypothesis.

In Young and Saegert (1966) subjects learned two lists of words. The second was a translation of the first, with the words in the same order as the first list for some subjects, and in a random order for other subjects. They found that the number of trials to learn the second list was less if the translations were in the same order as in the first list, than if they were in a random order.

Kolers (1966) had subjects recall lists with words and their translation equivalents, as well as lists with unrelated words from both languages. Words appeared either once, twice, three times or four times. He found that " $n/2$ occurrences of a word and its translation have the same effect upon the recall of the word in one language as n occurrences in that language" (p. 318).

Kintsch (1970), in a task involving recall of lists with translation equivalents, found that "word meanings interfere with recognition of language-specific forms . . ."

(but also that "language-specific cues intrude when subjects are concentrating upon word meanings. . ." [p. 409]).

Kintsch and Kintsch (1969) found greater errors in learning a list of words and their translations than in learning a list of unrelated words. However in another task, which involved subjects producing the word after a stimulus word in a list, no difference was found between such lists. The authors claim that this is because the second list tapped only short-term memory, where the acoustic features of words are stored. They claim that the first experiment involved long-term memory. However, it is not clear why the first experiment necessarily involves long-term memory, and the second short-term memory.

Segalowitz and Lambert (1969) trained subjects to recognize a specific subset of words within a larger list. They were then given a new list containing within it the original subset, as well as English and French synonyms of the subset. Subjects pushed a button if the words on the new list were not from the original subset. The longer the subject's reaction time, the greater the doubt about whether the word was on the original list. It was found that reaction time to other language synonyms was greater than reaction time to other language neutral words. This can also be viewed as supporting the interdependent hypothesis or the hypothesis that there are associations between translation equivalents.

The experiments cited so far can be taken as evidence for the interdependent hypothesis. However, since the experiments all involve only words and their translations, they can also be taken as evidence for the hypothesis that there are two sets of semantic representations with connections between translation equivalents. Lopez and Young (1974) and MacLeod (1976) also conducted bilingual recall tasks involving learning lists of words. Their results again support either the interdependent hypothesis or the hypothesis that translation equivalents are associated.

The experiments to be discussed next cannot be interpreted as involving only translation equivalents. Kolers (1965), Lambert, Ignatow and Krauthamer (1968), Nott and Lambert (1968), Dalton (1971) and Saegert, Overmeyer and Kazarian (1973) found that bilingual recall of bilingual lists of unrelated words was equal to recall of unilingual lists. This supports the interdependent hypothesis if it is assumed that switching from one set of semantic representations to another imposes a burden. It supports the revised independent hypothesis if one assumes that switching from one set to the other does not impose a burden. An additional problem with this task is that there is no way of knowing whether the semantic representations or only the linguistic tags were accessed.

Liepmann and Saegert (1974) presented subjects with 15 lists of 16 items each from a pool of 32 common words.

One group was given items in one language, another group was given mixed-language lists. The authors reasoned that if concepts are stored independently of language (the interdependent hypothesis) then the mixed language group should be worse than the one language group on recall of later lists. If items are stored as language specific units then the mixed language group should be better than the one language group. They find that the mixed language group experienced no difficulty in recall on the first list but that their recall became worse than the recall of the one language group on succeeding lists. The authors interpret their finding as support for the interdependent hypothesis. However, it is again not clear in this case whether subjects needed to access semantic representations or only needed to access linguistic tags. It is also interesting to note that although this study was similar to those by Dalrymple-Alford, Young, etc. described immediately above, the same interpretation was given to opposite results. In the first set of studies, it was found that recall of bilingual lists was equal to recall of unilingual lists. Liepmann and Saegert found that recall for the mixed language list was worse than for the unilingual list. Yet all authors conclude in favor of the interdependent hypothesis.

Saegert, Hamayan and Ahmar (1975) found that trilinguals were easily able to report the language of input of linguistically mixed lists of words. However, when the

words were in a sentence, subjects tended to forget the language of the word. They conclude in favor of the interdependent hypothesis, and postulate a selective attention mechanism to account for their results. However, a selective attention mechanism is also compatible with the revised independent hypothesis.

Three recall studies whose results have been interpreted as supporting the independent hypothesis will now be described. Dillon et al. (1973) (described above) found that in the recall of triads, groups that had a language switch after trial four recalled more than groups that did not. Since switching languages aided the subjects in recall, this supports the view that the languages are processed independently. However, there is again no way of knowing if the tags or also the semantic representations were accessed.

Tulving and Colotla (1970) found that subjects' recall of unilingual and bilingual lists was equal, if the words were recalled from primary (short-term) memory. Recall from secondary memory was better for unilingual than for bilingual lists, and better for bilingual than for trilingual lists. The authors conclude that a multilingual person's different languages exist in relative isolation from each other. Secondary and primary memory, however, are somewhat arbitrarily defined.

Goggin and Wickens (1971) presented bilingual subjects

with lists of words in a series of tests. They demonstrated that release from proactive interference (leading to improved recall) occurred when either the language or the semantic category of the items changed. They suggest that the words from the two languages may be psychologically distinct, and state that the data can be interpreted as support for the position that there is a separate memory store for each language.

4. Other tasks. Palić (1978) provides additional evidence for an association between translation equivalents in the bilingual's two languages. He uses a lexical decision task in which bilingual subjects were visually presented with pairs of letter strings, and instructed to indicate whether or not both strings were words. In the case where both were words, some were translation pairs and some were unassociated pairs. It was found that reaction time for the translation pairs was significantly faster than for the unassociated pairs.

Fiszman (1978) also used a lexical decision task. Bilingual subjects viewed a probe word followed by a related or unrelated word. On half the items, there was a language switch from the probe to the second word. Fiszman found no effect of language switch on bilingual reaction time. Again, this supports either the interdependent hypothesis or the revised independent hypothesis.

However, Meyer and Ruddy (1974) (described by

Gonzales [1977]) found different results in a paired lexical decision task with German-English bilinguals. Like Fiszman, they had pure trials, where both words were from the same language, and mixed trials, where one word was from each language. For both the pure and mixed list, there were trials in which the words were semantically related and trials in which the words were semantically unrelated. Unlike Fiszman, the authors found that reaction times for pure pairs were faster than reaction times for mixed pairs. This supports the independent hypothesis. They also found that reaction times were faster for related pairs than for unrelated pairs, for both the pure and mixed trials. The authors interpret their results as supporting a model in which associations among related words between languages are as direct as associations within languages.

MacKay and Bowman (1969) found that if subjects repeated a unilingual sentence 12 times their rate of production increased. They then found that repeating a translation of the original sentence facilitated speed of production more than repeating an unrelated sentence. This is taken as support for the interdependent hypothesis. However, once subjects heard the beginning of the translation sentence they may have been able to predict what the rest of the sentence would be. This could have caused the facilitating effect for the translation sentences.

The studies described above have problems of various

kinds, and thus leave unresolved the question of whether the bilingual has one or two sets of semantic representations. However, given Diller's (1974) argument that "no two languages are similar enough to allow morpheme-by-morpheme" correspondences (p. 260), it will be assumed that the bilingual has two sets of semantic representations which are both available during processing, with connections among the semantic representations between and within languages. That is, it will be assumed that the revised independent hypothesis is true.

The Monolingual vs. Bilingual Hypotheses

Assuming that the bilingual has two sets of phonotactic constraints (which will be confirmed by experiments 1 and 2), and since the bilingual must have two sets of linguistic tags, this section will address the question of whether the bilingual simply shuts one system off and processes as a monolingual does, or whether both sets of constraints and both lexicons are always available to the bilingual during processing. Since it is also assumed that the revised independent hypothesis is correct, i.e., that the bilingual hypothesis is true for the two sets of semantic representations, the monolingual vs. bilingual hypotheses with respect to the bilingual's lexicon reduces to the question of whether both sets of linguistic tags are always available to the bilingual. The linguistic tags must, of course, be labeled according to language since in

production bilinguals rarely have any difficulty producing the language appropriate tag.

There is little experimental evidence available which is directly relevant to the monolingual vs. bilingual hypotheses. However, a series of bi-alphabetic lexical decision tasks conducted by Lukatela, Savić, Gligorijević, Ognjenović and Turvey (1968) lend some support to the bilingual hypothesis. The bi-alphabetic lexical decision tasks were conducted in Serbo-Croatian. Serbo-Croatian is written in the Roman alphabet and in the Cyrillic alphabet. Most of the characters in each alphabet are unique to that alphabet, but some characters are common to both alphabets and receive the same phonological interpretation in each. Others are common to both alphabets and receive different phonological interpretations in each. For example, the letter "E" is pronounced [ɛ] in both languages, while the letter "P" is pronounced [pə] in the Roman alphabet and [rə] in the Cyrillic alphabet (Lukatela, Savić, Ognjenović and Turvey, 1978).

Subjects were asked to push the "yes" button if the item (or items) presented was a Roman word, and to push the "no" button if the item (or items) was not a Roman word. There were letter strings of various types, including items which were Roman words and impossible Cyrillic items (i.e., they contained uniquely Roman letters), items which were Roman words and possible but non-existing

Cyrilliss words (i.e., they contained no uniquely Roman letters), items which were both Roman and Cyrillic words, etc.

The authors found that "a letter string--if its structure permits--will receive both the Roman and the Cyrillic phonological interpretations . . . whether or not this phonological bivalence impairs lexical decision in the assigned alphabet mode depends on whether or not the letter string has a lexical entry in one of the alphabets" (p. 164). In these studies, the structure of a letter string is defined as permitting two phonological interpretations if the letter string contains no uniquely Roman letters. The authors tried to constrain these items so that they were legal in both languages. The authors' findings thus support the bilingual hypothesis because they support the hypothesis that two modes of processing are simultaneously available to the bilingual or bi-alphabetic speaker.

They also found that "a letter-string that was nonsense in Roman but a sensible Serbo-Croatian word in Cyrillic was rejected as a word with some difficulty" (p. 151). That is, the Cyrillic linguistic tag was accessed even when subjects were in a Roman mode.

Hamers (1973) describes a series of studies which also suggest that the linguistic tags from both languages are simultaneously available to the bilingual. She used words which are spelled the same in French and English

but which have different meanings in the two languages (e.g., pain means bread in French). These words are referred to as semantically ambiguous (SA) words. Hamers asked French-English bilinguals as well as English and French monolingual subjects to state the first word that came to mind when presented with a word. Twenty bilingual subjects received a French list and twenty received an English list. The SA words were among the words on each list.

She found that some of the bilingual associates given to the SA words were related to the meaning of the word in the other language (e.g., the response of butter to the English word pain). This was more likely to happen when the SA words were more frequent in the other language than in the language of response. She concludes that bilinguals cannot restrict their verbal decoding processes to one language.

It should be noted that Hamers' study can only be viewed as supporting the bilingual hypothesis if it is assumed that SA words are not treated differently from other linguistic tags. That is, it may be that these words have a single graphemic and possibly also a single phonological representation, in contrast to other linguistic tags.

This is the position taken by Elerick (1977) with respect to cognates. He suggests that the bilingual's lexicon has "union entries," in addition to entries for

words that are unique to each language. Union entries are single underlying representations for items such as desierto - desert, teléfono - telephone. The bilingual must also have two sets of phonological rules, one for each language, to relate the underlying representation to the two phonetic outputs. These rules include some that would not be part of a monolingual's grammar for English or Spanish. Elerick states that the apparent simplification of having union entries results in a complication of the bilingual's grammar as a whole, and leads to simplification and change. He cites examples of Spanish words used by some bilinguals in the United States, whose pronunciation has changed as a result of this process: e.g., teléfono - telefon, población - populacion. In effect, some features of the English form have been adapted in Spanish. If the bilingual had two separate lexicons, these changes would not be expected.

If one assumes that Elerick is correct and that SA words as well as cognates have one underlying representation, then question 2 (the monolingual vs. bilingual hypothesis) is still relevant but moved to another level. That is, one must now assume, with respect to SA words, that these are words with single underlying representations which are linked to two different semantic representations, one from each language. Question 2 is thus reformulated to ask whether these two routes to semantic

representations are always available to the bilingual, or whether the route to the contextually inappropriate semantic representation is blocked.

Thus, Hamers' results can be viewed as supporting one of two positions: 1) There are two sets of linguistic tags (including SA words), both of which are always available to the bilingual, or 2) There is one set of linguistic tags for SA words. This set is linked to two semantic representations and these two routes are always simultaneously available to the bilingual. The results of Lukatela, Savić, Gligorijević, Ognjenović and Turvey (1978) support the first position, since they demonstrate bi-alphabetic interference without the use of SA words. The analysis of Elerick supports the second position. In either case, the bilingual hypothesis is supported.

Five experiments, described in chapters 3, 4, 5 and 6, were conducted which further investigate the bilingual vs. monolingual hypotheses, by investigating bilingual lexical retrieval. Chapter 2 concludes with a discussion of the literature relevant to monolingual lexical retrieval, a necessary prelude to a discussion of bilingual lexical retrieval.

THEORIES OF MONOLINGUAL LEXICAL RETRIEVAL

Part of what speakers of a language must do in order to understand a sentence is to retrieve the words of that sentence and the information that is stored about the word from memory. There are two major groups of models of lexical retrieval--the search models represented by Forster (1976) and Landauer (1975), and the direct access models represented by Morton (1970) and Marslen-Wilson and Welsh (1978). Each of these models will now be briefly described.

In Forster's model (1976, pp. 267-269), lexical access involves an active search process. He assumes that memory is structured and organized in some way and that the organization of the mental lexicon is not too different from the organization of the words in a dictionary. There is one lexicon proper, called the master file. There are three peripheral access files to this master file, "one organizing words by orthographic properties, one by phonotological properties, and one by semantic and syntactic properties" (i.e., one for reading, one for speech perception, and one for speech production). "The entry for a word in the master file contains all the information that we have about that word, while the entry for the same word in each of the peripheral access files simply contains a description of the stimulus features

of the word (the access code) and a pointer to the corresponding entry in the master file."

During retrieval, there must be preparation of a coded description of the stimulus word and then a search through the access file, "comparing the description of the target item with the access codes in each actual entry." The description may include the first few letters of the word, and/or the first syllable. It may be a morphologically analyzed and/or unanalyzed form, i.e., each word may be filed under a number of descriptions, and a range of techniques is used for locating an item.

The entries in the access files are grouped together in bins. "Thus, the first stage of lexical access involves calculating which bin . . . the test word is likely to belong to." "Within each bin, the entries are listed according to the frequency of occurrence of the word." When a sufficiently accurate match between the description and the access code "is obtained (there being a variable criterion of sufficiency), the search terminates, the pointer specified in that entry is used to access the master file, and then a detailed comparison between the properties of the stimulus item and the properties of the word specified in the master file must be made." This is the post-access check.

For example, if the word henchman is visually presented in a lexical decision task, there will be a search

through the orthographic access file for, e.g., the first few letters, or the first syllable of the word. When a similarity between the stimulus and an entry exceeds some previously defined criterion, the search stops, "and the pointer is used to direct the system to the entry in the master file. At that point, the full orthographic specification of henchman needs to be extracted and compared with the properties of the input stimulus."

The model predicts a terminating search for words and an exhaustive search for legal nonwords. That is, the search for a word terminates when the word is found; the search for a legal nonword continues through the entire access file.

Forster proposes that there are two quite independent access functions, "one that computes an approximate address on the basis of the sensory features of the target word, and one that computes an approximate address based on presumed semantic properties" (the production access file) (p. 277). This is to account for the facilitating effect of words in context. In sentences, both sets are searched simultaneously and the semantic search is often the fastest. Thus, he assumes that the production access file is used in perception.

Landauer (1975, pp. 497-501) presents a model of retrieval which is like Forster's in that it requires an active search for words. However, in his model there is

random storage and undirected retrieval and, unlike Forster, he assumes that the lexicon is not structured and organized in any way. One result of the way his model is set up is that there are multiple entries for each word, one entry for each time the word is encountered.

According to Landauer, the memory store consists of a three-dimensional space, with storage loci distributed throughout the space. "Data are entered into this memory successively in time. . . . At any given point in time there is just one locus into which new data are written." The locus available for new data entry is at the tip of a pointer, which moves "slowly, erratically and ceaselessly through the space in a 3-dimensional random walk. In each successive epoch the pointer may or may not move one step in any direction." If the time between two entries is short, then the two storage loci will be near one another. If the time is longer, the locations will be more independent of one another. "When the pointer encounters an edge of the storage space, it re-enters the space again from a symmetrically opposite point."

In order to retrieve something from memory, an undirected search is begun. A signal is sent out from the pointer. If the signal encounters a memory location with all or some of the information sought, the information is returned to the pointer (and from there to the homunculus [the rest of the information processing system]).

"The search signal spreads uniformly in all directions, as an expanding sphere, . . . up to a limited radius. . . ." Memory loci are searched in a random order with respect to the content of the search signal. The same volume of storage space is always searched. "The time required for memory search is assumed to be a function only of how far the locus of stored information is from the pointer."

Any kind of information can go anywhere, and once entered, the contents of the memory cannot be rearranged or systematically erased.

"[E]ach time the same information is encountered, a new record of it is entered in a new location. . . ." Thus presumably, during a lexical decision task, a) the input is put in memory and b) a search is made for another instance of that input. The more occurrences of that input there have been in the past, the more likely the pointer will be to encounter an instance of the word in a shorter period of time.

Morton's model (1970, pp. 206-209) does not require an active search through the lexicon. Thus, the order that words are stored in is irrelevant. Rather, this is a direct access model, with threshold devices which respond automatically when they receive appropriate input.

In this system, each word has a corresponding logogen. Each logogen has a specification of the word's acoustic, visual and semantic attributes. The logogen is a counting device that is incremented everytime it receives

an input which matches one of the characteristics of the word. "When the count exceeds a certain critical value the appropriate response is made available." "The critical value is not the same for all logogens" (Morton, 1970). Note that in this system memory elements are accessed directly.

Thus, for example, if the word cat is the stimulus, all words beginning with "c" would have their count raised, as well as all three letter words. Those words whose second letter was "a" would also have their count raised. When the count for a logogen was raised above a certain threshold by a series of increments, then the word would become available.

"[F]ollowing the operation of a logogen its threshold is reduced. Fewer sensory attributes will then be needed to produce the response again." Following this threshold lowering, the critical value "rises more slowly toward its original value." "[T]he more a word is used, the lower the resting level of the critical count." If a noisy stimulus is presented, and no response is available, all the thresholds in the system are lowered.

The effect of a context (for example, a sentence) is to cause "the Cognitive System to send semantic information to the Logogen System." (The Cognitive System represents the long-term store and is responsible for

"such organizational and associational phenomena as might manifest themselves in a particular task.") "Attributes such as <noun>, <animate>, <male> might be produced by the sentence 'He was a drunken _____' and all logogens whose semantic sets contained these attributes would be incremented accordingly. These increments would effectively reduce the amount of sensory information required to produce the response, the attribute counts from the two sources simply adding without regard to source."

Marslen-Wilson and Welsh (1978, pp. 56-60) present a theory of lexical access which is a "direct access model of word-recognition . . . which is similar in many ways to the logogen system, but which makes no claims for the existence either of internal counting mechanisms or of all-or-none threshold based decision functions."

Given an aural input, they assume that by the time the first few phonemes of a word have been heard, there has been activation of a class of possible word-candidates. As in the logogen model, these become activated when they receive as input an attribute which matches one of the attributes of the represented word. Each element in this cohort of word-candidates "will then continue to monitor the subsequent input signals. Unlike logogens, these elements are assumed to have the ability to respond actively to mismatches in the input signal. Namely, at such point as the input diverges sufficiently from the internal

specification for an element, then that element will remove itself from the pool of word-candidates." (In the logogen theory, all words have their thresholds raised by matching information, until one of them reaches the critical level. Non-matching information simply fails to raise the logogen's count, but does not eliminate any candidates.) According to Marslen-Wilson and Welsh, "as more of the input is heard, more and more elements will remove themselves from consideration. The size of the original cohort will be progressively reduced, until eventually only a single candidate remains. At this point we may say that the word is recognized. Note that recognition is achieved without needing to invoke individual thresholds for each recognition element." They assume that the initial pattern-matching processes do not require a perfect match between the input and the specifications of words in the lexicon.

A word in memory can also be informed about the requirements of context. It can then determine,

whether or not the word it represents is either syntactically possible or semantically plausible at that point in the utterance. In just the same way as memory elements withdraw from the pool of word-candidates when they no longer fit the acoustic-phonetic input, so they will also drop out when they do not fit the specifications of context. This will have the effect of accelerating the process of partitioning the initial cohort of word-candidates down to a single choice.

However, this incorrectly predicts that incongruous words

will not be retrieved by listeners. For example, given the sentence, They served coffee and stereos, the model predicts that the element for stereos would have removed itself from the pool of word candidates on the basis of context. Yet listeners are able to process sentences with incongruous words.

Lexical Retrieval and Phonotactic Constraints

Although there are problems with all of these models, and each of them makes somewhat different predictions about various aspects of lexical retrieval, there are certain facts which all of them must account for.

A number of studies using the lexical decision task (in which subjects must indicate whether or not a string of letters is a word) have found that the reaction time for illegal nonwords (e.g., bzik) is faster than the reaction time for legal nonwords (e.g., blik) (Foster and Amey, undated, Schuberth and Eimas, 1977), Snodgrass and Jarvella, 1972). Subjects are able to reject illegal nonwords faster than legal nonwords apparently because their decision making apparatus recognizes that the illegal nonwords could not possibly be words, while the legal nonwords could. The illegal nonwords can thus be rejected without any further consideration. This indicates that subjects have knowledge of the phonotactic (in this case, graphemic) constraints of their language. This knowledge

is invoked either prior to, or simultaneous with, accessing the mental lexicon. Consequently, all of these models must incorporate a set of phonotactic constraints, hereafter referred to as the scanner, which operates during lexical retrieval.

Thus, a general model of lexical retrieval involves a scanner and a lexicon. There are at least two ways of describing the relationship between the scanner and the lexicon: a) the scanner is a set of constraints separate from the lexicon, invoked prior to or simultaneous with accessing the lexicon, and b) the scanner is incorporated into the lexicon as part of the procedure for determining in which bin to search for an item (for example, as in Forster's model).

It is unlikely that b) is true. This is because Forster and Amey (n.d.) found that illegal nonwords that are similar to words, e.g., bexause, have longer reaction times than equally illegal nonwords that are not similar to words. This suggests that the words were accessed and the scanner was bypassed. It also suggests that the scanner operates simultaneous to the accessing of the lexicon, rather than prior to the lexicon's being accessed. This is further supported by the finding of Snodgrass and Jarvella (1972) that words have faster reaction times than illegal nonwords. This result would not be possible if the scanner operated prior to the accessing of the lexicon.

Chapter 3

BILINGUAL LEXICAL RETRIEVAL

This chapter discusses bilingual lexical retrieval. It is divided into three major sections. Section 1 discusses a number of assumptions relevant to bilingual lexical retrieval. Section 2 discusses specific models of bilingual lexical retrieval. The third section describes the rationale and design of experiments 1 to 5, which will provide evidence indicating how lexical retrieval works for bilinguals, while the final section describes the overall procedure of the testing sessions.

ASSUMPTIONS

It will be assumed, on the basis of the evidence which will be presented in chapter 4, that the bilingual has two sets of phonotactic constraints, i.e., two scanners, one for each language. Three further assumptions are necessary.

It will be assumed, on the basis of the evidence presented in chapter 2, that the bilingual has two separate lexicons, i.e., two acts of linguistic tags linked to two

sets of semantic representations. It will also be assumed, again on the basis of the evidence presented in chapter 2, that the scanner operates simultaneous with, rather than prior to, the accessing of the lexicon. (These assumptions will be discussed further in chapter 5.)

A third assumption is that lexical access proceeds via a search model rather than a direct access model. Although all of the models described in chapter 2 have problems, the choice of a search rather than a direct access model for this study is not an arbitrary one. This is because the lexical decision task, which will be used in experiments 3, 4, and 5, requires subjects to identify items as words or nonwords, and the passive models do not adequately account for the identification of nonwords. Since it is assumed that all models have a scanner for the detection of illegal nonwords, it is solely the recognition of legal nonwords which is relevant here. Morton sets up a mechanism which prohibits the recognition of legal nonwords. In order to account for subjects' responses to noisy stimuli, Morton proposes (according to Marslen-Wilson and Welsh, 1978, p. 49), "that the listener is able to lower all thresholds in the logogen system, and then recirculate the original input through it. This procedure is repeated, if necessary, until a logogen responds." If this happens whenever the logogen system fails to produce an output, then how could nonwords ever be detected?

Marslen-Wilson and Welsh would have to claim that legal nonwords have longer reaction times than words because in order to detect a nonword every element has to be eliminated as a candidate, whereas in order to access a word all elements but one must be eliminated. Thus the longer reaction time is due only to the time required to eliminate one more element as a candidate. This explanation seems weak, given the significant difference in reaction time between legal nonwords and words found by a number of different investigators (Rubenstein, Garfield and Millikan, 1970; Snodgrass and Jarvella, 1972; Forster and Chambers, 1973; and Forster and Bednall, 1976).

The active model has no problem with the detection of legal nonwords, since it assumes an exhaustive search for them.

MODELS OF BILINGUAL LEXICAL RETRIEVAL

None of the monolingual models discussed in chapter 2 makes any specific claims about how lexical retrieval works for bilinguals. There are, however, two general possibilities. One is that the bilingual shuts off one lexical retrieval system including one set of phonotactic constraints, on the basis of contextual information (e.g., social situation, native language of other speakers, etc.), and then processes as a monolingual does. This is the monolingual hypothesis. Another possibility is that the

bilingual processes via the lexical retrieval systems of both languages. This is the bilingual hypothesis. Each of these two general hypotheses represents a range of possible models, which will now be described.

The monolingual hypothesis has two possibilities, because shutting off the inappropriate lexical retrieval systems may or may not take a measurable amount of time. It would not take a measurable amount of time if it is done once, at the beginning of a language situation, rather than repeatedly for each word, or if the other system is shut off simultaneous with the activation of the appropriate lexical retrieval system.

The bilingual hypothesis has a number of possibilities. One of these is that the bilingual processes via both lexical retrieval systems simultaneously and then rejects one output as inappropriate to the language context. This is analogous to the theory that a monolingual processes all meanings of an ambiguous sentence in parallel, and then rejects the contextually inappropriate meanings. This will be called the parallel processing model. It requires that the bilingual have some kind of "language check" to determine which output is appropriate to the language context and which is inappropriate and should be rejected.

Another possibility is that the bilingual processes via both lexical retrieval systems, but not simultaneously.

Rather, one system at a time is operating. This is analogous to the theory that a monolingual processes the meanings of an ambiguous sentence serially, one meaning at a time. This will be called the serial processing model.

The parallel and serial models can each be either self-terminating or exhaustive. The term "self-terminating" will be used to mean that processing in the contextually inappropriate language terminates when a response can be made in the contextually appropriate language. The term "exhaustive" will be used to indicate that both lexical retrieval systems operate, either in parallel or serially, even if a response is already available in the contextually appropriate language. The models described thus far are diagrammed on the following pages.

"L₂" will be used to refer to the contextually inappropriate language. Each lexical retrieval system will be assumed to consist of a scanner and a lexicon (which may contain access files).

Note that in the serial self-terminating model A, if a lexical item is retrieved in L₁, the L₂ system is not activated. Only if no item is found in L₁ is the L₂ system activated.

Another possibility is that the L₂ system is activated only if the item is found to be illegal in L₁. That is, the language check receives information from the scanner. This implies that only the illegality of an item in

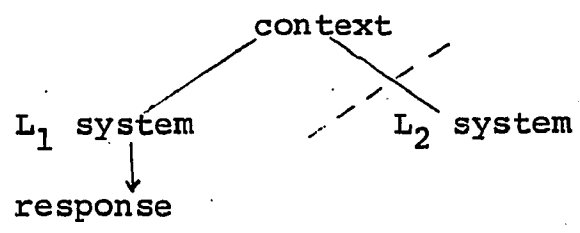
L_1 is a cue to switch to the L_2 system. This is the serial self-terminating model B.

In the parallel self-terminating model A, both lexical retrieval systems are operating simultaneously but if a word is retrieved in the contextually appropriate language before the L_2 system completes processing, the L_2 system is shut off.

Again, another possibility is that the language check receives information directly from the scanner, and shuts off the L_2 system if the item is found to be legal in L_1 , regardless of whether or not it is a word in L_1 . This is the parallel self-terminating model B.

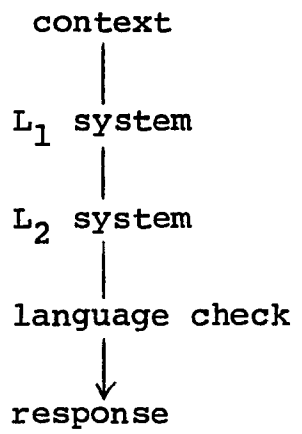
A series of experiments will be described which are able to distinguish between the monolingual and bilingual hypotheses, and which will shed some light on the range of models which each of these hypotheses represents. The question of whether the bilingual has two lexicons, one for each language, or one large lexicon, will also be addressed. The following section will describe the design of the five experiments.

I The Monolingual Model

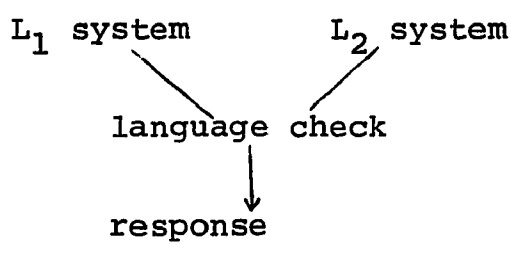


Model IA-shutting off L₂ takes no time
 Model IB-shutting off L₂ takes time

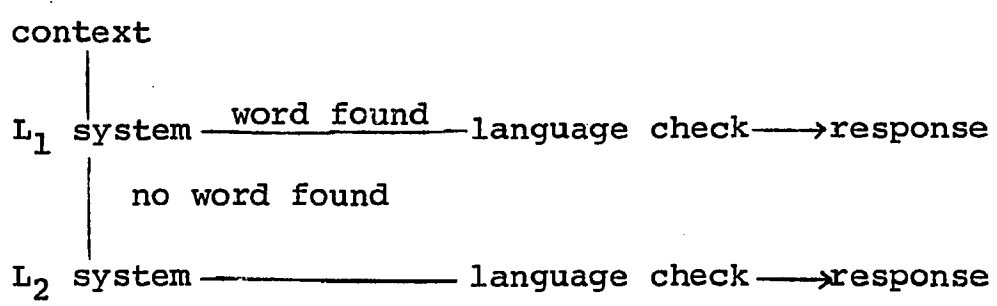
II The Serial Exhaustive Model



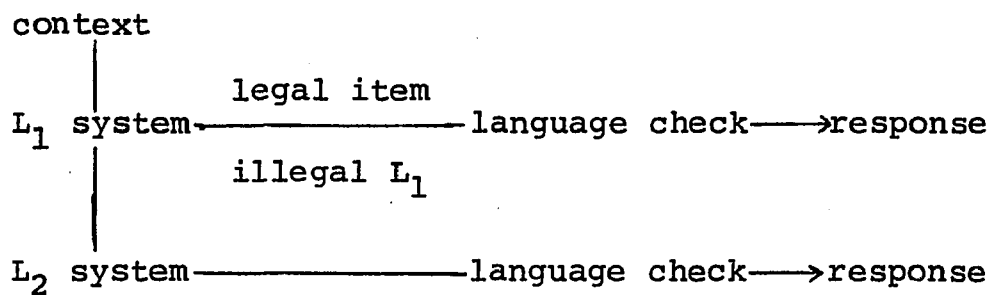
III The Parallel Exhaustive Model



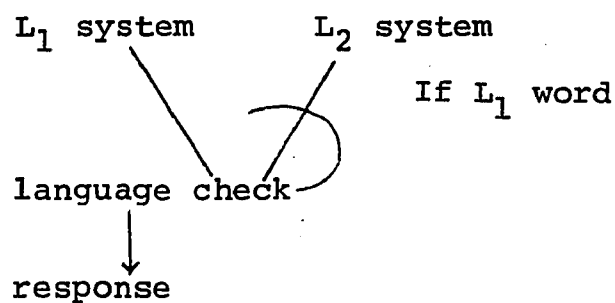
IVA The Serial Self-Terminating Model A



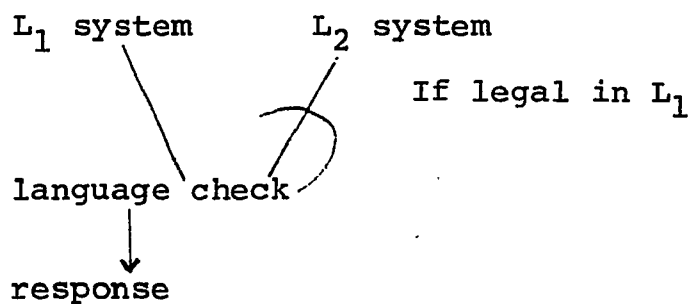
IVB Serial Self-Terminating Model B



VA The Parallel Self-Terminating Model A



VB The Parallel Self-Terminating Model B



THE EXPERIMENTS

Experiments 1 and 2--Rating Tasks

Experiments 1 and 2 are designed to confirm the existence, for the bilingual, of two sets of phonotactic constraints, using an adaptation of the Anisfeld, Anisfeld and Semogas (1969) design. If bilingual German-English subjects are asked to rate the acceptability of different types of nonwords in each of their two languages, then this can indicate whether or not the bilingual has two sets of phonotactic constraints. The nonwords are of four different types: legal in both languages (EG), legal only in English (\overline{EG}), legal only in German (\overline{EG}), and illegal in both languages ($\overline{\overline{EG}}$). For example, German-English bilinguals can be asked to rate the acceptability of PFLOK as a possible new word of English or of German. PFL- is a legal word initial consonant cluster in German but not in English. If bilinguals rate the nonwords identically, regardless of language mode, then this would be evidence for one set of phonotactic constraints; if the nonwords are rated differently, depending on whether they are rated as acceptable in German or English, then the bilingual must have a knowledge of two sets of phonotactic constraints. Further, a comparison with monolingual speakers can indicate whether or not the bilingual's phonotactic constraints are the same as the monolingual's. Experiments 1 and 2 were therefore rating tasks using these four different

types of nonwords. In experiment 1, the initial consonant cluster of the nonword determined the legal status of the nonword; in experiment 2, the final consonant cluster of the nonword determined the legal status of the nonword.

Experiments 3 and 4--Lexical Decision Tasks

Since experiments 1 and 2, described in detail in chapter 4, confirmed the existence of two sets of phonotactic constraints, experiments 3 and 4, lexical decision tasks, were conducted to see if both sets of constraints are available during bilingual lexical retrieval, or if one is "shut off" while the other is on (the bilingual vs. monolingual hypotheses). In the lexical decision task, subjects indicate whether or not a string of letters is a word. As discussed in chapter 2, it has been established by a number of investigators that monolingual reaction time to illegal nonwords is faster than monolingual reaction time to legal nonwords (Forster and Amey, undated; Schuberth and Eimas, 1977; Snodgrass and Jarvella, 1972), indicating that subjects' knowledge of phonotactic constraints (the scanner) is invoked in this task. Experiments 3 and 4 investigated among other things, whether the legal status of the item in L_2 would have an effect on L_1 reaction time.

In experiment 3, one lexical decision task was conducted with bilingual German-English subjects in English

and one in German; in experiment 4, one lexical decision task was conducted with bilinguals in English. In both experiments, monolingual subjects participated in an English lexical decision task. The nonwords in the task were the same as those used in the rating tasks, and were thus either legal in one language only, legal in both languages, or illegal in both languages. The words also contained consonant clusters which were either legal or illegal in the other language. Experiment 3 contained words and nonwords whose legal status in English and German was determined by their initial consonant cluster. Experiment 4 contained words and nonwords whose legal status in English and German was determined by their word-final consonant cluster.

If one takes the models of bilingual lexical retrieval outlined in chapter 3 and charts the results that each would predict in this lexical decision task, one finds that the models can be distinguished from one another, i.e., each of the models makes different predictions about reaction time for the various letter strings and subject groups. A chart for each model is reproduced in tables 1 to 8, indicating its predictions for the lexical decision task.

Examples of some of the predictions of the different models will now be discussed. All of the models assume, on the basis of various studies (Forster and Bednall, 1976;

Snodgrass and Jarvella, 1972; etc.), that monolinguals respond faster to illegal than to legal nonwords and slower to words than to legal nonwords. They make no prediction about the relation for monolinguals between words and illegal nonwords, since there is no way of knowing whether the scanner will operate faster or slower than the accessing of a particular word.

Model IA, the monolingual model which assumes that the language check does not take a measurable amount of time, predicts that the reaction time for bilinguals in English should equal the reaction times for the monolingual group. Model IB, which assumes that the language check will contribute to bilingual reaction times, predicts that the reaction times for bilinguals will be greater than those for monolinguals on all letter strings by a relatively small constant. Most importantly, both monolingual models predict no significant difference in the overall pattern of reaction times for monolinguals and bilinguals. If such a difference is found, it would be evidence in support of the bilingual hypothesis.

Model II, the serial exhaustive model, also predicts that bilinguals will have longer overall reaction times than monolinguals. It also predicts that the reaction time for bilinguals for nonwords that are illegal L_1 , legal L_2 should be longer than the reaction time for nonwords that are illegal L_1 , illegal L_2 .

Model III, the parallel exhaustive model, predicts, for example, that nonwords which are illegal L_1 , legal L_2 will have reaction times equal to nonwords which are legal in L_1 , illegal L_2 , and to nonwords which are legal L_1 , legal L_2 .

Model IVA is the serial self-terminating model which assumes that the L_2 system is activated only if no word is found in L_1 . It predicts that bilinguals will have longer reaction times than monolinguals for nonwords, but not for words. Model IVB is the serial self-terminating model which assumes that the L_2 system is activated only if an item is found to be illegal in L_1 . It predicts, among other things, that legal L_1 , illegal L_2 nonwords should have shorter reaction times than illegal L_1 , legal L_2 nonwords.

Model VA is the parallel self-terminating model which assumes that the L_2 system is shut off when a word is found in L_1 . It predicts equal reaction times for monolinguals and bilinguals for words and L_1 legal items. Model VB assumes that the L_2 system is shut off when it is determined that an item is legal in L_1 . Like model III, it predicts that illegal L_1 , legal L_2 nonwords will have reaction times equal to those for legal L_1 , illegal L_2 nonwords.

Experiment 5--Paired Lexical Decision Task

Experiment 5 was designed to investigate the question of whether both sets of linguistic tags are simultaneously available and accessed by the bilingual (the bilingual hypothesis) or whether only one set of linguistic tags at a time is available to the bilingual (the monolingual hypothesis). Since it is assumed, on the basis of the evidence discussed in chapter 2, that the bilingual's two sets of semantic representations are simultaneously available, the term "lexicon" will hereafter be used to refer to a set of linguistic tags.

There are words in German and English which are spelled the same but have different meanings in the two languages. For example, the word rock means skirt in German. These words will be referred to as homonyms. If the bilingual shuts the German lexicon off while processing in the English mode, then only the English meaning of rock should be available to him/her. If, however, both lexicons are automatically accessed by the bilingual then both meanings should be available during processing.

These two hypotheses were tested using a paired lexical decision task. In the paired lexical decision task, two words are presented at the same time (with one displayed above the other), or sequentially (one after the other). Subjects respond yes if both are words and respond no if both are not words. It has been established that

subjects respond yes faster if the words are associated than if they are not (Meyer and Schvaneveldt, 1971; Becker and Killion, 1977; and Fischler, 1977). That is, reaction times to doctor-nurse are faster than to doctor-lamp. German-English bilinguals can be in an English mode and presented with pairs of words in which the first word is a homonym and the second word is associated to its German meaning, e.g., rock-dress. If bilingual subjects respond faster to such pairs than to pairs where the second word is unassociated to either meaning of the homonym (e.g., rock-dream) this would provide evidence that the German meaning, and thus the German linguistic tag, was accessed while subjects were in an English mode. The reaction times to rock-dress pairs can also be compared to the reaction time to pairs where the homonym is associated to its English meaning, e.g., rock-stone.

OVERALL DESIGN OF THE EXPERIMENTS

There were two testing sessions, conducted approximately four months apart. During the first session, experiments 1 and 3 were conducted. During the second session, experiments 2, 4, and 5 were conducted. Experiments 1 and 2 were the rating tasks, experiments 3 and 4 were the lexical decision tasks, and experiment 5 was the paired lexical decision task. The order of the tasks for the different subjects groups is indicated on table 9.

Bilingual subjects were also given a dominance test in each of their languages. It should be noted that the dominance test served not only to indicate the subjects' stronger language but also helped to put the subjects in the appropriate language mode. It should also be noted that the rating task was always given in the same language as the preceding experiment. For half the bilingual subjects this was German, for the other half it was English.

Chapter 4

EXPERIMENTS 1 AND 2--RATING TASK

Two studies are described in which bilingual and monolingual subjects were asked to rate the acceptability of written nonwords. Written nonwords were used, rather than aurally presented nonwords, in order to avoid the problem of subjects misperceiving illegal sequences.

METHOD

Materials

There were two sets of stimuli, one in which the initial consonant cluster of a nonword (experiment 1) determined its legal status in German and English, and one in which the final consonant cluster of the nonword determined its status (experiment 2). These same nonwords were also used in experiments 3 and 4, the lexical decision tasks.

Each set consists of 48 nonwords containing four groups of 12 nonwords each. Each group contains four consonant clusters, with three different nonwords constructed for each consonant cluster. The EG group consists of nonwords whose initial or final consonant cluster is legal in

both languages, e.g., FLESS, DERL. The \overline{EG} group consists of nonwords whose initial or final consonant cluster is legal in English and illegal in German, e.g., TWOG, HEISP. The \overline{EG} group contains nonwords whose consonant cluster is illegal in English and legal in German, e.g., ZWOK, TANF. The \overline{EG} group contains nonwords whose initial or final consonant cluster is illegal in both languages, e.g. SREF, VAZG.

Initial Consonant Cluster Nonwords

A variety of factors were taken into consideration in the construction of the initial consonant cluster nonwords. See table 10. In order to avoid the question of whether phonemic recoding takes place during reading, all consonant clusters selected have the same orthographic and phonological legal status in German and English. If phonemic recoding takes place, this means that graphemic representations are converted to phonological representations during reading. Thus, consonant clusters like CL- were avoided because, although CL- is orthographically illegal in German, its pronunciation /kl/ is phonologically legal in German. Other factors controlled for were frequency, markedness and distance from English and German.

Frequency. Frequency was the primary determinant used in selecting the four consonant clusters for each group. Word-initial consonant cluster frequency was

tabulated by using frequency word counts. For English, A Computational Analysis of Present-Day American English, by Kučera and Francis (1967) was used. The frequency of each consonant cluster was determined by reference to the authors' alphabetical listing of all the words in their corpus plus its frequency. It was thus possible to obtain the frequency of, for example, FL- in word initial position by adding up the frequency of all words beginning with FL. A frequency percentage was then obtained by dividing this raw score by 1,014,232, the total number of words in the Kučera and Francis corpus. That is, it was possible to arrive at a figure indicating what percentage of all items in the corpus begin with FL.

For German, Deutsche Sprachstatistik, by Meier (1964) was used. Meier lists only words with a frequency of ten or more. The frequency of each consonant cluster was determined by referring to the alphabetical listing and frequency count of words with a frequency of ten or more. Since, according to Meier, the original corpus contained 10,910,777 words and the alphabetical word list of those words with more than ten occurrences contained 96.3% of the original corpus, then the alphabetical word list must contain a total of 10,507,078 words. Consequently, the raw score of each consonant cluster was divided by 10,507,078 in order to arrive at a frequency percentage for each

consonant cluster. These frequencies are indicated on table 10. Consonant clusters were selected for each group so that the average frequency of each group of consonant clusters would be as equal as possible, and so that German and English average frequencies would be as equal as possible.

Markedness. Since the markedness values for consonant clusters does not already exist in the literature, a chart of such values for the consonant clusters of German and English was developed by C. E. Cairns and myself. This chart is reproduced in table 11, and the markedness values for the consonant clusters indicated on table 10 are taken from this chart.

Markedness values were determined by using the following criteria: 1) which consonant appears in positions of neutralization; 2) how positions of neutralization are defined; 3) text frequency; and 4) universal criteria (according to Cairns, 1969; Greenberg, 1965; and Pertz and Bever, 1975).

The discussion below will present the reasoning used for the determination of markedness values of the chart.

Sonorant. According to universal criteria, the least marked consonant clusters contain obstruents followed by sonorants. Consequently, [-sonorant] is marked following an obstruent.

Voicing. According to universal criteria (Greenberg,

1965), consonant clusters whose first consonant is voiceless are less marked than those whose first consonant is voiced. Consequently, in the first position, [+voice] is marked.

Nasal. According to universal criteria, a consonant cluster whose second consonant is [+nasal] is more marked than one whose second consonant is [-nasal]. Also, more consonants appear to the left of [-nasal] consonants than of [+nasal] consonants, specifically, in German and English only /s/ or /s̥/ can appear to the left of a nasal consonant.

Continuant. Since all stops appear to the left of liquids in English and German, but very few fricatives do (only /f, s, ʃ, θ), a fricative before a liquid or glide is marked for continuancy. However, a consonant preceding a nasal consonant is marked if it is [-continuant] since it would be less marked to have a fricative in that position.

Coronal. [+coronal] non-continuants are marked in consonant clusters because they suppress a following /l/, i.e., */t_l, d_l, st_l, ʃt_l/ but /p_l, b_l, k_l, g_l, sp_l/.

Among continuants, [-coronal] continuants are more marked than [+coronal] continuants (in the first consonantal position) because [+coronal] continuants allow more different phonemes to follow them than [-coronal] continuants.

Anterior. [-anterior] is marked in consonant clusters on the basis of text frequency and also because less can appear after /sk/ than after /sp/.

Strident. Fricatives which are [-strident] (i.e., /θ/) are marked for strident because fewer phonemes can appear after /θ/ than after /f/ and /s/.

Lateral. [+lateral] is marked because /l/ does not appear after /t/ or /d/, and because [-lateral] liquid is more frequent than [+lateral] liquid.

Glides. Glides are marked because more phonemes can appear to the left of a liquid than of a glide.

Consonantal. The feature [consonantal] is used to distinguish liquids in second or third position of initial clusters from vowels, i.e., to distinguish clusters of two to three members from onsets which would be one phoneme shorter. The feature [glide] is used to signal the occurrence of a /w/ (or /v/ in German) as the final member of an onset cluster.

Delayed Release. [+Delayed release] is marked because it constrains what can follow it, i.e., only /l/ and /v/ can follow a [+delayed release] phoneme. Also, according to universal criteria, [+delayed release] is more marked than [-delayed release].

Consonant clusters were selected so that the average markedness of the consonant clusters in all four groups is as equal as possible. Special care was taken to ensure

that the consonant clusters which are illegal in both languages are no more marked than the consonant clusters occurring in one or both of the languages. This was to ensure that subjects not notice anything odd or bizarre about any of these consonant clusters.

Distance from English and German. The distance of the consonant clusters was calculated in two ways: a) using a method developed by Greenberg and Jenkins (1964) and b) calculating the least number of phonemes, graphemes or features needed to convert the illegal cluster to a legal cluster in German and/or English.

An illustration of the Greenberg and Jenkins method follows. If there is, for example, a two phoneme cluster such as /cv/ (spelled zw in German), its distance from English is calculated by indicating in the first column below, the number of simultaneous substitutions of phonemes that can be made, i.e., either one phoneme can be changed at a time, or both phonemes can be changed at the same time. The second column indicates the number of ways this can be done and the third column the number of these changes which result in English words. The identity substitution is allowed.

<u>A</u>	<u>B</u>	<u>C</u>	
1	2	1	(/c → x = x v/)
2	1	<u>1</u>	(changing both phonemes results in legal sequence)
			2 out of 3

Thus, for /cv/, if /æ/ is substituted for /c/ it results in a possible English sequence (as in avarice). However, there is nothing that can be substituted for /v/ to create a possible English sequence, since no word in English begins with /c/. Thus, the first number under column C is 1, not 2. Since changing both phonemes certainly results in a legal sequence, /cv/ allows 2 out of 3 possible substitutions. /šl/ (schl) is closer to English since it allows 3 out of 3 possible substitutions.

<u>A</u>	<u>B</u>	<u>C</u>	
1	2	2	(/š → s = sl/, /l → r = šr/)
2	1	<u>1</u>	(changing both phonemes results in legal sequence)
			3 out of 3

This method was used for all consonant clusters, substituting graphemes as well as phonemes.

The rest of the nonword. After the initial consonant clusters were selected, the rest of the nonword was constructed by randomly adding a vowel or diphthong that occurs in both languages, taken from the following set: "a, e, i, o, u, au, ei, ie." The vowel or diphthong was followed by a consonant or geminate occurring in final position in both English and German: "b, d, f, g, k, l, m, n, p, r, s, ss, t, tt, x, z." Thus, other than the initial consonant cluster, the rest of the nonword was always legal in both languages. All vowels and consonants were randomly added to the initial consonant cluster, but constrained so that

the vowels and consonants are equally distributed over all four groups of nonwords, and so that the same consonant cluster is not followed by the same vowel or consonant more than once. (That is, once SCHNAM was constructed, SCHNEM or SCHNAD were no longer possibilities.)

All nonwords are monosyllabic, with from four to six graphemes and phonemes. Each group of nonwords has an average number of graphemes ranging from 4.92 to 5.25 and an average number of phonemes ranging from 4.33 to 4.92. Thus, the average number of graphemes and phonemes in each group of nonwords was made as equal as possible.

Further, construction of the nonwords was constrained such that none of the nonwords can be pronounced as actual words of English or German. That is, a nonword such as STRIEM would be avoided, since it might be pronounced as stream (/strim/). There are two groups of nonwords (I and II) with the same initial consonant clusters, but with the rest of the nonwords different, although meeting the above criteria. Two groups were needed because the same nonwords were used in experiment 3 (below) where the design required two groups of nonwords. All nonwords were typed in uppercase letters. They are indicated on table 12.

Word Final Consonant Cluster Nonwords

Frequency. The consonant clusters for each group were selected primarily on the basis of frequency. The

consonant clusters are indicated on table 13. Frequency here refers solely to the number of different lexical items which end in a particular consonant cluster, not to the number of times each of these items occurs. These numbers were then converted to percentages, indicated on Table E. For English, The Rhyming Dictionary of the English Language by Walker (1936) was used to determine the frequency of each consonant cluster. It contained approximately 50,000 lexical items. For German, Rückläufiges Wörterbuch der deutschen Gegenwartssprache, by Mater (1967) was used. It contains approximately 130,000 different lexical items.

Legal status. The EG consonant clusters (legal in both languages) are both orthographically and phonologically legal in both languages. The $\bar{E}G$ consonant clusters (legal only in German) are both orthographically and phonologically illegal only in English. The \overline{EG} consonant clusters are both orthographically and phonologically illegal in both languages.

However, although -LTH and -RTH (of the ($\bar{E}G$) group) are orthographically illegal in German, German has word initial THR- which is pronounced [tr]. If -LTH and -RTH are pronounced [lt] and [rt], rather than [lθ] and [rθ], then they are phonologically legal.

Also, -WL is orthographically illegal in German but is phonologically legal, as in the German word faul (lazy), pronounced [fæwl]. However, there were not any

other word final consonant clusters in the \overline{EG} group which could be used instead of these.

Markedness. Given the small number of possible consonant clusters for each group, it was not possible to select them on any basis other than orthographic and phonological status and frequency. However, the consonant clusters selected for the \overline{EG} group were selected on the basis of their plausibility of occurring in languages of the world, and their similarity to clusters occurring in English and German. Thus, -RSP is similar to -RST, which occurs in both English and German, -ZB is the voiced counterpart of -SP, which occurs in English, -PK is similar to -PT, which occurs in English and German, and -ZG is the voiced counterpart of -SK, which occurs in both English and German.

The rest of the nonword. As with the word initial nonwords, the rest of the nonword was always legal in both languages. All begin with a single consonant taken from the following class of consonants, all appearing in initial position in both English and German: "b, d, f, g, h, k, l, m, n, p, r, s, t, v, w, z." The consonant is followed by one of the following vowels or diphthongs: "a, e, i, o, u, ei, ie." This was followed by one of the word final consonant clusters. The different initial consonants and vowels are again distributed as evenly as possible among the four groups of nonwords. The same initial

consonant or vowel is again not used more than once with any particular word final consonant cluster.

The nonwords are all monosyllabic. They consist of four or five graphemes and phonemes. The average number of graphemes in each group ranges from 4.6 to 4.9, the average number of phonemes ranges from 4.2 to 4.3. Due to the design of experiment 4, all subjects rated the same set of word final consonant cluster nonwords. All nonwords were typed in uppercase letters. The nonwords are indicated on table 14.

Subjects

Monolingual Subjects

All monolingual subjects were Queens College undergraduate students who did not consider themselves to be bilingual in any languages. None had ever studied a Germanic language other than English or had any other Germanic language spoken by members of their immediate family.

There were 20 monolingual subjects in the first testing session. Six were male, 14 were female, two were left-handed, and 18 were right-handed. The subjects' age ranged from 17 to 25. Subjects were paid \$1.- for every 20 minutes. The experimental time was approximately forty minutes, which included participation in experiment 3.

There were 18 monolingual subjects in the second testing session. Four were male, 14 were female, 4 were left-

handed and 14 were right-handed. Subjects' age ranged from 17 to 24. One student was older than the others but her responses did not differ from those of the other monolingual subjects. Subjects were paid \$1.- for every 20 minutes. The experimental time was approximately one hour, which included participation in experiments 4 and 5. Two monolingual subjects participated in both sessions.

Bilingual Subjects

Twenty German-English bilingual subjects participated in the first testing session. Eighteen of the same subjects also participated in the second testing session. The subjects ranged in age from 18 to 26 years. One subject was 43 but his responses did not differ from those of the other subjects. All subjects were right-handed. Three were male, 17 were female. Subjects were paid \$1.- for every 20 minutes. The first session lasted approximately one hour and fifteen minutes. The second session lasted approximately one hour.

Table 15 contains information on the background of the bilingual subjects. The information was obtained via a questionnaire which subjects were asked to fill out after completing the first testing session. All but three of the bilingual subjects were undergraduate students at Queens College. Of these, two were recent graduates of the college and one worked in the neighborhood of the college.

Many of the bilingual subjects had grown up in homes where German was spoken, many had also attended some classes at a German school, and many were attending advanced German classes at Queens College.

The column headed "Self-Rated Overall Proficiency," on Table 15, indicates the subjects' self-rating of comparable overall proficiency in German and English, on a scale of one to seven, where 1 = much better in German, 4 = equally skilled in German and English, and 7 = much better in English. All the subjects rated themselves as equal in both languages or as more proficient in English. The columns headed "Dominance Test" indicate the results of an objective test designed to confirm subjects' self-rating.

The dominance test used was adapted from Johnson (1953). Subjects were asked to write down as many English or German words as they could think of, in two minutes. Johnson suggests that subjects are able to think of more words in their dominant language. The results of the dominance test confirm the results of self-rating. (Articles added to nouns were not counted as separate words, e.g., Das Kind was counted as one word.)

Although most subjects were dominant in English, all considered themselves proficient in both languages and none experienced any difficulty with any of the tasks.

Procedure

The monolingual subjects and half of the bilingual subjects were given the following instructions: "Below are a series of nonsense words. How acceptable do you think these strings of letters would be, as new words of English?" These were printed on a sheet, followed by the scale which ranged from completely acceptable (=1) to completely unacceptable (=5). This was followed by the nonwords, in a random order. An example of a sheet used for the English rating task is reproduced in table 15. The other half of the bilingual subjects received the instructions and definitions of the scale translated into German, and asking them to rate the acceptability of the nonwords as new words of German.

RESULTS

The results of experiments 1 and 2 comparing the bilingual ratings in the German condition and the bilingual ratings in the English condition are indicated on table 17. A repeated measures analysis of variance was done for both experiments, with one within factor (type of nonword: EG, E \bar{G} , $\bar{E}G$, and $\bar{E}\bar{G}$) and one between factor (language condition: English vs. German). For both experiments 1 and 2, there was a significant effect of type of nonword: experiment 1, $F(3, 54)=60.175, p<.001$; experiment 2, $F(3, 48)=55.250, p<.001$. In experiment 1, no effect of language

condition was found: $F(1,18)=.380$, $p > .500$, while in experiment 2, there was a significant effect of language condition: $F(1,16)=9.468$, $p=.008$. There was a significant interaction of type of nonword and language condition: experiment 1, $F(3,54)=19.403$, $p < .001$; experiment 2, $F(3,48)=38.907$, $p < .001$. That is, in both experiments bilinguals rated the nonwords differently, depending on language condition. All comparisons of means for individual types of nonwords were made using a Tukey range test, at the .05 level of significance. These results are indicated graphically on table 17.

The monolingual results for experiments 1 and 2 are also indicated on table 17. A repeated measures analysis of variance was done for both experiments, with one within factor (type of nonword) and one between factor (subject group: monolingual vs. bilingual in English). For both experiments 1 and 2, there was again a significant effect of type of nonword: experiment 1, $F(3,54)=64.659$, $p < .001$; experiment 2, $F(3,48)=115.341$, $p < .001$. For experiment 1, there was a significant effect of subject group: $F(1,18)=7.590$, $p=.014$, while in experiment 2, no difference was found between the ratings of monolingual and bilingual subjects: $F(1,16)=3.324$, $p=.088$. For both experiments 1 and 2, there was no interaction of subject group and type of nonword: experiment 1, $F(3,54)=.936$, $p=.430$; experiment 2, $F(3,48)=.664$, $p > .500$. That is, bilinguals in the

English condition had the same pattern of responses to the nonwords as did English monolinguals.

DISCUSSION

There are two major findings of interest. Both support the hypothesis that the bilingual has a knowledge of two sets of phonotactic constraints. The first is the finding of a significant interaction between bilingual language condition and type of nonword in both experiments 1 and 2. This indicates that bilinguals rated the nonwords differently, depending on whether they were rated as potential English or German words.

Specifically, the Tukey range tests reveal that in both experiments 1 and 2 the ratings of the nonwords, as German or English words was equal for the EG and \overline{EG} groups. This is just what one would expect, since the legal status of these nonwords is identical in both German and English. However, ratings in the German and English conditions varied for the \overline{EG} and \overline{EG} nonwords, which is also what one would expect if the bilingual has a knowledge of two sets of phonotactic constraints. In experiment 1, there was a significant difference between the rating for \overline{EG} nonwords in the German and English conditions, and a significant difference between the rating for \overline{EG} nonwords in the German and English conditions, in the directions expected: \overline{EG} was rated as better in English, \overline{EG} was rated as better in

German. In experiment 2, there was also a significant difference in the ratings for \overline{EG} nonwords in the English vs. the German conditions, with \overline{EG} nonwords rated as more acceptable in the German condition than in the English condition. However, there was no significant difference between ratings for the $E\overline{G}$ nonwords in the English and German conditions in experiment 2. This may have been due to the fact that it was not possible to control the frequency of the word final consonant clusters, although the frequency of the word initial consonant clusters was controlled. Nonetheless, the difference, although not significant, is in the expected direction. ($E\overline{G}$ - English condition=2.963, \overline{EG} - German condition=3.519.)

The range test of bilingual ratings in the two conditions also reveals one surprising result, which is not, however, central to the main issue of one or two sets of phonotactic constraints. There was a significant difference in the English condition between EG and $E\overline{G}$ nonwords in experiment 1 ($2.232 < 3.284$). This suggests that despite the fact that both types of nonwords are legal in English and despite the controls used in the construction of the nonwords, the EG and $E\overline{G}$ groups were not equally acceptable. In fact, $E\overline{G}$ nonwords were rated as being as unacceptable as \overline{EG} nonwords, though not as unacceptable as \overline{EG} nonwords in English.

The second major finding is that in both experiments

1 and 2, there was no significant interaction between subject group (monolinguals vs. bilinguals) and type of nonword in English. This indicates that bilinguals had the same pattern of responses as did monolinguals, when asked to rate nonwords as potential English words. One can thus conclude, on the basis of experiments 1 and 2, that bilinguals have a knowledge of two sets of phonotactic constraints, one for each language, and further, that German-English bilinguals have a knowledge of the same phonotactic constraints for English that English monolinguals do.

Chapter 5

EXPERIMENTS 3 AND 4--LEXICAL DECISION TASKS

Experiments 3 and 4 are lexical decision tasks. The stimuli for experiment 3 are ones in which the initial consonant cluster of the nonwords and words determines its legal status in German and English. In experiment 4, the final consonant cluster of the item determines its legal status.

METHOD

Experiment 3--Word Initial Lexical Decision Task

Experiment 3 was conducted during the same testing session as experiment 1. Monolingual subjects and bilingual subjects were given the lexical decision task in English. Bilingual subjects also participated in a German lexical decision task, where they were asked to decide if an item was a German word or a nonword. Half of the bilingual subjects did the English lexical decision task followed by the German task; half did German first, followed by English.

Materials

All words and nonwords were monosyllabic. All items appeared on the slides typed in uppercase letters.

Nonwords. Nonwords were the same as those used in experiment 1. (See chapter 4 for a discussion of the criteria used in their construction.) The nonwords are reproduced in table 12. Half of the monolingual subjects saw nonword set I, half saw nonword set II. These two sets of nonwords began with the same consonant clusters and met identical criteria. For example, nonword set I contained BLIEX and BLEM while nonword set II contained BLUN and BLIEZ.

Words. There were two groups of English test words and two groups of German test words. One group contained words which were legal in the other language, that is, they were possible but never actual words in the other language. The second group contained words which were illegal in the other language. The words contained the same initial consonant clusters as did the nonwords, i.e., three words began with BL-, three with FL-, etc.

The English test words are reproduced on table 18, the German test words on table 19. Since there are 48 nonwords and 24 test words for each language, 24 filler words were selected for each language so that subjects would see an equal number of words and nonwords. The filler words appear on tables 20 and 21.

Frequency counts for the English words were taken from Kučera and Francis (1967). Frequency counts for German words were taken from Meier (1964). For all words, the frequency indicated on tables 18 and 19 refers to the number of occurrences of the word in the corpus. The mean number of occurrences for each group is also indicated, as well as the percentage of the entire corpus which the mean represents (so that German and English frequencies can be compared).

In almost all cases only the initial consonant cluster of the word makes it illegal or legal in the other language. The test words are both orthographically and phonologically legal or illegal, in order to avoid the question of phonemic recoding. Attempts were made, as much as possible, to have the rest of the word legal in both languages.

Selection of words was also constrained such that words in one language were not written or pronounced as words in the other language. For example, a German word like braun would be avoided since it is pronounced much like the English word brown.

Words with asterisks contain two morphemes. All others contain one morpheme. There are two test words and two filler words with two morphemes.

In order to keep the total number of legal and illegal items balanced, half of the English filler words are legal in German and half are illegal in German; half of

the German filler words are legal in English and half are illegal in English. However, these words are only orthographically legal or illegal. This is because there were not enough consonant clusters available meeting this constraint. Also, the frequency, markedness, etc. of the filler words was not controlled.

The number of graphemes for all words ranged from 4 to 7. The average for each group ranged from 4.83 to 6. The number of phonemes for test words ranged from 3 to 6. The average for each group ranged from 3.92 to 4.67. All words were nouns, verbs or adjectives.

Subjects

Subjects were the same as those who participated in experiment 1. They are described in Chapter 4.

Experiment 4--Word Final Lexical Decision Task

Experiment 4 was conducted during the same testing session as experiments 2 and 5. Monolingual and bilingual subjects were given the lexical decision task in English only.

Materials

All items are monosyllabic and appeared on the slides typed in uppercase letters.

Nonwords. Nonwords were the same as those used in experiment 2. They are reproduced on table 14. Since

bilingual subjects as well as monolingual subjects only participated in an English lexical decision task, only one set of nonwords was required.

Words. There were two groups of test words, one containing words legal in both languages, the other containing words illegal in German. In all cases, only the final consonant cluster determines which group (EG or E \bar{G}) the word belongs to. The words contained the same word final consonant clusters as did the nonwords, i.e., three ended with -RCH, three with -LK, etc. In no case did subjects see any actual German words. All words were monosyllabic. The 24 test words are reproduced on table 22.

The number of graphemes of the test words ranged from 4 to 6. The average number of graphemes was 4.6 and 5.1. The number of phonemes was 4 or 5, the average number of phonemes for the two groups of test words was 4.2 and 4.3

The 24 filler words appear on table 23. Due to a scarcity of appropriate consonant clusters, many of the consonant clusters of the filler words are only orthographically illegal in German. The filler words were not controlled for frequency, etc., although words with high frequencies were usually selected on the assumption that subjects would be more comfortable with more common words. The items of each experiment were presented in a random order, subject to the restriction that no more than three items from any group appeared consecutively.

Subjects

Subjects were the same as those who participated in experiment 2. They are discussed in chapter 4.

Procedure for Experiments 3 and 4

Subjects were seated in front of a screen, in a booth which blocked out light from other sources. The stimuli were presented for 500 msec. by means of a Gerbrands tachistoscope attached to a timer. Subjects pushed either a "yes" button or a "no" button with their dominant hand.

Subjects were given the following instructions: "You will see a series of slides with letters. Some of the slides have words on them, and some have sequences of letters that are not words. As quickly as possible, push the button labeled yes if the item is an English word, and push the button labeled no if the item is not an English word. Try to respond as quickly and as accurately as possible."

For the German version of experiment 3, subjects were given a translation of the above instructions, with German substituted for English. (Buttons were labeled ja and nein.)

The word "ready" or "fertig" was said before each slide appeared. Subjects first saw a series of practice slides.

RESULTS

Monolingual and bilingual results in English on experiments 3 and 4 are indicated on tables 24 and 25 respectively. Only correct responses are included. Occasional trials with extremely high or low reaction times were cut off using Forster and Chambers' (1973) method. Each subject's mean reaction time over all test items was calculated, as was the value two standard deviations above the mean and the value two standard deviations below the mean. Any scores more than two standard deviations from the mean were replaced by these values.

A repeated measures analysis of variance was done for both experiments 3 and 4 with one between factor (subject groups: monolingual vs. bilingual) and one within factor (six types of stimuli: two types of words and four types of nonwords). For both experiments, there was no significant effect of subject groups: experiment 3, $F(1,38)=2.330$, $p=.136$; experiment 4, $F(1,34)=.237$, $p>.500$. That is, there was no overall difference in reaction time between monolinguals and bilinguals. There was a significant effect of type of stimulus: experiment 3, $F(5,190)=35.885$, $p<.001$; experiment 4: $F(5,170)=15.026$, $p<.001$. In experiment 3 there was a significant group by stimulus type interaction: $F(5,190)=2.912$, $p=.015$, and in experiment 4 this interaction was approaching significance: $F(5,170)=2.148$, $p=.063$. All comparisons of means for individual types of stimuli

were made using a Tukey range test at the .05 level of significance. These comparisons are indicated graphically on tables 24 and 25.

The results of the two groups of nonwords used in experiment 3 are indicated on table 26. A repeated measures analysis of variance was done with two between subject factors (subject type: monolingual vs. bilingual, and nonword set: set I or II), and one within subject factor (type of stimulus). There was no significant effect of nonword set: $F(1,36)=.071$, $p>.500$.

Table 27 indicates bilingual means in the English condition of experiment 3 when bilinguals participated in the English task before the German task, and when they participated in the English task after the German task. A repeated measures analysis of variance was done with one between factor (order of presentation: English condition first vs. English condition second) and one within factor (type of stimulus). There was a significant effect of type of stimulus: $F(5,90)=16.994$, $p<.001$, and there was a tendency toward a significant effect of order of presentation: $F(1,18)=3.405$, $p=.082$. There was no interaction of order of presentation and type of stimulus: $F(5,90)=.779$, $p>.500$. A similar analysis of variance was done comparing bilingual means in German, depending on whether subjects participated in the German task before or after participating in the English task. The means are also

indicated on table 26. There was a significant effect of type of stimulus: $F(5,90)=15.848$, $p < .001$, and again a strong tendency toward a significant effect of order of presentation: $F(1,18)=4.090$, $p=.059$. There was no interaction of order of presentation and type of stimulus: $F(5,90)=1.008$, $p=.418$.

The number of bilingual and monolingual errors in experiments 3 and 4 are indicated on table 28. For both experiments, a repeated measures analysis of variance was done on the number of errors. There was one between factor (subject group: monolingual vs. bilingual) and one within factor (type of stimulus). There was no effect of subject group: experiment 3, $F(1,38)=2.426$, $p=.128$; experiment 4, $F(1,34)=2.068$, $p=.160$. That is, bilinguals did not have more errors than monolinguals. There was a significant effect of type of stimulus: experiment 3, $F(5,190)=13.466$, $p < .001$; experiment 4, $F(5,170)=10.460$, $p < .001$. In experiment 3, there was no significant interaction of subject group and stimulus type: $F(5,190)=.783$, $p > .500$, while in experiment 4 the interaction was significant: $F(5,170)=3.799$, $p=.003$.

Bilingual subjects' reaction times in the English condition and the German condition are indicated on table 29. Only correct responses are included. A repeated measures analysis of variance was done with two within subject factors: language condition (English vs. German) and type of stimulus. There was a significant effect of type

of stimulus: $F(5,95)=23.518$, $p < .001$ and a significant effect of language condition: $F(1,19)=67.848$, $p < .001$. There was also a significant interaction of language condition and type of stimulus: $F(5,95)=4.844$, $p = .001$. All comparisons of means for individual types of stimuli were made using a Tukey range test at the .05 level of significance. These comparisons are indicated graphically on table 29.

DISCUSSION

Monolingual vs. Bilingual Results

The major finding of experiments 3 and 4 is that there was an interaction of subject group and type of stimulus. This indicates that bilinguals and monolinguals did not have the same pattern of reaction times to the six types of stimuli. This finding supports the bilingual hypothesis, which is that the bilingual processes via the lexical retrieval systems of both languages. This is because both monolingual models predict no significant subject group by type of stimulus interaction. Given the interaction that was found, one can reject the monolingual hypothesis. This conclusion is supported by the findings of Lukatela, Savić, Gligorijević, Ognjenović and Turvey (1978), using a bi-alphabetic lexical decision task.

It might be suggested that these results are due to the fact that subjects were not in two modes simultaneously, but rather were switching from one mode to the other. If

this were true, then one would expect greater errors for bilingual subjects than for monolingual subjects. As indicated above, such a difference was not found. One can thus reject the monolingual models of bilingual lexical retrieval.

Another important finding is that for both experiments 3 and 4, there was no significant overall difference in reaction time between monolinguals and bilinguals in English. Although a trend was found for a difference between monolinguals and bilinguals in experiment 3, one can safely reject this for two reasons. First, it was not found in experiment 4. Second, the trend in experiment 3 can be accounted for by the fact that half of the bilingual subjects first participated in the German lexical decision task. As indicated above, this group had a tendency toward slower reaction times than the bilingual group which did English first. Apparently, subjects were less confident in their responses if they had German first, since most were dominant in English. They thus set themselves a slower initial pace, which was carried over in the English task.

(Similarly, on the German lexical decision task, there was a strong tendency for reaction times to be faster in German for those subjects who first did the English lexical decision task and then the German, than for those who did English first.) It would have been surprising if the results had been in the opposite direction. This difference in order of presentation can thus account for the slight

tendency found in experiment 3 for longer bilingual reaction times. In experiment 4, all subjects began with and only had an English lexical decision task. Given no difference in monolingual and bilingual overall reaction times, one can reject any model which assumes that, in all cases, bilinguals have to add some kind of extra step which monolinguals do not have to do.

Thus, given the finding that there was a different pattern of bilingual and monolingual reaction times and no difference in monolingual and bilingual overall reaction times, one can reject models IA and IB, the monolingual models, as well as model II, the serial exhaustive model. In order to decide among the remaining five bilingual models, the monolingual responses to specific types of stimuli will be used as a base line and bilingual responses will be compared to them. A closer look at monolingual responses is thus necessary.

As expected, in both experiments there was no difference between EG and $E\bar{G}$ words for monolinguals. Legal English nonwords (EG and $E\bar{G}$ had longer reaction times than words and on the whole, longer reaction times than illegal English nonwords ($\bar{E}G$ and $\bar{E}\bar{G}$). There were, however, two unexpected results found with the monolingual control group. There was no reason to expect that in experiment 3, EG nonwords would have longer reaction times than $E\bar{G}$ nonwords for monolinguals, since they are both legal in English, and their

status in German should be irrelevant, and yet such a difference was found. It should be noted that the \overline{EG} nonwords were the same ones which were unexpectedly rated as less acceptable in experiment 1, the rating task. There may be something about the construction of the nonwords in this group which caused this result.

There was also no reason to expect that \overline{EG} nonwords, although no different in reaction time from \overline{EG} nonwords, would also not be different in reaction time from \overline{EG} nonwords, which are legal in English. It may be that, despite the controls used, there were differences between the \overline{EG} and \overline{EG} groups. However, given the fact that this was found for both experiments 3 and 4, it may be that the \overline{EG} nonwords were more bizarre looking, causing subjects to hesitate.

A comparison of bilingual and monolingual reaction times to specific types of stimuli reveals a number of significant differences in the pattern of results, and allows one to decide which of the remaining bilingual models are most plausible. Monolingual reaction times for \overline{EG} nonwords was greater than monolingual reaction times for \overline{EG} nonwords. This was to be expected, since only the former are legal in English. For bilinguals, reaction times for \overline{EG} nonwords was equal to reaction times for \overline{EG} nonwords. Thus, bilinguals treated these two groups of nonwords identically, suggesting that the German phonotactic constraints had an effect on reaction time.

The conclusion that the second language phonotactics have an effect receives additional support from the error data. For monolinguals, the number of errors for \overline{EG} nonwords was greater (at Tukey, .05) than the number of errors for \overline{EG} nonwords. This is to be expected since the first are legal in English, and this could cause subjects to mistakenly push the "yes" button. For bilinguals, there was no statistically significant difference in the number of errors between the \overline{EG} and \overline{EG} nonwords (although the \overline{EG} group had a greater number of errors).

Of the bilingual models remaining, the serial self-terminating model B can be rejected since it predicts that \overline{EG} nonwords should have shorter reaction times than \overline{EG} nonwords, since according to this model the L_2 system is only accessed if an item is illegal in L_1 . The model also predicts that monolingual and bilingual reaction times should be equal for words and L_1 legal nonwords, and that bilingual reaction times should be longer only for L_1 illegal items. The results do not fit this pattern.

The serial self-terminating model A predicts longer reaction times on nonwords for bilinguals than for monolinguals, but equal reaction times for monolinguals and bilinguals on words. Experiments 3 and 4 do not yield the same results, in a comparison of monolingual and bilingual reaction times on each group of stimuli. However, even in experiment 3, where there are differences between monolingual

and bilingual reaction times for nonwords, there are also differences for the words, contrary to the predictions of this model. Thus, it seems reasonable to rule out the serial models. The parallel models are in fact, more efficient because less time consuming.

The parallel self-terminating model A predicts equal reaction times for monolinguals and bilinguals for words and for L_1 legal items. No such result was found for experiment 3, and in experiment 4, the only significant difference between bilinguals and monolinguals was found for EG words, contrary to the predictions of the parallel self-terminating model A.

Model III, the parallel exhaustive model, and model VB, the parallel self-terminating model B, both predict the finding that bilinguals have the same reaction time for \overline{EG} and \overline{EG} nonwords. However, only the parallel exhaustive model correctly predicts that reaction times for monolingual EG words should be faster than \overline{EG} nonwords while for bilinguals these should not be significantly different. Thus, although both the parallel exhaustive model and the parallel self-terminating model B are compatible with many of the results of experiments 3 and 4, the experiments most nearly fit the predictions of the parallel exhaustive model. This conclusion must remain tentative, however, since some of the results found do not fit any of the bilingual models.

In experiment 3, the reaction time for monolinguals

for EG nonwords is greater than that of \overline{EG} nonwords, as expected. However, the reaction time for bilinguals for EG nonwords is not different from that of \overline{EG} nonwords. This is an unexpected result which none of the models predict, since all assume an exhaustive search for legal nonwords and an aborted search for illegal nonwords.

In experiment 3, the reaction time for monolinguals for \overline{EG} words equals that for \overline{EG} nonwords, while for bilinguals the words have faster reaction times than the \overline{EG} nonwords. None of the models make any predictions about the relation between words and nonwords. This is because, if one assumes that the operation of the scanner and the search for nonwords is concurrent, there is no way of knowing whether a word will be located in more or less time than it takes the scanner to decide that a word is illegal. Thus, this finding is neither compatible nor incompatible with any of the models.

Also, none of the models predicts that bilingual reaction times to \overline{EG} words will not be different from \overline{EG} nonwords, as found in experiment 4. Further, some of the predictions of the parallel exhaustive model were not found. For example, the model predicts that the reaction time for bilingual EG words should be greater than the reaction time for bilingual \overline{EG} words. In both experiments 3 and 4, no significant difference was found between these two groups of words for bilinguals. Also, occasionally, the

results of one of the experiments will fit the predictions of the model while the other does not. For example, the model predicts that EG nonwords will have equal reaction times to $\bar{E}\bar{G}$ nonwords. This was found in experiment 4 but not experiment 3.

However, of the models that predict an effect of the L_2 retrieval system, the parallel models in general and the parallel exhaustive model in particular are the most plausible, since they come closest to predicting the results found.

Bilingual English vs. Bilingual German Results

A comparison of bilingual reaction times in the English and German conditions reveals longer overall reaction times in German than in English. This can be accounted for by the fact that almost all of the bilingual subjects were dominant in English. There was therefore greater uncertainty and lack of confidence in German, causing a delay in reaction time.

Some of the interaction among type of stimulus and language can be accounted for by the fact that the $\bar{E}\bar{G}$ and $\bar{E}G$ nonwords have different legal status in English and German. One would therefore expect, for example, that $\bar{E}G$ nonwords have faster reaction times than EG nonwords in English, since only the latter are legal in English, but that $\bar{E}\bar{G}$ nonwords have equal reaction times to EG nonwords in German, since both are legal in German. This result was found.

However, unlike experiment 3 in English and experiment 4, there was a significant difference in German between $\bar{E}G$ and $E\bar{G}$ nonwords, the former having longer reaction times. This may have been due to the fact that subjects were less certain about the accuracy of their responses in the German lexical decision task. Subjects' self-rating indicated that they felt that their knowledge of German was not equal to their knowledge of English. They may have delayed pushing the "no" button for legal German nonwords because they were concerned that the item was an actual German word which they did not happen to know. Subjects may also have checked their German lexicons again to make certain that the German legal nonwords were not actual words. Factors such as these can account for the different pattern of reaction times found in the German vs. the English lexical decision tasks.

Assumptions Revisited

The Scanner

One assumption made in chapter 5 was that there is a scanner which requires a knowledge of the phonotactic constraints of a language in order to operate. The results of experiments 3 and 4 support the assumption that the scanner operates at the same time that the search through the lexicon is made. If the scanner operated before the accessing of the lexicon, then one would predict that

illegal nonwords have faster reaction times than words. However, in both experiments 3 and 4, words have equal or faster reaction times than nonwords. This result is compatible with the findings of Forster and Amey (undated) and Snodgrass and Jarvella (1972). Thus, the operation of a scanner prior to the accessing of the lexicon is not possible. (This argument assumes that it does not take longer to execute a "no" response than a "yes" response. However, if such an assumption is not made and one argues that there is a prescanner and that illegal nonwords have longer reaction times because it takes longer to execute a "no" response, then the results of Forster and Amey must remain unexplained.)

A comparison of monolingual reaction times on the word initial and word final experiments (experiments 3 and 4) can also shed some light on the operation of the scanner. Specifically, this comparison addresses the question of whether the scanner operates from left to right, right to left, or as a kind of filter over the entire item at once.

An analysis of variance reveals no significant difference between overall reaction times of monolingual subjects on the word initial vs. word final lexical decision tasks. An analysis of variance was done with one between subjects factor (task: word initial vs. word final) and one within subjects factor (type of stimulus). There was no

effect of task: $F(1,30)=.384$, $p > .500$, a significant effect of stimulus type: $F(5,150)=24.583$, $p < .001$, and no task by stimulus type interaction: $F(5,150)=1.442$, $p = .213$. The fact that monolingual subjects had equal reaction times on the word final lexical decision task and the word initial lexical decision task allows one to rule out the possibility that the scanner operates from left to right or from right to left. Thus, it works as a filter over the entire item at once. This conclusion must remain tentative, since the word initial and word final stimuli were not designed to be comparable to one another. However, it should be noted that the words of experiment 4 have a lower frequency than those of experiment 3, so that frequency alone would predict faster reaction times for words for experiment 3 than experiment 4. An examination of tables 24 and 25 reveals that this is not the case, supporting the conclusions drawn above.

The Bilingual's Lexicon

It was also assumed that the bilingual has two lexicons, i.e., two sets of linguistic tags. The evidence from experiments 3 and 4 supports the assumption of two lexicons. This is because if there were one large lexicon, containing tags from both languages, a search model would predict longer reaction times for bilinguals than for monolinguals for words and legal items. This was not found.

In experiment 4, there was no significant difference in reaction time between bilinguals and monolinguals, except for EG words. In experiment 3, reaction times are longer for bilinguals in most groups, but they are not longer than those of monolinguals in the EG nonword group. Further, they are longer for bilinguals than monolinguals for the $\overline{\text{EG}}$ nonwords, which would not be predicted by a one lexicon model. Given these results, and the arguments presented above accounting for the differences in experiment 3 between monolingual and bilingual reaction times, one can conclude that the assumption of two separate sets of linguistic tags is justified.

Given two sets of tags, one can now ask whether only one set is searched during lexical retrieval, while the other is "shut off," or whether both sets are always available to be accessed and searched simultaneously, as suggested by the findings of Hamers (1973) and Lukatela, Savić, Gligorijević, Ognjenović and Turvey (1978). (See chapter 2.) This question will be addressed by experiment 5, described in chapter 6.

Conclusions

The results of experiments 1 and 2, the rating tasks, indicate that the bilingual has a knowledge of two sets of phonotactic constraints. The results of experiments 3 and 4, the lexical decision tasks, demonstrate that both of the

bilingual's sets of phonotactic constraints are available during processing, i.e., the bilingual hypothesis most accurately describes bilingual processing at the level of lexical retrieval. This is because of the significant interaction of subject group and type of stimulus. Further, given the lack of a significant overall difference in reaction time between monolinguals and bilinguals, as well as a comparison of individual means, one can conclude that the parallel processing model is most appropriate for describing bilingual lexical retrieval.

Chapter 6

EXPERIMENT 5--PAIRED LEXICAL DECISION TASK

Experiments 3 and 4 demonstrated that the bilingual has two sets of linguistic tags which are stored separately. Experiment 5 was designed to investigate the question of whether both sets are simultaneously available and accessed by the bilingual (the bilingual hypothesis) or whether only one set of linguistic tags at a time is available to the bilingual (the monolingual hypothesis). The term "lexicon" will hereafter be used to refer to a set of linguistic tags.

METHOD

Experiment 5 was conducted during the same testing session as experiments 2 and 4.

MaterialsHomonyms

Table 30 lists the homonyms which were selected, along with their frequency in English (taken from Kučera and Francis, 1967) and frequency in German (taken from Meier, 1964). For both English and German, raw scores were

converted to percentages.

There are two groups of homonyms: one with the frequency of the homonym higher in English than in German and one with the frequency higher in German. There are nine items in each group. These 18 homonyms were seen by all subjects as the first of a pair of words.

Table 31 lists words which are associated to the English meaning of the homonym (the associated-English group). Forty-three Queens College undergraduates (all native speakers of English with no knowledge of a Germanic language other than English) filled out a form with the following instructions: "Below are a series of 45 words. After each word write the first word that it makes you think of. Use only a single word for each response. Work rapidly until you have finished all 45 words." The 45 words contained the homonyms as well as their translations. However, gift, held and herd were not on the original form and so a second group of 7 students was administered a form with the same instructions and these homonyms.

The associated words listed in tables 31 and 32 were all selected from the students' responses to the homonyms. The column headed "Degree of Association" indicates the number of students who wrote that word as a response to the homonym. (For example, given rock, 13 students wrote stone as the word that rock made them think of.)

Table 32 lists words which were students' responses

to the translation of the German meaning of the homonym (the associated-German group). (For example, rock means skirt in German. Given skirt, 20 students wrote dress as the word that skirt made them think of.)

As much as possible, the associate to the German meaning and the associate to the English meaning of each homonym were equated with respect to degree of association, frequency in English, and the number of letters, syllables and morphemes of the word.

Table 33 lists words which are unassociated to either meaning of the homonym. Their frequency and number of letters are, wherever possible, the average of the frequency of the two associated words. For example, for rock, the two associated words are stone and dress. Their average frequency is 62.5. Dream has a frequency of 64, and the same number of letters, syllables and morphemes as stone and dress. The unassociated words were not selected by any student as a response to the homonym or its translation.

Filler Words

Table 34 contains 18 pairs of filler words. The filler words were included so as to retain the English mode as much as possible for the bilingual subjects. Thus, out of a total of 72 pairs of items, only 18 contained a homonym as the first member of that pair. The first word in

each pair of filler words was matched, as much as possible, with a homonym in terms of frequency, and number of letters, morphemes and syllables. The second word in each pair was similarly matched to the unassociated word (table 33) of each homonym. This was done so that the test words would not appear to be significantly different from the filler words.

Nonwords

Given 36 word pairs, there must be 36 pairs to which subjects respond "no," i.e., pairs in which one or both items are not words. Table 35 lists pairs with one word and one nonword. All the nonwords are legal in English. Many are taken from Forster and Chambers (1973), and Chambers and Forster (1975). The words were again equated with the homonyms and unassociated words in terms of frequency, and number of letters, morphemes and syllables. The number of letters and syllables of the nonwords were also controlled so that these pairs would not look different from the word-word pairs.

Table 36 lists 18 pairs of nonwords, many taken from Forster and Chambers (1973) and Chambers and Forster (1975). All are legal in English. Again, the number of letters and syllables of the nonwords were controlled so that they would not look different from the word-word pairs.

Subjects

Monolingual and bilingual subjects were the same as those who participated in experiments 2 and 4. They are described in chapter 4.

Procedure

There were three groups of monolingual and bilingual subjects. Each saw each homonym only once, followed by one of the three paired words. That is, the three paired words for each homonym were balanced across subjects.

Pairs appeared centered on the slides, typed in upper-case letters, with the first member of the pair typed directly above the second. The same equipment and testing procedure was used for experiment 5 as was used for experiments 3 and 4. (See chapter 5.) All subjects were given the following instructions: "You will see a series of slides with two rows of letters. As quickly as possible, push the button labeled yes, if both items are English words, and push the button labeled no if one or both of the items are not English words. Try to respond as quickly and as accurately as possible.

RESULTS AND DISCUSSION

The overall results (across the three monolingual and bilingual subject groups) are indicated on table 37. (Table 38 breaks these results down according to the three

monolingual and bilingual subject groups.) A repeated measures analysis of variance was done with one between subjects factor (subject group: monolinguals vs. bilinguals) and one within subjects factor (association to homonym: associated to English meaning, associated to German meaning and unassociated to either meaning). There was no overall difference between monolingual and bilingual reaction times: $F(1,34)=.099$, $p > .500$ and no significant difference among the three types of associated word pairs, although a tendency in that direction: $F(2,68)=2.860$, $p=.065$. There was no significant subject group by association to homonym interaction, i.e., monolinguals and bilinguals did not pattern differently from one another: $F(2,68)=.840$, $p=.437$.

These results are surprising, given the facilitating effect of word association on reaction time which other investigators have found. It is a particular problem since if monolinguals did not show any facilitating effect of having a prior associated word, then a comparison with bilinguals cannot be made. It might be suggested that some of the word pairs were not as associated as pre-testing had appeared to indicate. Table 39 indicates the average reaction times for monolinguals and bilinguals for the ten word pairs where the monolingual reaction time for the associated-English pairs was faster than the monolingual reaction time for the associated-German pairs. There is a smaller difference in the bilingual reaction times for the

two groups than in the monolingual reaction times for the two groups. However, the reaction times suggest that this is due to a latency in bilingual reaction time to the associated-English group rather than to a bilingual facilitation in the associated-German group. The reaction time to the filler words is also indicated on table 39. The reaction time to the filler words also suggests a problem with the stimuli. This is because reaction times to the filler pairs are no longer than reaction times to the associated-English pairs, despite the fact that the filler words did not contain any associated words and should thus have had longer reaction times.

Thus, there is no evidence of facilitation in any of the groups of stimuli for either monolinguals or bilinguals, suggesting that there was a problem in the selection of the stimuli.

Chapter 7

CONCLUSIONS

Two questions were raised in chapter 1. The first was: 1) Does the bilingual have one unified language processing system, used for processing both languages, or two processing systems, one for each language? The second question was: 2) If the bilingual has two language processing systems, is one "shut off" while the other is "on" (the monolingual hypothesis) or are both systems always available and/or operating (the bilingual hypothesis)? These two questions were investigated with respect to bilingual lexical retrieval, i.e., with respect to the bilingual's phonotactic constraints and lexicons.

Experiments 1 and 2, the rating tasks, demonstrate that the German-English bilingual has a knowledge of two sets of phonotactic constraints. It was also argued that the bilingual must have two sets of linguistic tags, i.e., two sets of words. Question 2 could now be addressed. The results of experiments 3 and 4, the lexical decision tasks, support the bilingual hypothesis, i.e., the hypothesis that both lexical retrieval systems are simultaneously available

to the bilingual. This conclusion is reached because bilinguals and monolinguals have a different pattern of reaction times to the stimuli. This difference would not be expected if bilinguals simply "shut off" their L_2 lexical retrieval system. A closer examination of the data indicates that, of the bilingual models described, the parallel models in general and the parallel exhaustive model in particular, most accurately predicts the results of the lexical decision tasks.

According to the parallel models, the bilingual has two lexical retrieval systems, i.e., two scanners and two lexicons, and both systems are always operating during lexical retrieval. Further, according to the parallel exhaustive model, the bilingual does not make a decision in the lexical decision task until input from both lexical retrieval systems has been received. Also, given the fact that there was no overall difference in reaction time between monolinguals and bilinguals, one can conclude that the bilingual's two sets of linguistic tags are stored separately, rather than in one large lexicon.

As noted in chapter 5, one aspect of the data which led to the parallel exhaustive model of bilingual lexical retrieval was the finding, in both experiments 3 and 4, that while monolinguals have longer reaction times to \overline{EG} nonwords than to \overline{EG} nonwords, bilinguals have equal reaction times to \overline{EG} nonwords and \overline{EG} nonwords in the English lexical

decision task. One would expect, in the German lexical decision task, that bilinguals again have equal reaction times to \overline{EG} and \overline{EG} nonwords. However, as also noted in chapter 5, bilinguals had longer reaction times to \overline{EG} nonwords than to \overline{EG} nonwords in the German task, so that it appears as if the bilingual was acting as one would expect a monolingual German speaker to act. However, it should be noted that the bilinguals had significantly longer overall reaction times in the German condition than in the English condition. It is argued that this time difference is not due to either the scanner or the lexical search, but rather to the language check, i.e., that point at which input is available from both lexical retrieval systems and the bilingual implements his/her response. Since almost all of the subjects were dominant in English, they were less certain about the accuracy of their responses in the German lexical decision task, and this hesitancy caused the longer overall reaction times in the German task. Further, it is argued that subjects experienced greatest uncertainty about the lexical status of the nonwords which are legal in German. That is, subjects were more hesitant, and perhaps re-searching parts of their lexicon, because the legal nonwords could have been actual German words that they just did not happen to know. Thus, this can account for the difference between the \overline{EG} and \overline{EG} nonwords which was found in the German lexical decision task.

It should be noted that an alternative analysis might be proposed to account for the different bilingual reaction times to the \overline{EG} and \overline{EG} nonwords in the German and English conditions. One could argue that bilingual reaction times in English are due to the fact that bilinguals are able to complete an exhaustive search of their entire English lexicon before receiving information from the scanner about the item's legal status. Thus, the reaction time for \overline{EG} nonwords should equal that for \overline{EG} nonwords. The German results would be accounted for by claiming that bilinguals need more time to search their German lexicon than their English lexicon, and are thus able to receive information from the scanner in the German condition before completing an exhaustive search of the German lexicon.

However, this alternative analysis requires two ad hoc assumptions. The first assumption is that for some reason the bilingual's scanner takes longer to scan an item than the monolingual's scanner. The second assumption is that it takes bilinguals longer to search their German lexicon than to search their English lexicon, despite the fact that their German lexicon is likely to have fewer words in it than their English lexicon. These assumptions are ad hoc and unmotivated.

Further, this alternative analysis makes predictions which are not supported by the data. It predicts that for bilinguals the reaction time for all nonwords should be equal.

However, in experiment 3, EG nonwords were not equal in reaction time to \overline{EG} and \overline{EG} nonwords and in experiment 4, bilingual reaction time to EG nonwords was significantly different from bilingual reaction time to both illegal nonwords, \overline{EG} and \overline{EG} . This analysis also incorrectly predicts that the bilingual reaction time for all nonwords should be longer than their reaction time for all words. This was also not found: in experiment 3, \overline{EG} , \overline{EG} and \overline{EG} nonwords were equal in reaction time to EG words; in experiment 4, \overline{EG} , \overline{EG} and \overline{EG} nonwords were equal in reaction time to EG words and to \overline{EG} words.

Thus, this alternative analysis fails to account for much of the data and requires two unmotivated assumptions about the time it takes bilinguals to do various stages of lexical retrieval. This alternative analysis will thus be rejected and the parallel exhaustive model retained as the most plausible account of the results of experiments 3 and 4.

It should be noted that the fact that the German phonotactic constraints had an effect on reaction times in the lexical decision tasks in no way conflicts with the fact that in the rating tasks, the two sets of phonotactic constraints were kept separate. This is because of the different nature of the two tasks. In the rating task, subjects did not need to access their lexicon since they knew that all of the items were nonwords. They only needed to access

their knowledge of phonotactic constraints, and although both sets of constraints were presumably operating, there was no time limitation in the rating task. Subjects thus had time to make a decision about which scanner's evaluation of legality was appropriate for the language in which the bilinguals were rating the nonwords.

It should also be noted that although the lexical decision task is not a typical language processing situation, it nonetheless taps a process which must be part of every speaker's system of speech comprehension. Every speaker has the ability to recognize when he/she has encountered an unknown or nonexistent word. Further, every speaker must retrieve words from memory during speech comprehension and production. The parallel models of bilingual lexical retrieval claim that during speech comprehension bilinguals are always processing in both lexical retrieval systems simultaneously.

The parallel exhaustive model of bilingual lexical retrieval has a number of implications and raises questions about other aspects of bilingual processing and about second language acquisition. For example, it is possible that bilingual syntax processing operates in an analogous way: the bilingual has two sets of syntactic rules, both of which operate in parallel to attempt to analyze incoming linguistic input. It is not unreasonable to suggest that, just as monolinguals may process both meanings of an

ambiguous sentence in parallel, bilinguals may use whatever processing rules and strategies they have available for syntactic processing. A first step in investigating this question might be to construct a syntactic version of the rating task, to establish that the fluent bilingual has a knowledge of two sets of syntactic rules.

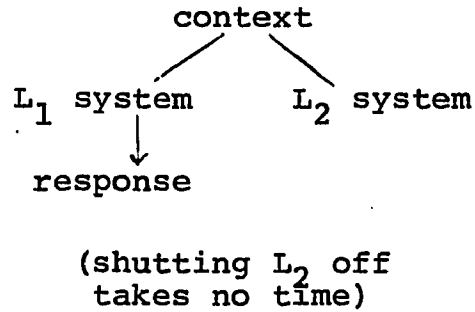
As stated in the discussion of compound and coordinate bilinguals (chapter 2), the language acquisition backgrounds of bilingual subjects may have an effect on processing. Five out of the 20 bilinguals who participated in experiments 1 through 5 had first learned English and German at age 12 or earlier. It would be interesting to see if similar results are found with bilinguals with different language acquisition backgrounds as well as with speakers of languages other than English or German.

Other questions are raised by the results of the rating tasks and lexical decision tasks. How does the bilingual's production system differ from the bilingual's comprehension system? How does a system like the parallel exhaustive system develop in bilingual children and adult second language learners? Do adult second language learners always have two separate lexical retrieval systems or is this something that develops as speakers become more proficient in the second language and approach fluent bilingualism? These questions indicate interesting areas for future research on bilingualism.

TABLES

Table 1
Predictions---Model IA

Monolingual Model A



	M-WE	B-WEG	B-WEG ⁻	M-NE	B-NEG	B-NEG ⁻	M-NE ⁻	B-NEG ⁻	B-NEG ⁻
M-WE		M-WE = B-WEG	M-WE = B-WEG	M-WE < M-NE	M-WE < B-NEG	M-WE < B-NEG	M-WE ? M-NE	M-WE ? B-NEG	M-WE ? B-NEG
B-WEG			B-WEG = B-WEG	B-WEG < M-NE	B-WEG < B-NEG	B-WEG < B-NEG	B-WEG ? M-NE	B-WEG ? B-NEG	B-WEG ? B-NEG
B-WEG ⁻				B-WEG < M-NE	B-WEG < B-NEG	B-WEG < B-NEG	B-WEG ? M-NE	B-WEG ? B-NEG	B-WEG ? B-NEG
M-NE					M-NE = B-NEG	M-NE = B-NEG	M-NE > M-NE	M-NE > B-NEG	M-NE > B-NEG
B-NEG						B-NEG = B-NEG	B-NEG > M-NE	B-NEG > B-NEG	B-NEG > B-NEG
B-NEG ⁻							B-NEG > M-NE	B-NEG > B-NEG	B-NEG > B-NEG
M-NE ⁻								M-NE = B-NEG	M-NE = B-NEG
B-NEG ⁻									B-NEG = B-NEG
B-NEG ⁻									

M-WE=Monolingual Word

B-WEG=Bilingual Word, Legal English, Legal German

B-WEG⁻=Bilingual Word, Legal English, Illegal German

M-NE=Monolingual Nonword, Legal English

B-NEG=Bilingual Nonword, Legal English, Legal German

B-NEG⁻=Bilingual Nonword, Legal English, Illegal German

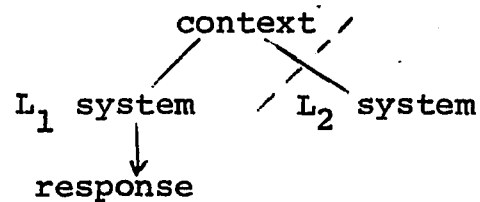
M-NE⁻=Monolingual Nonword, Illegal English

B-NEG⁻=Bilingual Nonword, Illegal English, Legal German

B-NEG⁻=Bilingual Nonword, Illegal English, Illegal German

Table 2
Predictions--Model IB

Monolingual Model B



(shutting L₂ off
takes time)

	M-WE	B-WEG	B-WEG _{il}	M-NE	B-NEG	B-NEG _{il}	M-NE _{il}	B-NEG _{il}	B-NEG _{il}
M-WE		M-WE < B-WEG	M-WE < B-WEG	M-WE < M-NE	M-WE < B-NEG	M-WE < B-NEG	M-WE ? M-NE	M-WE ? B-NEG	M-WE ? B-NEG
B-WEG			B-WEG = B-WEG	B-WEG ? M-NE	B-WEG < B-NEG	B-WEG < B-NEG	B-WEG ? M-NE	B-WEG ? B-NEG	B-WEG ? B-NEG
B-WEG _{il}				B-WEG ? M-NE	B-WEG < B-NEG	B-WEG < B-NEG	B-WEG ? M-NE	B-WEG ? B-NEG	B-WEG ? B-NEG
M-NE					M-NE < B-NEG	M-NE < B-NEG	M-NE > M-NE	M-NE ? B-NEG	M-NE ? B-NEG
B-NEG						B-NEG = B-NEG	B-NEG > M-NE	B-NEG > B-NEG	B-NEG > B-NEG
B-NEG _{il}							B-NEG > M-NE	B-NEG > B-NEG	B-NEG > B-NEG
M-NE _{il}								M-NE < B-NEG	M-NE < B-NEG
B-NEG _{il}									B-NEG = B-NEG
B-NEG _{il}									

M-WE=Monolingual Word

B-WEG=Bilingual Word, Legal English, Legal German

B-WEG_{il}=Bilingual Word, Legal English, Illegal German

M-NE=Monolingual Nonword, Legal English

B-NEG=Bilingual Nonword, Legal English, Legal German

B-NEG_{il}=Bilingual Nonword, Legal English, Illegal German

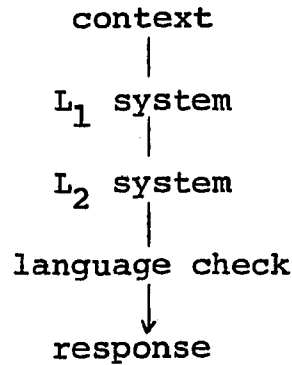
M-NE_{il}=Monolingual Nonword, Illegal English

B-NEG_{il}=Bilingual Nonword, Illegal English, Legal German

B-NEG_{il}=Bilingual Nonword, Illegal English, Illegal German

Table 3
Predictions--Model II

Serial Exhaustive Model



	M-WE	B-WEG	B-WEG _{il}	M-NE	B-NEG	B-NEG _{il}	M-NE _{il}	B-NEG _{il}	B-NEG _{il}
M-WE		M-WE < B-WEG	M-WE < B-WEG _{il}	M-WE < M-NE	M-WE < B-NEG	M-WE < B-NEG _{il}	M-WE ? M-NE _{il}	M-WE < B-NEG _{il}	M-WE ? B-NEG _{il}
B-WEG			B-WEG > B-WEG _{il}	B-WEG > M-NE	B-WEG < B-NEG	B-WEG > B-NEG _{il}	B-WEG > M-NE	B-WEG ? B-NEG _{il}	B-WEG ? B-NEG _{il}
B-WEG _{il}				B-WEG ? M-NE	B-WEG < B-NEG	B-WEG < B-NEG _{il}	B-WEG > M-NE _{il}	B-WEG < B-NEG _{il}	B-WEG ? B-NEG _{il}
M-NE					M-NE < B-NEG	M-NE < B-NEG _{il}	M-NE > M-NE _{il}	M-NE < B-NEG _{il}	M-NE ? B-NEG _{il}
B-NEG						B-NEG > B-NEG _{il}	B-NEG > M-NE _{il}	B-NEG > B-NEG _{il}	B-NEG > B-NEG _{il}
B-NEG _{il}							B-NEG > M-NE _{il}	B-NEG _{il} = B-NEG _{il}	B-NEG _{il} > B-NEG _{il}
M-NE _{il}								M-NE _{il} < B-NEG _{il}	M-NE _{il} < B-NEG _{il}
B-NEG _{il}									B-NEG > B-NEG _{il}
B-NEG _{il}									

M-WE=Monolingual Word

B-WEG=Bilingual Word, Legal English, Legal German

B-WEG_{il}=Bilingual Word, Legal English, Illegal German

M-NE=Monolingual Nonword, Legal English

B-NEG=Bilingual Nonword, Legal English, Legal German

B-NEG_{il}=Bilingual Nonword, Legal English, Illegal German

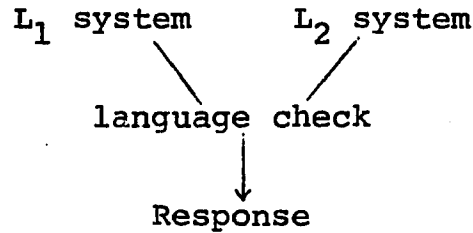
M-NE_{il}=Monolingual Nonword, Illegal English

B-NEG_{il}= Bilingual Nonword, Illegal English, Legal German

B-NEG_{il}= Bilingual Nonword, Illegal English, Illegal German

Table 4
Predictions--Model III

The Parallel Exhaustive Model



	M-WE	B-WEG	B-WEG $\bar{}$	M-NE	B-NEG	B-NEG $\bar{}$	M-NE $\bar{}$	B-NEG $\bar{}$	B-NEG $\bar{}$
M-WE		M-WE < B-WEG	M-WE = B-WEG	M-WE < M-NE	M-WE < B-NEG	M-WE < B-NEG	M-WE ? M-NE	M-WE < B-NEG	M-WE ? B-NEG
B-WEG			B-WEG > B-WEG	B-WEG = M-NE	B-WEG = B-NEG	B-WEG = B-NEG	B-WEG ? M-NE	B-WEG ? B-NEG	B-WEG ? B-NEG
B-WEG $\bar{}$				B-WEG < M-NE	B-WEG < B-NEG	B-WEG < B-NEG	B-WEG ? M-NE	B-WEG ? B-NEG	B-WEG ? B-NEG
M-NE					M-NE = B-NEG	M-NE = B-NEG	M-NE > M-NE	M-NE = B-NEG	M-NE > B-NEG
B-NEG						B-NEG = B-NEG	B-NEG > M-NE	B-NEG = B-NEG	B-NEG > B-NEG
B-NEG $\bar{}$							B-NEG > M-NE	B-NEG = B-NEG	B-NEG > B-NEG
M-NE $\bar{}$								M-NE < B-NEG	M-NE = B-NEG
B-NEG $\bar{}$									B-NEG > B-NEG
B-NEG $\bar{}$									

M-WE=Monolingual Word

B-WEG=Bilingual Word, Legal English, Legal German

B-WEG $\bar{}$ =Bilingual Word, Legal English, Illegal German

M-NE=Monolingual Nonword, Legal English

B-NEG=Bilingual Nonword, Legal English, Legal German

B-NEG $\bar{}$ =Bilingual Nonword, Legal English, Illegal German

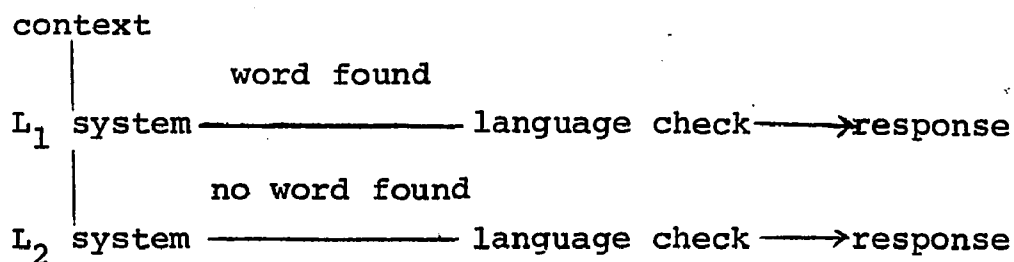
M-NE $\bar{}$ =Monolingual Nonword, Illegal English

B-NEG $\bar{}$ =Bilingual Nonword, Illegal English, Legal German

B-NEG $\bar{}$ =Bilingual Nonword, Illegal English, Illegal German

Table 5
Predictions--Model IVA

The Serial Self-Terminating Model A



	M-WE	B-WEG	B-WEG ⁻	M-NE	B-NEG	B-NEG ⁻	M-NE ⁻	B-NEG ⁻	B-NEG ⁻
M-WE		M-WE = B-WEG	M-WE = B-WEG	M-WE < M-NE	M-WE < B-NEG	M-WE < B-NEG	M-WE ? M-NE	M-WE < B-NEG	M-WE ? B-NEG
B-WEG			B-WEG = B-WEG	B-WEG < M-NE	B-WEG < B-NEG	B-WEG < B-NEG	B-WEG ? M-NE	B-WEG < B-NEG	B-WEG ? B-NEG
B-WEG ⁻				B-WEG < M-NE	B-WEG < B-NEG	B-WEG < B-NEG	B-WEG ? M-NE	B-WEG < B-NEG	B-WEG ? B-NEG
M-NE					M-NE < B-NEG	M-NE < B-NEG	M-NE > M-NE	M-NE < B-NEG	M-NE ? B-NEG
B-NEG						B-NEG > B-NEG	B-NEG > M-NE	B-NEG > B-NEG	B-NEG > B-NEG
B-NEG ⁻							B-NEG > M-NE	B-NEG = B-NEG	B-NEG > B-NEG
M-NE ⁻								M-NE < B-NEG	M-NE < B-NEG
B-NEG ⁻									B-NEG > B-NEG
B-NEG ⁻									

M-WE=Monolingual Word

B-WEG=Bilingual Word, Legal English, Legal German

B-WEG⁻=Bilingual Word, Legal English, Illegal German

M-NE=Monolingual Nonword, Legal English

B-NEG=Bilingual Nonword, Legal English, Legal German

B-NEG⁻=Bilingual Nonword, Legal English, Illegal German

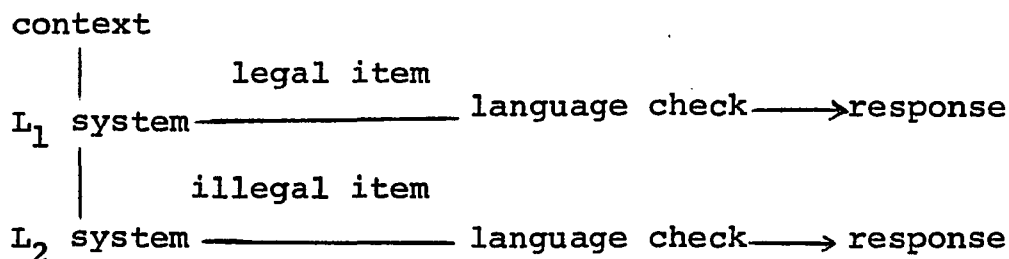
M-NE⁻=Monolingual Nonword, Illegal English

B-NEG⁻=Bilingual Nonword, Illegal English, Legal German

B-NEG⁻=Bilingual Nonword, Illegal English, Illegal German

Table 6
Predictions--Model IVB

Serial Self-Terminating Model B



	M-WE	B-WEG	B-WEG ⁻	M-NE	B-NEG	B-NEG ⁻	M-NE ⁻	B-NEG ⁻	B-NEG ⁻
M-WE		M-WE = B-WEG	M-WE = B-WEG	M-WE < M-NE	M-WE < B-NEG	M-WE < B-NEG	M-WE < M-NE	M-WE ? B-NEG	M-WE ? B-NEG
B-WEG			B-WEG = B-WEG	B-WEG < M-NE	B-WEG < B-NEG	B-WEG < B-NEG	B-WEG ? M-NE	B-WEG < B-NEG	B-WEG ? B-NEG
B-WEG ⁻				B-WEG < M-NE	B-WEG < B-NEG	B-WEG < B-NEG	B-WEG ? M-NE	B-WEG < B-NEG	B-WEG ? B-NEG
M-NE					M-NE = B-NEG	M-NE = B-NEG	M-NE > M-NE	M-NE < B-NEG	M-NE ? B-NEG
B-NEG						B-NEG = B-NEG	B-NEG > M-NE	B-NEG < B-NEG	B-NEG ? B-NEG
B-NEG ⁻							B-NEG > M-NE	B-NEG < B-NEG	B-NEG ? B-NEG
M-NE ⁻								M-NE < B-NEG	M-NE < B-NEG
B-NEG ⁻									B-NEG > B-NEG
B-NEG ⁻									

M-WE=Monolingual Word

B-WEG=Bilingual Word, Legal English, Legal German

B-WEG⁻=Bilingual Word, Legal English, Illegal German

M-NE=Monolingual Nonword, Legal English

B-NEG=Bilingual Nonword, Legal English, Legal German

B-NEG⁻=Bilingual Nonword, Legal English, Illegal German

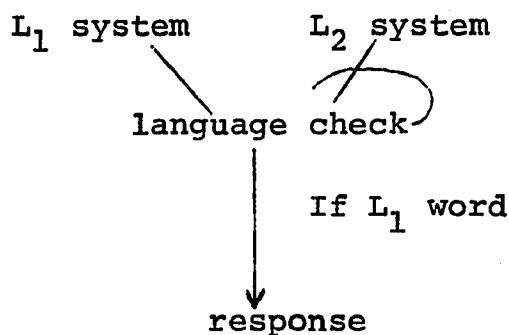
M-NE⁻=Monolingual Nonword, Illegal English

B-NEG⁻=Bilingual Nonword, Illegal English, Legal German

B-NEG⁻=Bilingual Nonword, Illegal English, Illegal German

Table 7
Predictions--Model VA

The Parallel Self-Terminating Model A



	M-WE	B-WEG	B-WEG ⁻	M-NE	B-NEG	B-NEG ⁻	M-NE ⁻	B-NEG ⁻	B-NEG ⁻
M-WE		M-WE = B-WEG	M-WE = B-WEG	M-WE < M-NE	M-WE < B-NEG	M-WE < B-NEG	M-WE ? M-NE	M-WE < B-NEG	M-WE ? B-NEG
B-WEG			B-WEG = B-WEG	B-WEG < M-NE	B-WEG < B-NEG	B-WEG < B-NEG	B-WEG ? M-NE	B-WEG < B-NEG	B-WEG ? B-NEG
B-WEG ⁻				B-WEG < M-NE	B-WEG < B-NEG	B-WEG < B-NEG	B-WEG ? M-NE	B-WEG < B-NEG	B-WEG ? B-NEG
M-NE					M-NE = B-NEG	M-NE = B-NEG	M-NE > M-NE	M-NE < B-NEG	M-NE > B-NEG
B-NEG						B-NEG = B-NEG	B-NEG > M-NE	B-NEG = B-NEG	B-NEG < B-NEG
B-NEG ⁻							B-NEG > M-NE	B-NEG = B-NEG	B-NEG > B-NEG
M-NE ⁻								M-NE < B-NEG	M-NE = B-NEG
B-NEG ⁻									B-NEG > B-NEG
B-NEG ⁻									

M-WE=Monolingual Word

B-WEG=Bilingual Word, Legal English, Legal German

B-WEG⁻=Bilingual Word, Legal English, Illegal German

M-NE=Monolingual Nonword, Legal English

B-NEG=Bilingual Nonword, Legal English, Legal German

B-NEG⁻=Bilingual Nonword, Legal English, Illegal German

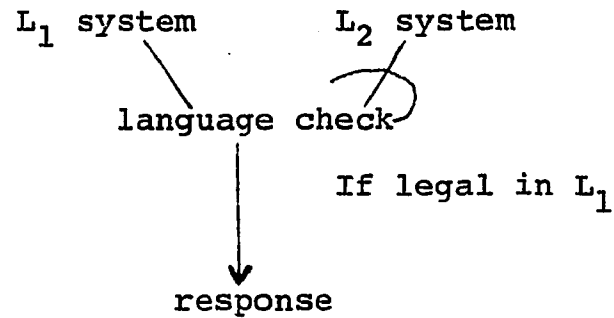
M-NE⁻=Monolingual Nonword, Illegal English

B-NEG⁻= Bilingual Nonword, Illegal English, Legal German

B-NEG⁻= Bilingual Nonword, Illegal English, Illegal German

Table 8
Predictions--Model VB

The Parallel Self-Terminating Model B



	M-WE	B-WEG	B-WEG $\bar{}$	M-NE	B-NEG	B-NEG $\bar{}$	M-NE $\bar{}$	B-NEG $\bar{}$	B-NEG $\bar{}$
M-WE		M-WE = B-WEG	M-WE = B-WEG $\bar{}$	M-WE < M-NE	M-WE < B-NEG	M-WE < B-NEG $\bar{}$	M-WE ? M-NE $\bar{}$	M-WE < B-NEG $\bar{}$	M-WE ? B-NEG $\bar{}$
B-WEG			B-WEG = B-WEG $\bar{}$	B-WEG < M-NE	B-WEG < B-NEG	B-WEG < B-NEG $\bar{}$	B-WEG ? M-NE $\bar{}$	B-WEG < B-NEG $\bar{}$	B-WEG ? B-NEG $\bar{}$
B-WEG $\bar{}$				B-WEG < M-NE	B-WEG < B-NEG	B-WEG < B-NEG $\bar{}$	B-WEG ? M-NE $\bar{}$	B-WEG < B-NEG $\bar{}$	B-WEG ? B-NEG $\bar{}$
M-NE					M-NE = B-NEG	M-NE = B-NEG $\bar{}$	M-NE > M-NE $\bar{}$	M-NE = B-NEG $\bar{}$	M-NE > B-NEG $\bar{}$
B-NEG						B-NEG = B-NEG $\bar{}$	B-NEG > M-NE $\bar{}$	B-NEG = B-NEG $\bar{}$	B-NEG > B-NEG $\bar{}$
B-NEG $\bar{}$							B-NEG > M-NE $\bar{}$	B-NEG = B-NEG $\bar{}$	B-NEG > B-NEG $\bar{}$
M-NE $\bar{}$								M-NE < B-NEG $\bar{}$	M-NE = B-NEG $\bar{}$
B-NEG $\bar{}$									B-NEG > B-NEG $\bar{}$
B-NEG $\bar{}$									

M-WE=Monolingual Word

B-WEG=Bilingual Word, Legal English, Legal German

B-WEG $\bar{}$ =Bilingual Word, Legal English, Illegal German

M-NE=Monolingual Nonword, Legal English

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B-NEG $\bar{}$ =Bilingual Nonword, Illegal English, Legal German

B-NEG $\bar{}$ =Bilingual Nonword, Illegal English, Illegal German

Table 9

Overall Design of the Experiments

 First Testing Session

Bilingual Group 1

dominance test-English
 Lexical decision task, experiment 3-English
 dominance test-German
 lexical decision task, experiment 3-German
 rating task, experiment 1-German
 language background questionnaire

Bilingual Group 2

dominance test-German
 lexical decision task, experiment 3-German
 dominance test-English
 lexical decision task, experiment 3-English
 rating task, experiment 1-English
 language background questionnaire

Monolingual Subjects

lexical decision task, experiment 3-English
 rating task, experiment 1-English
 language background questionnaire

Second Testing Session

All Subjects

lexical decision task, experiment 4-English
 paired lexical decision task, experiment 5-English
 rating task, experiment 2-in English in all monolingual
 subjects and half of the bilingual subjects; in
 German for the other bilingual subjects
 language background questionnaire-for subjects who did
 not participate in the first testing session

Table 10
Consonant Clusters

Consonant Cluster	Frequency (%)		Markedness	Distance from English and German						
	English	German		Phonemes Greenberg & Jenkins	Graphemes Greenberg & Jenkins	Least # Phonemes	Least # Graphemes	Least # Features	# of Letters	# of Phonemes
fl	.157	.132	3						2	2
bl	.159	.232	2						2	2
spr	.040	.113	2						3	3
str	.245	.13	3						3	3
sum	.601	.607	10						10	10
tw	.195		1	2 out of 3	3 out of 3	1	1	1	2	2
dw	.007		2	2 out of 3	3 out of 3	1	1	1	2	2
sl	.125		2	3 out of 3	3 out of 3	1	1	1	2	2
sm	.121		2	3 out of 3	2 out of 3	1	1	1	2	2
sum	.448		7						8	8
zw		.342	3	2 out of 3	3 out of 3	2	1	3	2	2
pfl		.046	4	2 out of 3	6 out of 7	1	2	1	3	2
schn		.043	1	3 out of 3	12 out of 15	1	1	1	4	2
schw		.188	2	3 out of 3	10 out of 15	1	1	3	4	2
sum		.619	10						13	8
tl			2	3 out of 3	3 out of 3	1	1	1	2	2
sr			2	3 out of 3	3 out of 3	1	1	1	2	2
pw			2	3 out of 3	3 out of 3	1	1	1	2	2
fn			2	3 out of 3	3 out of 3	1	1	1/3 (Eng./Germ.)	2	2
sum			8						8	8

Table 11

Markedness of Consonant Clusters

	pl	pr	bl	br	tr	dr	kl	kr	gl	gr	fr	fl	θr	sl	^v sl	^v sr	sp	^v sp	st	^v st	sk	spr	^v spr
sonorant																	M	M	M	M	M	M	M
voicing			M	M		M			M	M													
nasal																							
continuant											M	M	M	M	M	M							
coronal					M	M					M	M								M	M		
anterior							M	M	M	M												M	
strident													M										
lateral	M		M				M		M			M		M	M								
glides																							
consonantal																						M	M
delayed release																							
"v" vs. "n"																							
total number of Ms	1	0	2	1	1	2	2	1	3	2	2	3	2	2	2	1	1	1	2	2	2	2	2

Table 11 (Continued)

	spl	^v spl	str	^v str	skr	sm	^v sm	sn	^v sn	kn	kv	gn	p ^f l	cv	tw	kw	dw	gw	θw	sw	^v sv	skw		
sonorant	M	M	M	M																		M		
voicing												M					M	M						
nasal						M	M	M	M	M		M												
continuant										M		M								M	M	M		
coronal			M	M		M	M						M											
anterior					M						M					M		M						
strident																				M				
lateral	M	M											M											
glides											M			M	M	M	M	M	M	M	M	M	M	M
conson- antal	M	M	M	M	M								M	M										
delayed release													M	M										
"v" vs. "n"																								
total num- ber of Ms	3	3	3	3	2	2	2	1	1	2	2	3	4	3	1	2	2	3	3	2	2	2	2	

Table 12
Nonwords I and II
(Experiment 1 and Experiment 3)

Nonwords I					
EG	# of Letters	# of Phonemes	$\bar{E}\bar{G}$	# of Letters	# of Phonemes
FLESS	5	4	TWOG	4	4
FLOUG	5	5	TWAUL	5	5
FLAL	4	4	TWIR	4	4
BLUK	4	4	DWIES	5	4
BLIEX	5	5	DWAUK	5	5
BLEM	4	4	DWETT	5	4
SPROUN	6	6	S LIEN	5	4
SPREIB	6	6	SLEIF	5	5
SPROD	5	5	SLOUT	5	5
STRAUP	6	6	S MOUSS	6	5
STRUZ	5	5	SMEIZ	5	5
STRIT	5	5	SMATT	5	4
\bar{X}	5	4.92	\bar{X}	4.92	4.5
$\bar{E}\bar{G}$			$\bar{E}\bar{G}$		
ZWUX	4	5	TLITT	5	4
ZWAT	4	4	TLOUS	5	5
ZWOK	4	4	TLAX	4	5
PFLLOL	5	5	SREF	4	4
PFLES	5	5	SRAUB	5	5
PFLAZ	5	5	SRUED	5	4
SCHNER	6	4	PFREIR	6	6
SCHNAM	6	4	PFRAUG	6	5

Table 12 (Continued)

\overline{EG}	# of Letters	# of Phonemes	\overline{EG}	# of Letters	# of Phonemes
SCHNIB	6	4	PFRUM	5	5
SCHWOP	6	4	FNEIN	5	5
SCHWID	6	4	FNIEP	5	4
SCHWUF	6	4	FNOSS	5	4
\overline{X}	5.25	4.33	\overline{X}	5	4.67

Nonwords II

EG			\overline{EG}		
FLAUG	5	5	TWOUL	5	5
FLID	4	4	TWAUB	5	5
FLOUL	5	5	TWIESS	6	4
BLUN	4	4	DWUF	4	4
BLEIT	5	5	DWIETT	6	4
BLIEZ	5	4	DWEIG	5	5
SPRAP	5	5	SLAR	4	4
SPROM	5	5	SLAUX	5	6
SPRER	5	5	SLEIK	5	5
STRATT	6	5	SMOUN	5	5
STROS	5	5	SMOSS	5	4
STROUF	6	6	SMES	4	4
\overline{X}	5	4.83	\overline{X}	4.92	4.58

\overline{EG}			\overline{EG}		
ZWUG	4	4	TLON	4	4
ZWAX	4	5	TLIET	5	4
ZWIZ	4	4	TLOUZ	5	5

Table 12 (Continued)

$\bar{E}G$	# of Letters	# of Phonemes	$\bar{E}G$	# of Letters	# of Phonemes
PFLOK	5	4	SRIEL	5	4
PFLUD	5	4	SRIM	4	4
PFLES	5	4	SRAUTT	6	5
SCHNIM	6	4	PFRAD	5	4
SCHNOP	6	4	PFRUSS	6	4
SCHNEB	6	4	PFREIK	6	5
SCHWIT	6	4	FNAUX	5	6
SCHWEF	6	4	FNEB	4	4
SCHWAR	6	4	FNEIP	5	5
\bar{X}	5.25	4.08	\bar{X}	5	4.5

Table 13
 Word Final Consonant Clusters
 (Experiment 2 and Experiment 4)

	Consonant Cluster	Frequency (%)		# of Letters	# of Phonemes
		English	German		
EG	-RCH	.078	.021	3	2
	-RL	.054	.023	2	2
	-SK	.064	.009	2	2
	-LK	.056	.084	2	2
	\bar{X}	.063	.034	2.3	2
$\bar{E}\bar{G}$	-LTH	.014		3	2
	-RTH	.034		3	2
	-SP	.024		2	2
	-WL	.054		2	2
	\bar{X}	.032		2.5	2
$\bar{E}\bar{G}$	-NF		.016	2	2
	-RZT		.058	3	3
	-MPF		.140	3	2
	-TZT		.070	3	2
	\bar{X}		.071	2.8	2.3
$\bar{E}\bar{G}$	-RSP			3	3
	-ZB			2	2
	-ZG			2	2
	-PK			2	2
	\bar{X}			2.3	2.3

TABLE 14
 Word Final Consonant Clusters--Nonwords
 (Experiment 2 and Experiment 4)

EG	# of Letters	# of Phonemes	$\overline{\text{EG}}$	# of Letters	# of Phonemes
HURCH	5	4	FOLTH	5	4
GIRCH	5	4	BILTH	5	4
SORCH	5	4	GALTH	5	4
NURL	4	4	TERTH	5	4
FARL	4	4	WARTH	5	4
DERL	4	4	SIRTH	5	4
WIELF	5	4	MUSP	5	4
PELF	4	4	HEISP	5	5
BEILF	5	5	KIESP	4	4
KILK	4	4	ZEWL	4	4
VEILK	5	5	LEIWL	5	5
RIELK	5	4	DIEWL	5	4
\bar{X}	4.6	4.2	\bar{X}	4.8	4.2
$\overline{\text{EG}}$			$\overline{\text{EG}}$		
KIENF	5	4	TORSP	5	4
TANF	4	4	RARSP	5	4
BEINF	5	5	HIRSP	5	4
GURZT	5	5	LEPK	4	4
VERZT	5	5	DEIPK	5	5
WIRZT	5	5	PUPK	4	4
ZUMPF	5	4	NOZB	4	4
MOMPF	5	4	ZUZB	4	4
REMPF	5	4	MIEZB	5	4
PITZT	5	4	SIEZG	5	4

Table 14 (Continued)

\overline{EG}	# of Letters	# of Phonemes	\overline{EG}	# of Letters	# of Phonemes
NATZT	5	4	FEIZG	5	5
LOTZT	5	4	VAZG	4	4
\overline{X}	<u>4.9</u>	<u>4.3</u>	\overline{X}	<u>4.6</u>	<u>4.2</u>

Table 15
Bilingual Subjects

Subject	Age (yrs.) of First Learning		Self-Rated Overall Proficiency*	Dominance Test # of Words	
	English	German		English	German
B1	0	12	4	17	23
B5	0	0	5	49	24
B9	0	0	7	45	32
B13	0	23	7	41	30
B21	0	18	5	48	44
B2**	1½	1	6	40	26
B10	0	0	7	50	42
B14	5	0	5	43	32
B18	5	0	6	48	33
B22	0	0	5	60	46
B3	4-5	0	5	47	34
B7**	0	22	6	33	27
B11	0	12	5	50	42
B15	0	0	6	37	36
B19	1	5	5	38	34
B4	4-5	0	5	50	35
B8	0	5	5	58	41
B12	0	18	4	31	27
B16	5	0	5	39	33
B20	15	0	4	43	37
\bar{x}			5.35	43.35	33.90

*1=much better German, 4=equally skilled in German and English,
7=much better in English.

**Participated only in word initial session

Table 16

Sample Answer Sheet, Experiments 1 and 2

INSTRUCTIONS: Below are a series of nonsense words. How acceptable do you think these strings of letters would be, as new words of English?

<u>Example:</u>	<u>completely</u> <u>acceptable</u>	<u>fairly</u> <u>acceptable</u>	<u>can't</u> <u>decide</u>	<u>fairly</u> <u>unacceptable</u>	<u>completely</u> <u>unacceptable</u>
STRAR	1	2	3	4	5
	completely acceptable	fairly acceptable	can't decide	fairly unacceptable	completely unacceptable
1. SCHNEB	1	2	3	4	5
2. PFLAZ	1	2	3	4	5
3. DWETT	1	2	3	4	5
4. PFREIR	1	2	3	4	5
5. SLIEN	1	2	3	4	5
6. SPROUM	1	2	3	4	5
7. SRAUB	1	2	3	4	5
8. TWOL	1	2	3	4	5
9. TLITT	1	2	3	4	5
10. BLEP	1	2	3	4	5
11. FLESS	1	2	3	4	5
12. PFLOL	1	2	3	4	5
13. FNEIN	1	2	3	4	5
14. STRAUN	1	2	3	4	5
15. BLIEX	1	2	3	4	5
16. TWIF	1	2	3	4	5
17. FLAL	1	2	3	4	5
18. ZWAT	1	2	3	4	5
19. SLEIR	1	2	3	4	5
20. BLUK	1	2	3	4	5
21. PFLES	1	2	3	4	4
22. TLAX	1	2	3	4	5
23. SRIED	1	2	3	4	5

Table 16 (Continued)

	completely acceptable	fairly acceptable	can't decide	fairly unacceptable	completely unacceptable
24. ZWUX	1	2	3	4	5
25. SMASS	1	2	3	4	5
26. PFRAUG	1	2	3	4	5
27. ZWOK	1	2	3	4	5
28. DWALK	1	2	3	4	5
29. STRUB	1	2	3	4	5
30. DWIES	1	2	3	4	5
31. SCHWUF	1	2	3	4	5
32. FNIEP	1	2	3	4	5
33. SPROT	1	2	3	4	5
34. SCHWOP	1	2	3	4	5
35. FNOSS	1	2	3	4	5
36. TWAUG	1	2	3	4	5
37. SREF	1	2	3	4	5
38. STRIZ	1	2	3	4	5
39. SCHNIR	1	2	3	4	5
40. SCHNAM	1	2	3	4	5
41. SMEIZ	1	2	3	4	5
42. FLOUG	1	2	3	4	5
43. PFRUM	1	2	3	4	5
44. SCHWID	1	2	3	4	5
45. SPREID	1	2	3	4	5
46. SROUTT	1	2	3	4	5
47. TLOUS	1	2	3	4	5
48. SLOUT	1	2	3	4	5

Table 17
Results--Rating Tasks

Type of Nonword	Monolingual Subjects	Bilingual Subjects		\bar{X}
		English	German	
Word Initial Rating Task				
EG (e.g., BLUK)	1.967	2.232 ¹	2.575 ⁵	2.403
$\bar{E}\bar{G}$ (e.g., TWOUL)	2.590	3.284 ²	4.001 ⁶	3.642
$\bar{E}\bar{G}$ (e.g., PFLOK)	3.334	3.742 ³	2.433 ⁷	3.087
$\bar{E}\bar{G}$ (e.g., TLIET)	4.024	4.259 ⁴	4.176 ⁸	4.217
\bar{X}	2.979	3.379	3.296	3.338
		<u>1 7 5</u> <u>2 3</u> 6 8 4		
Word Final Rating Task				
EG (e.g., PELF)	2.149	2.510 ¹	2.414 ⁵	2.462
$\bar{E}\bar{G}$ (e.g., TERTH)	2.537	2.963 ²	3.519 ⁶	3.241
$\bar{E}\bar{G}$ (e.g., ZUMPF)	4.176	4.259 ³	1.979 ⁷	3.118
$\bar{E}\bar{G}$ (e.g., LEPK)	4.074	4.407 ⁴	4.038 ⁸	4.222
\bar{X}	3.234	3.535	2.987	3.261
		<u>7 5 1</u> 2 6 8 3 4		

Those means that are underlined are not significantly different from one another, according to the Tukey range test at the .05 level of significance. For example, in experiment 1, means 5 and 2 are significantly different from one another, while means 2 and 3 are not significantly different from one another.

Table 18
English Words--Experiment 3

Word	Frequency	# of Letters	# of Phonemes	Grammatical Category
EG				
FLAT	67	4	4	Adj.
FLED	28	4	4	V
FLAG	16	4	4	N
BLAST	15	5	5	N
BLACK	203	5	4	Adj.
BLEAK	10	5	4	Adj.
SPREAD	83	6	5	N + V
SPRIG	1	5	5	N
SPREE	4	5	4	N
STRONG	202	6	5	Adj.
STRESS	107	6	5	N
STREAM	51	6	5	N + V
\bar{X}	65.58= .0065%	5.08	4.5	
\bar{EG}				
TWELVE	48	6	5	Adj.
TWIN	7	4	4	N + Adj.
TWIST	18	5	5	N + V
DWARF	3	5	5	N
DWELL	8	5	4	V
DWELT*	1	5	5	V
SLEEP	65	5	4	N + V
SLAVE	30	5	4	N
SLID	24	4	4	V
SMALL	542	5	4	Adj.

Table 18 (Continued)

Word	Frequency	# of Letters	# of Phonemes	Grammatical Category
SMILE	58	5	5	N
SMOKE	41	5	4	N + V
\bar{X}	$70.42 =$ $.0069\%$	4.92	4.42	

Table 19
German Words--Experiment 3

Word	Frequency	# of Letters	# of Phonemes	Grammatical Category
EG				
FLUG	83	4	4	N
FLUSS	416	5	4	N
FLUCH	192	5	4	N
BLIEB	1800	5	5	V
BLICK	1637	5	4	N
BLUT	1064	4	4	N
SPRECH	16	6	5	V
SPRICH	279	6	5	V
SPRUCH	124	6	5	N
STREIT	474	6	6	N
STROM	373	5	5	N
STRENG	462	6	5	Adj.
\bar{X}	576.67= .0055%	5.33	4.67	
\bar{EG}				
ZWANG	417	5	5	N
ZWECK	173	5	4	N
ZWERK	14	5	5	N
PFLEGT*	516	6	5	V
PFLICHT	1215	7	5	N
PFLUG	45	5	4	N
SCHNEE	316	6	3	N
SCHNELL	1757	7	4	Adj.
SCHNUR	118	6	4	N
SCHWACH	462	7	4	Adj.
SCHWER	1862	6	4	Adj.
SCHWUR	128	6	4	N
\bar{X}	585.25= .0056%	6	4.25	

Table 20

English Filler Words--Experiment 3

Word	Frequency	# of Letters	# of Phonemes	Grammatical Category
EG				
GLAD	38	4	4	Adj.
GLOOM	14	5	4	N
PLAN	205	4	4	N + V
PLANT	125	5	5	N + V
BREAK	88	5	4	N + V
BROAD	84	5	4	Adj. + N
TRUTH	126	5	4	N
TRAIN	82	5	4	N + V
FREE	260	4	3	Adj. + V
FRUIT	35	5	4	N
THREE	610	5	3	Adj.
THROAT	51	6	4	N
\bar{X}	143.17	4.83	3.92	
EG				
SWEET	70	5	4	Adj.
SWEAT	23	5	4	N + V
SNAKE	44	5	4	N + V
SNAP	12	4	4	N + V
WHITE	365	5	4	Adj.
WHOLE	309	5	3	Adj.
THWACK	1	6	4	N + V
THWART	4	6	5	V
SCREEN	48	6	5	N + V
SCREAM	13	6	5	N + V
CLUB	145	4	4	N + V
CLEAR	219	5	4	Adj.
\bar{X}	104.42	5.17	4.17	

Table 21

German Filler Words--Experiment 3

Word	Frequency	# of Letters	# of Phonemes	Grammatical Category
EG				
GLATT	124	5	4	Adj.
GLAUB	125	5	5	V
BROT	491	4	4	N
BRAUT	380	5	4	N
TRAUM	421	5	5	N
TRIEB	587	5	4	N
DRUCK	764	5	4	N
DRANG	417	5	5	N
STARB	589	5	5	V
STAUB	380	5	5	N + V
SPIEL	719	5	4	N
SPART*	19	5	5	V
\bar{X}	418	4.92	4.5	
\bar{EG}				
SCHLUG	646	6	4	V
SCHLAF	373	6	4	N + V
PFERD	458	5	4	N
PFUND	610	5	4	N
SCHREI	101	6	4	N + V
SCHRIE	270	6	3	V
SCHMAL	38	6	4	Adj.
SCHMERZ	789	7	5	N
KLAGT*	121	5	5	V
KLEIN	640	5	5	Adj.
KRAM	23	4	4	N
KRIEG	1281	5	4	N + V
\bar{X}	445.83	5.5	4.17	

Table 22

Words--Experiment 4

Words	Frequency	# of Letters	# of Phonemes	Grammatical Category
EG				
SEARCH	66	6	4	N, V
STARCH	4	6	5	N, V
PORCH	43	5	4	N
PEARL	9	5	4	N, Adj.
BURL	2	4	4	Adj.
HURL	3	4	4	V
DISK	25	4	4	N
BRISK	7	5	5	Adj.
DUSK	9	4	4	N
MILK	49	4	4	N, V
SILK	12	4	4	N
HULK	2	4	4	N
\bar{X}	19.3	4.6	4.2	
\bar{EG}				
HEALTH	105	6	4	N
WEALTH	22	6	4	N
FILTH	2	6	4	N
BIRTH	66	5	4	N
HEARTH	4	6	4	N
MIRTH	2	5	4	N
WASP	2	4	4	N
GASP	2	4	4	N, V
GRASP	17	5	5	N, V
BOWL	23	4	4	N, V
SPRAWL	3	6	5	V
PROWL	2	5	5	V
\bar{X}	20.8	5.1	4.3	

Table 23

Filler Words--Experiment 4

EG	EG
JUST	CROWD
LEAST	LEWD
LEFT	HAWK
DRAFT	SQUAWK
LEARN	BREADTH
BORN	WIDTH
SOUND	PACT
TEND	FACT
FIELD	FIFTH
BOLD	TWELFTH
SPORT	RIGHT
PART	LIGHT

Table 24

Experiment 3, Word Initial Lexical Decision Task--English

	Reaction Times		\bar{X}
	Monolinguals	Bilinguals	
	Words		
EG (e.g., FLAG)	.734 ¹	.825 ⁷	.779
$\bar{E}\bar{G}$ (e.g., TWIN)	.736 ²	.791 ⁸	.763
	Nonwords		
EG (e.g., BLUK)	.856 ³	.894 ⁹	.875
$\bar{E}\bar{G}$ (e.g., TWOUL)	.795 ⁴	.843 ¹⁰	.819
$\bar{E}\bar{G}$ (e.g., PFLOK)	.741 ⁵	.831 ¹¹	.786
$\bar{E}\bar{G}$ (e.g., TLIET)	.771 ⁶	.848 ¹²	.809
\bar{X}	.772	.839	.805
	<u>1 2 5 6 8 4 7 11 10 12 3 9</u>		

Note. Reaction times are indicated in seconds. Those means that are underlined are not significantly different from one another, according to the Tukey range test, .05 level of significance.

Table 26

Experiment 3, Nonwords I vs. Nonwords II

	Reaction Times					
	Words		Nonwords			
	EG	\bar{EG}	EG	\bar{EG}	\bar{EG}	\bar{EG}
Monolinguals						
I	.738	.744	.874	.815	.754	.793
II	.730	.728	.838	.777	.727	.748
\bar{X}	.734	.736	.856	.796	.741	.771
Bilinguals						
I	.819	.791	.871	.855	.830	.851
II	.830	.790	.917	.830	.832	.845
\bar{X}	.825	.791	.894	.843	.831	.848

Note. Reaction times are indicated in seconds.

Table 27

Bilingual--Order of Presentation

Reaction times for English, when English lexical decision task was done first and for English when it followed German lexical decision task.						
	Words		Nonwords			
	EG	\bar{EG}	EG	\bar{EG}	\bar{EG}	\bar{EG}
English First	.762	.734	.825	.790	.765	.777
English Second	.887	.847	.963	.895	.897	.919
\bar{X}	.825	.791	.894	.843	.831	.848
Reaction times for German, when German lexical decision task was done first and for German when it followed English lexical decision task.						
German Second	.840	.823	.928	.854	.892	.869
German First	.945	.977	1.092	.980	1.051	1.015
\bar{X}	.892	.900	1.010	.917	.971	.942

Note. Reaction times are indicated in seconds.

Table 28

Experiments 3 (English) and 4--Number of Errors

	Experiment 3		Experiment 4	
	Monolinguals	Bilinguals	Monolinguals	Bilinguals
Word				
EG	1.60 ¹	1.35 ⁷	.611 ¹	.833 ⁷
\bar{EG}	.70 ²	.70 ⁸	.722 ²	1.111 ⁸
Nonword				
EG	1.40 ³	.70 ⁹	1.667 ³	.611 ⁹
\bar{EG}	.85 ⁴	.40 ¹⁰	1.167 ⁴	.556 ¹⁰
\bar{EG}	.20 ⁵	.00 ¹¹	.000 ⁵	.000 ¹¹
\bar{EG}	.20 ⁶	.10 ¹²	.222 ⁶	.111 ¹²
\bar{X}	.825	.542	.731	.537
	<u>11 12 5 6 10 2 8 9 4 7 3 1</u>		<u>5 11 12 6 10 1 9 2 7 8 4 3</u>	

Note. Reaction times are indicated in seconds. Those means that are underlined are not significantly different from one another, according to the Tukey range test, .05 level of significance.

Table 30

Experiment 5--Homonyms

Homonym	Meaning in German	Freq. (%) English	Freq. (%) German	G'al. Category English	G'al. Category German
Frequency Higher in English					
ROCK	skirt	.0074	.0019	N,V	N
SEE	lake	.076	.0068	V	N
SPECK	bacon	.0007	.0004	N	N
KIND	child	.0309	.0201	Adj.	N
BAD	bath	.014	.0006	Adj.	N
LEG	lay	.0057	.0004	N	V
GIFT	poison	.0033	.0020	N	N
HERD	stove	.0022	.0008	N	N
HELD	hero	.0261	.0025	V	N
\bar{X}		.0185	.0039		
Frequency Higher in German					
WAND	wall	.0001	.0035	N	N
TAG	day	.0005	.0291	N,V	N
BALD	soon	.0005	.0549	Adj.	Adv.
NUN	now	.0002	.0170	N	Adv.
HUT	hat	.0013	.0050	N	N
GANG	walk	.0022	.0055	N	N
REIN	pure	.0003	.0107	N,V	Adj.
WART	wait	.0011	.0013	N	V
LAG	lay	.0003	.0161	V	V
\bar{X}		.0007	.0159		
\bar{X} , both groups		.0096	.0099		

Table 31

Experiment 5--Associate to English Meaning of Homonym

Homonym	Associate to English Meaning	Degree of Assoc.	Freq.	#/Letters	#/Syllables	#/Morphemes	G'al. Category
ROCK	STONE	13	58	5	1	1	N
SEE	HEAR	6	153	4	1	1	V
SPECK	DOT	7	13	3	1	1	N,V
KIND	NICE	13	75	4	1	1	Adj.
BAD	EVIL	4	72	4	2	1	Adj.
LEG	FOOT	11	70	4	1	1	N,V
GIFT	PRESENT	7	377	7	2	1	N,V
HERD	CATTLE	2	97	6	2	1	N
HELD	LIFT	1	23	4	1	1	N,V
\bar{X}		7.1	104.2	4.6	1.3	1	
WAND	STICK	5	39	5	1	1	N,V
TAG	PLAY	3	200	4	1	1	N,V
BALD	HAIR	8	148	4	1	1	N
NUN	CHURCH	6	348	6	1	1	N
HUT	GRASS	2	53	5	1	1	N
GANG	GROUP	11	390	5	1	1	N,V

Table 31 (Continued)

Homonym	Associate to English Meaning	Degree of Assoc.	Freq.	#/Letters	#/Syllables	#/Morphemes	G'al. Category
REIN	HORSE	10	117	5	1	1	N
WART	MOLE	3	4	4	1	1	N
LAG	SLOW	8	60	4	1	1	Adj.
\bar{X}		6.2	151	4.7	1	1	
\bar{X} , both groups		6.7	127.6	4.6	1.2	1	

Table 32

Experiment 5--Associate to German Meaning of Homonym

Homonym	Associate to German Meaning	Degree of Assoc.	Freq.	#/Letters	#/Syllables	#/Morphemes	G'al. Category
ROCK	DRESS	20	67	5	1	1	
SEE	RIVER	9	165	5	2	1	
SPECK	EGG	3	12	3	1	1	
KIND	BABY	7	62	4	2	1	
BAD	CLEAN	6	70	5	1	1	
LEG	SLEEP	9	65	5	1	1	
GIFT	DEATH	1	277	5	1	1	
HERD	HOT	1	130	3	1	1	
HELD	SANDWICH	2	10	8	2	1	
\bar{X}		6.4	95.3	4.8	1.3	1	
WAND	FLOOR	6	158	5	1	1	
TAG	LIGHT	2	333	5	1	1	
BALD	LATE	7	179	4	1	1	
NUN	LATER	25	397	5	2	2	
HUT	CAP	3	27	3	1	1	
GANG	LEGS	2	67	4	1	2	

Table 32 (Continued)

Homonym	Associate to German Meaning	Degree of Assoc.	Freq.	#/Letters	#/Syllables	#/Morphemes	G'al. Category
REIN	CLEAN	4	70	5	1	1	
WART	BUS	4	34	3	1	1	
LAG	SLEEP	9	65	5	1	1	
\bar{X}		6.9	147.8	4.3	1.1	1.2	
\bar{X} , both groups		6.7	121.6	4.6	1.2	1.1	

Table 33

Experiment 5--Unassociated to Either Meaning

Homonym	Unassociated Word	Freq.	#/Letters	#/Syllables	#/Morphemes	G'al. Category
ROCK	DREAM	64	5	1	1	
SEE	RANGE	160	5	1	1	
SPECK	FUR	13	3	1	1	
KIND	SEEK	69	4	1	1	
BAD	HILL	72	4	1	1	
LEG	BEAT	68	4	1	1	
GIFT	COUNTRY	324	7	2	1	
HERD	STAY	113	4	1	1	
HELD	BASKET	17	6	2	1	
\bar{X}		100	4.7	1.2	1	
WAND	SHARE	98	5	1	1	
TAG	TELL	268	4	1	1	
BALD	SORT	164	4	1	1	
NUN	GIVEN	377	5	2	2	
HUT	CODE	40	4	1	1	
GANG	VOICE	226	5	1	1	

Table 33 (Continued)

Homonym	Unassociated Word	Freq.	#/Letters	#/Syllables	#/Morphemes	G'al. Category
REIN	SHOWS	94	5	1	2	
WART	DIM	19	3	1	1	
LAG	SHOP	63	4	1	1	
\bar{X}		149.9	4.3	1.1	1.2	
\bar{X} , both groups		124.9	4.5	1.2	1.1	

Table 34
Experiment 5--Filler Words

First Word	Freq.	#/Letters	#/Morphemes	#/Syllables	Second Word	Freq.	#/Letters	#/Morphemes	#/Syllables
CAMP	75	4	1	1	DROVE	62	5	1	1
OWN	772	3	1	1	FINE	161	4	1	1
BARGE	7	5	1	1	SHY	13	3	1	1
DOOR	312	4	1	1	DREW	68	4	1	1
TRY	140	3	1	1	BOAT	72	4	1	1
SKY	58	3	1	1	DRESS	67	5	1	1
RICE	33	4	1	1	TURNED	320	6	2	1
JOKE	22	4	1	1	PLANE	114	5	1	1
REAL	260	4	1	1	ABSURD	17	6	1	2
PUFF	1	4	1	1	CLAIM	98	5	1	1
MAT	5	3	1	1	KEEP	264	4	1	1
BEAN	5	4	1	1	REST	163	4	1	1
HOP	2	3	1	1	SOCIAL	380	6	1	2
MIX	13	3	1	1	TOOL	40	4	1	1
SOAP	22	4	1	1	COURT	230	5	1	1
FLAW	3	4	1	1	OLDER	93	5	2	2
DASH	11	4	1	1	HAM	19	3	1	1
DEW	3	3	1	1	FUND	62	4	1	1
\bar{X}	96.9	3.7	1	1		124.6	4.6	1.2	1.1

Table 35
 Experiment 5--One Word, One Nonword

First Word	Freq.	#/Letters	#/Morphemes	#/Syllables	Second Word	Freq.	#/Letters	#/Morphemes	#/Syllables
VOTE	75	4	1	1	VEB		3		1
MAPLE	7	5	1	2	LATS		4		1
DUE	142	3	1	1	BRIEM		5		1
BONE	33	4	1	1	FERGIN		6		2
FREE	260	4	1	1	LOSO		4		2
RIG	5	3	1	1	BIGE		4		1
FAD	2	3	1	1	SCISS		5		1
PALM	22	4	1	1	STRACKEM		8		2
SIGH	11	4	1	1	BEMMER		6		2
\bar{X}	61.9	3.8	1	1.1			5		1.4
RAL		3		1	CENT	158	4	1	1
BRON		4		1	LIPS	69	4	2	1
TRIND		5		1	SIGNS	68	5	2	1
NER		3		1	STAFF	113	5	1	1
LOND		4		1	STYLE	98	5	1	1
ENT		3		1	SORT	164	4	1	1
RINT		4		1	DEAN	40	4	1	1

Table 35 (Continued)

First				Second					
Word	Freq.	#/Letters	#/Morphemes	#/Syllables	Word	Freq.	#/Letters	#/Morphemes	#/Syllables
HILK		4		1	WORTH	94	5	1	1
ROOP		4		1	COOL	62	4	1	1
\bar{X}		<u>3.8</u>		<u>1</u>		<u>96.2</u>	<u>4.4</u>	<u>1.2</u>	<u>1</u>

Table 36

Experiment 5--Both Nonwords

First Nonword	#/Letters	#/Syllables	Second Nonword	#/Letters	#/Syllables
CAL	3	1	WEAF	4	1
LAT	3	1	PRONK	5	1
VER	3	1	BRONE	5	1
DOB	3	1	HARN	4	1
NUS	3	1	SHAN	4	1
DUP	3	1	WREAT	5	1
KIB	3	1	FIK	3	1
GRAT	4	1	BEAL	4	1
MOLK	4	1	FLEINDIN	8	2
PELK	4	1	CLOST	5	1
NEEK	4	1	PILT	4	1
STOG	4	1	CHADE	5	1
PITE	4	1	VALLAR	6	2
CRAD	4	1	FREILT	6	1
LUNK	4	1	HAB	3	1
DOKE	4	1	CACEED	6	2
LIBE	4	1	WOON	4	1
TORTH	5	1	SART	4	1
\bar{X}	3.7	1		4.7	1.2

Table 37
 Overall Reaction Times, Experiment 5,
 Paired Lexical Decision Task

	Monolingual	Bilingual
Associated to English Meaning	.878	.902
Associated to German Meaning	.909	.895
Unassociated	.917	.944
\bar{X}	.901	.914

Note. Reaction times are indicated in seconds.

Table 38
 Reaction Times, Experiment 5, Paired Lexical
 Decision Task, According to Group

	Monolingual	Bilingual
Group A		
Associated to English Meaning	.865	.820
Associated to German Meaning	.932	.909
Unassociated	.967	.916
Group B		
Associated to English Meaning	.912	.914
Associated to German Meaning	.916	.894
Unassociated	.950	.980
Group C		
Associated to English Meaning	.898	.833
Associated to German Meaning	.915	.882
Unassociated	.867	.912

Note. Reaction times are indicated in seconds.

Table 39

Reaction Times, Experiment 5, for Filler Words and
 Pairs Where the Monolingual Associated-English
 Reaction Time Was Less Than the Monolingual
 Associated-German Reaction Time

	Monolingual	Bilingual
Associated to English Meaning	.881	.950
Associated to German Meaning	<u>.963</u>	<u>.925</u>
\bar{X}	.922	.938
Filler Words	.897	.902

Note. Reaction times are indicated in seconds.

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