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THE EFFECTS OF TRAINING AND THE KEYWORD METHOD
ON THE RECALL OF AN UNFAMILIAR VOCABULARY

by

Linda DeRoy Wieland

Thesis presented to the School of Graduate Studies and
Research in partial fulfilment of the requirements for
the degree of Doctor of Philosophy

School of Psychology
University of Ottawa
Ottawa, Ontario



Linda Wieland, Ottawa, Canada, 1990



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UNIVERSITÉ D'OTTAWA
UNIVERSITY OF OTTAWA

ABSTRACT

Two experiments were conducted to investigate applications of the mnemonic keyword method to the recall of unfamiliar words when cued with their meanings. Both experiments used a study-test procedure and involved university students who were asked to study a list of 6-letter pseudowords, each with an English "translation". Keyword groups were presented with a concrete noun keyword for each pseudoword/translation pair, the first three letters of which were identical to the first half of the pseudoword. Subjects were asked to respond in writing with the pseudoword when cued with its translation, and keyword subjects in Experiment 1 were asked to also recall the keyword. Subjects were asked to describe, in a post-experimental interview, the method used to study each item set. Dependent measures were proportions of correctly-recalled pseudowords, letters in correct serial position, halves of pseudowords, and (only for keyword subjects in Experiment 1) keywords.

Experiment 1 examined the effects of instructions to use a modification to the mnemonic keyword method, in which the orthographic form of the pseudoword was to be added to the interactive image containing the keyword and translation, were compared to free-strategy and to standard mnemonic keyword instructions across 4 study-test trials. The modified instructions neither helped nor hindered backward recall, as all groups recalled equivalent proportions of pseudowords and letters. Both keyword groups recalled more keyword-mapped portions of the pseudowords than did controls, and both groups recalled a large proportion of keywords by the second trial. Backward recall conditionalized on reported strategy use suggested that modifying the keyword method by extending the use of mediators in order to map the entire pseudoword might be effective in promoting backward recall.

Experiment 2 investigated the effects of training (including instruction, practice, and feedback) on backward recall for both subjects either provided or not provided with a keyword to map the first half of the pseudoword, across 3 study-test trials.

Trained subjects were instructed to either generate mediators for the entire pseudoword (trained control group) or were instructed to use the provided keyword and generate a second to map the second half of the pseudoword (trained keyword group) and to associate the mediators with each other and with the translation, either imaginally or verbally. Individual differences in aptitude for acoustically decoding unfamiliar words into familiar words were measured with Part III of the Modern Languages Aptitude Test. An effect of training was found for recall of pseudowords, and a Trials x Training interaction for letters and for halves was observed due to differences between trained and untrained groups by the second and third trials respectively. Providing a keyword facilitated recall of first, but not second halves for trained subjects. Interestingly, more first halves were recalled by untrained than by trained keyword subjects. The opposite was true for second halves, indicating that the cognitive effort expended by trained subjects to generate further mediators may have detracted from their ability to exploit the provided mediator. MLAT scores were positively correlated to recall scores, but the correlations reached significance only for the untrained keyword group. Tests of heterogeneity of slopes revealed a significant difference in the relationship of MLAT and recall of first halves only between the trained and untrained keyword groups. While aptitude aids recall overall, training may benefit low- more than high-aptitude subjects when they are given the added advantage of a provided mediator.

The discussion bears on the practical implications of this research for promoting the use of the keyword method for backward recall in a classroom setting.

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TABLE OF CONTENTS

	Page
CERTIFICATE OF EXAMINATION	ii
ABSTRACT	iii
ACKNOWLEDGMENTS	v
TABLE OF CONTENTS	vi
LIST OF TABLES	viii
LIST OF FIGURES	x
LIST OF APPENDICES	xi
CHAPTER 1: A COMPARISON AND ANALYSIS OF THE ROLE OF THE MNEMONIC KEYWORD METHOD IN RECALL OF FAMILIAR VERSUS UNFAMILIAR WORDS	
	1
The Nature and Purpose of Mnemonic Strategies	3
The Mnemonic Keyword Method - Its Structure and Function	7
Empirical Evidence for the Effectiveness of the Keyword Method	8
A Theoretical Account of the Encoding and Retrieval Processes Involved in the Use of the Keyword Method	14
Modifying the Mnemonic Keyword Method for the Recall of Unfamiliar Words	20
Introduction to the Experiments	26

CHAPTER 2: THE EFFECTS OF A MODIFIED MNEMONIC KEYWORD METHOD ON THE RECALL OF UNFAMILIAR WORDS	28
Assessing the Effectiveness of the Keyword Method	29
Method of Experiment 1	33
Results and Discussion	40
General Discussion	59
CHAPTER 3: THE EFFECTS OF TRAINING THE GENERATION AND ASSOCIATION OF NATURAL LANGUAGE MEDIATORS ON THE RECALL OF UNFAMILIAR WORDS	62
Issues in Encouraging the Use of Mediators to Map Entire Unfamiliar Words	63
Empirical Questions Addressed in Experiment 2	71
Method of Experiment 2	76
Results and Discussion	82
General Discussion	112
CHAPTER 4: SUMMARY AND CONCLUSIONS	117
APPENDIX A: Instructions	123
APPENDIX B: Lexical Material	147
APPENDIX C: Interview Questions and Scoring Criteria	151
APPENDIX D: Computer Programs	163
APPENDIX E: Summary of ANOVAs and Tests of Simple Effects	171
REFERENCES	189
CURRICULUM VITAE	197

LIST OF TABLES

Table	Page
2.1 Mean proportions of pseudowords and of letters recalled in Experiment 1	42
2.2 Mean proportions of first and second halves of pseudowords recalled in Experiment 1	43
2.3 Mean proportions of keywords recalled in Experiment 1	44
2.4 Mean proportions of reported strategies used to study the experimental stimuli	50
2.5 Mean proportions of reported strategies used by each experimental group to study the experimental stimuli in Experiment 1	52
2.6 Frequency of reported strategy use and probability of recall of first and second halves and whole pseudowords conditionalized on type of strategy reported	55
3.1 MLAT scores of subjects in four experimental conditions	83
3.2 Mean proportions of pseudowords and of letters recalled in Experiment 2	84
3.3 Mean proportions of first and second halves of pseudowords recalled in Experiment 2	88
3.4 Correlations of MLAT score with recall of whole pseudowords, letters, and first and second halves of pseudowords under four conditions of strategy method and training	98

3.5	<i>F</i> ratios for tests of heterogeneity of slopes for four comparisons between experimental groups for recall of whole pseudowords, correct letters, and first and second halves of pseudowords	99
3.6	Mean proportions of reported strategies used to study the experimental stimuli	107
3.7	Mean proportions of reported strategies used by each experimental group to study the experimental stimuli in Experiment 2	109
3.8	Frequency of reported strategy use and probability of recall of first and second halves and whole pseudowords conditionalized on type of strategy reported	111

LIST OF FIGURES

Figure	Page
1.1	The study phase of the mnemonic keyword method for forward and backward recall 16
1.2	The recall phase of the mnemonic keyword method for forward and backward recall 17
3.1	Effect of training on recall of pseudowords in Experiment 2 86
3.2	Effect of training on recall of letters in Experiment 2 87
3.3	Effect of training on recall of pseudoword halves in Experiment 2 89
3.4	Effects of method and training on recall of pseudoword halves in Experiment 2 90
3.5	Scatterplot showing the relationship between scores on Part III of the MLAT and recall of whole pseudowords under four conditions 100
3.6	Scatterplot showing the relationship between scores on Part III of the MLAT and recall of pseudoword letters under four conditions 101
3.7	Scatterplot showing the relationship between scores on Part III of the MLAT and recall of first pseudoword first halves under four conditions 102
3.8	Scatterplot showing the relationship between scores on Part III of the MLAT and recall of first pseudoword second halves under four conditions 103

LIST OF APPENDICES

Appendix	Page
A. Instructions	123
B. Experimental Stimuli	147
C. Strategy-Use Interviews: Interview Questions and Coding Criteria	151
D. Computer Programs to Analyze Data	163
E. Summary of ANOVAs and Tests of Simple Effects	171

CHAPTER 1

A Comparison and Analysis of the Role of the Mnemonic Keyword Method in the Recall of Familiar Versus Unfamiliar Words

Professionals involved in foreign language instruction contend that acquiring foreign language vocabulary is the most significant obstacle students must overcome in order to use their foreign language effectively (Ludwig, 1984; Ott, Blake, & Butler, 1976; Wilkens, 1972). Consequently, techniques which facilitate the acquisition of foreign words and their meanings should play a valuable role in the acquisition of a foreign language. The primary purpose of this research was to investigate means of exploiting a specific mnemonic technique, the mnemonic keyword method, to facilitate recall of unfamiliar words. The task of recalling unfamiliar words in response to their meanings is analogous to the necessary and demanding task of recalling foreign language vocabulary when learning to speak or write a foreign language.

The present research is related to the current interest in imagery-based associative mnemonic techniques applied to the learning of foreign language vocabulary (see Bellezza, 1981, 1983; McDaniel & Pressley, 1987; Paivio & Desrochers, 1981; Pressley, Levin, & Delaney, 1982) and augments the previous research in the use of the mnemonic keyword method for the acquisition and retention of unfamiliar words. Briefly, the keyword method is a two-stage process used to learn foreign, or otherwise unfamiliar, vocabulary words. The first stage consists of deriving a *keyword*, a familiar word, usually a concrete noun, which is acoustically and/or orthographically similar to a portion of the unfamiliar or foreign word. A commonly-cited example of a keyword is the English word "cart" for the

Spanish word *carta*, which means a postal letter. The second stage consists of the formation of a meaningful association between an object representing this familiar keyword and an object representing the translation. In the implementation of the mnemonic keyword method, this meaningful association has typically taken the form of an interactive mental image involving the referents of the keyword and the meaning of the unfamiliar word. In the example of *carta* and "cart", an image of a large postal letter in a shopping cart, or alternatively a sentence describing this interaction, could be constructed to form this meaningful association. At the time of recall, retrieval of the interactive image or sentence is cued by either the unfamiliar word or its translation, and the acoustically and/or orthographically similar familiar word is used to mediate the retrieval of the remaining member of the foreign word-translation pair.

Two experiments are reported in this dissertation, both of which are concerned with the application of the mnemonic keyword method to the association of an unfamiliar word with its translation and to the resulting acquisition and recall of the unfamiliar foreign word. Numerous and wide-ranging empirical studies demonstrate that the keyword method promotes recall of definitions when subjects are cued with unfamiliar words, however studies in the method's effect on recall of unfamiliar words have been far less encouraging. The first experiment examines the effects of instructions which modify the mnemonic keyword method by supplementing the two basic steps of the study phase with a third step in which an additional element is included in the interactive image containing the keyword mediator and the translation. The two basic steps of the keyword method will be described in further detail in the next section of this chapter, and the details of the modification of the keyword method will be described in Chapter 2. The second experiment investigates the effects of implementing a procedure for training the generation and association of keywords as well as other forms of natural language mediators on the recall of unfamiliar words. A *natural language mediator* has been defined by Montague, Adams, and Kiess (1966) in the following manner:

" The NLM may be a one-word association between the stimulus and response terms of a pair, one or more sentences, an association based on similarity of sounds, or an association between selected segments of the terms such as single letters or subgroups of letters" (p. 829).

According to this definition, a keyword is one type of a natural language mediator among several types of associations possible between a stimulus and response items of a pair.

In order to provide the background for describing these studies, four topics will be discussed in some detail in this chapter. First, the nature and purpose of mnemonic strategies will be considered, with the intent of defining terms and processes central to a discussion of memory processes and the role of memory strategies in facilitating various types of memory performance. Second, empirical evidence for the effectiveness of the keyword method will be presented in order to compare and contrast the relative effectiveness of this method for recall of familiar (e.g., translations) and of unfamiliar (e.g., foreign) vocabulary items. Third, a theoretical account of the encoding and retrieval processes involved in using the keyword method will be proposed. And finally, a proposal for the modification of the mnemonic keyword method will be presented based on evidence from other areas of research such as spelling acquisition, word recognition, and task-appropriate processing.

The Nature and Purpose of Mnemonic Strategies

Basic Concepts

There are several concepts which are fundamental to understanding the nature and purpose of memory strategies. The term *memory strategy* refers to an intentional, goal-oriented activity on the part of an individual, where the goal is to be able to

remember certain items of information. The purpose of any mnemonic strategy is to study information in such a way as to promote its retrieval, either by organizing the information at the time of study, or by transforming it into a more memorable form. The decision to employ a particular memory strategy is based on a combination of metacognitive factors such as the individual's prior knowledge base and previous learning experiences, the assessment of item difficulty of to-be-remembered material, the anticipated retrieval requirements (e.g., recognition, free recall, cued recall), and the expected temporal duration between study and retrieval. A memory strategy can be as simple as rote repetition, or as elaborate as the mnemonic devices described below.

In order to remember a unit of information, it must be attended to, encoded, stored as a memory trace, and finally retrieved and used. The memory system is assumed to contain a number of *memory traces* or units of information (cf. Mandler, 1967; Tulving, 1968, 1983), each of which corresponds to a set of one or more previously-studied items of information. The number of units of information represented in each trace corresponds to the number of units meaningfully associated during study. Memory performance requires that the appropriate trace(s) be accessed and used at the time of retrieval.

The processes which underlie memory performance include encoding, storage, and retrieval. The term *encoding* has been defined as "the act of translating the external, to-be-retained items of information into a form which is understandable to the individual, and that is amenable to retrieval at the appropriate time" (Cermak, 1972, p.144). At the time of study, items of information become *memory traces*, which can consist of one or more items, depending on whether those items were associated in some way during study. *Storage* refers to the retention of memory traces in the memory system. *Retrieval* is the accessing of information represented in stored memory traces, and transferring that information into working memory (cf. Lachman, Lachman, & Butterfield, 1979).

Two major categories of encoding have been identified, namely, "organization" and "mediation". Organization is the ordering and classifying of information, and linking it with a cue (such as a semantic category label) that will help to retrieve the information at a later time. Mediation, on the other hand, occurs during encoding

when new items of information are compared to and associated with those items already in memory so that, at retrieval, the association with the former items serves to retrieve the newer items (Cermak, 1972). A *mnemonic device* is a specific strategy for enhancing the organization and/or mediation of information at the time of encoding in order to render it more memorable. The operations for organizing and encoding information to facilitate retrieval include the creation and use of "cognitive cuing structures", usually visual images or sentences, which can be used to facilitate recall (Bellezza, 1981).

Recently, an explanation of how the mnemonic keyword method facilitates recall of unfamiliar words and their translations has been proposed (Desrochers & Begg, 1987) based on the organization-redintegration hypothesis (see Begg, 1982, 1983). If the contents of memory are to be conceptualized as memory traces or units, each of which corresponds to a set of information which has been studied, then the amount of information included in a memory trace can be increased by encoding several pieces of information in a meaningful way, as in the case of an interactive image or sentence containing several items. Retrieval of a partial memory trace depends on the degree of distinctive similarity between the memory trace and the retrieval cue (item-specific information), whereas redintegration (revival of the entire trace from a remembered portion of it) depends on the quality of organizational encoding (relational information) between that portion of the trace retrieved by the cue and the remainder of the information originally encoded with that trace.

Two General Types of Mnemonic Strategies

Bellezza (1981, 1987) has identified two major types of mnemonics which correspond to the two major ways in which information can be encoded, namely, *organizational mnemonics* and *encoding mnemonics*. These types of mnemonics vary in both structure and function. The function of organizational mnemonics is to organize or order familiar items, whereas that of encoding mnemonics is to facilitate the learning of unfamiliar items without regard to serial order. Consequently, organizational mnemonics involve primarily operations that organize units of

information in such a way that unrelated units of information can be related to each other, whereas encoding mnemonics involve operations that transform information into another form for ease of association (Bellezza, 1981). Examples of organizational mnemonics are peg-type mnemonics and chain-type mnemonics. Peg-type mnemonics include the method of loci, traced to Roman rhetoric books (see Yates, 1966), and the peg-word mnemonic. The method of loci involves first the memorization of an ordered series of locations, such as rooms in a large building, and then association of the individual items of new information with these locations, by means of a mental image, in the order in which they will be recalled. At the time of recall, the series of places are recalled, one by one, in order, so that the associated new pieces of information are recalled by their association with the previously-learned places. The peg-word mnemonic is similar in that a series of objects is memorized (e.g., "one is a bun, two is a shoe") and the units of novel information are associated with these objects so that they can be recalled in serial order.

Other examples of organizational mnemonics include chain-type mnemonics in which a visual image is formed of the first two objects of a list, then an image is formed of the second and third objects, and so on to form a series of overlapping visual images, or the story mnemonic in which to-be-learned items on a list are associated in a particular order by incorporating them into a story.

Encoding strategies, on the other hand, involve the transformation of new material into a form which is more familiar, and/or more easily associated than is the original material. Encoding strategies are used for rendering relatively meaningless information more meaningful in order to facilitate its integration, association, and retrievability. According to Bellezza (1981), the act of transforming a word into a visual image would qualify as an encoding mnemonic, as would the more elaborate operation of transforming a difficult-to-image word into a easily-imaged word, because pictures have consistently been found to be better remembered than are words (for reviews, see Madigan, 1983; Paivio, 1971). The mnemonic keyword method is an encoding strategy because it is used to transform an unfamiliar and meaningless word into a form which is more memorable, that of the acoustically- or orthographically-similar native language keyword mediator(s) which can then be semantically associated with the translation of the unfamiliar word.

The Mnemonic Keyword Method - Its Structure and Function

The *mnemonic keyword method* (Atkinson, 1975) is an imagery-based encoding mnemonic device which involves the use of both an acoustic and/or orthographic link and a semantic link to associate pairs of items. The method can be used to associate pairs of items, even when one of the members of the pair is an unfamiliar word, for example a foreign word with its translation, a new native language vocabulary word with its definition, or a province with its capital. In order to illustrate the keyword method, the operations involved in the task of associating a foreign word with its native-language translation will be described in detail.

The mnemonic keyword method consists of a two-step process during study. In the first step, a perceptual link is formed between a foreign word and a native-language word which resembles the foreign word. In order to form this link, the learner either derives, or is provided with a native language word, some portion of which is orthographically and/or acoustically similar to a portion of the foreign word. This native language word is called the *keyword* or mediator. In the second step, a semantic link is formed between the meaning of the keyword and the translation equivalent of the foreign word. This link can be formed in a variety of ways, but in the mnemonic keyword method this link is usually formed by creating an interactive mental image which includes a cognitive representation of the referents signified by both the keyword and the translation. At the time of recall, the learner is either presented with the foreign word and asked to recall its translation (referred to as *forward recall*), or is presented with the translation and asked to recall the foreign word (referred to as *backward recall*). In the commonly-cited example of the mnemonic keyword method used for forward recall the Spanish vocabulary word "carta" is associated with its English translation, "postal letter". In the first step of the method, a keyword mediator which sounds and looks like "carta", the English word "cart", would be provided to learners. In the second step, learners would be instructed to form a mental image of a cart interacting with the translation, postal letter. A mental image of a grocery cart with a large letter inside would be an example of an interactive mental image which includes both the keyword and translation referents. At recall, the retrieval cue would be provided by the foreign

word *carta*, which by virtue of its acoustic and orthographic similarity with the English keyword *cart*, would facilitate retrieval of the interactive image containing a cart and which also contains the translation of *carta*, a letter. Thus, the keyword "cart" serves as a natural language mediator between *carta* and "letter".

Empirical Evidence for the Effectiveness of the Keyword Method

Effects on the Recall of the Familiar Translation

The mnemonic keyword method of associating foreign word-translation pairs is not a new technique (see Desrochers & Begg, 1987), but only relatively recently has the method been subject to empirical investigation (e.g., Atkinson & Raugh, 1975) and theoretical interpretation (cf. Desrochers & Begg, 1987; Paivio & Desrochers, 1981). The task of recalling the meaning of a word, given its unfamiliar equivalent (forward recall), has been widely studied during the past decade (for reviews, see Levin & Pressley, 1985; Paivio & Desrochers, 1981; Pressley, Levin, & Delaney, 1982; Pressley, Levin, & McDaniel, 1987), whereas the task of recalling the unfamiliar word, given its more familiar meaning (backward recall), has been investigated in relatively few empirical studies (Pressley & Levin, 1981; Pressley, Levin, Hall, Miller, & Berry, 1980; Pressley, Levin, Nakamura, Hope, Bispo, & Toye, 1980).

The efficacy of the mnemonic keyword method for recall of one member of a pair of items given the other member as a retrieval cue has been demonstrated in a great number of empirical investigations, only a few of which will be cited here as examples of its versatility. Early experiments with the method were concerned with foreign language learning. Later studies investigated acquisition of foreign vocabulary, native-language vocabulary, and other types of paired associates. Experiments with college students, using Spanish (Raugh & Atkinson, 1975), and Russian vocabulary (Atkinson & Raugh, 1975), demonstrated that the method facilitates recall of

translations by keyword groups relative to that of repetition control groups in which subjects were instructed to repeat the foreign word-translation pairs (Raugh & Atkinson, 1975), and relative to no-strategy control groups in which subjects were instructed to remember the pairs however they wished (Atkinson & Raugh, 1975; Raugh & Atkinson, 1975). This facilitating effect of the keyword method was found in both immediate and delayed recall of translations, given the foreign word as a retrieval cue. These initial studies stimulated a wide variety of research on the method and it was subsequently found to be effective in aiding associative recall of states and their capitals (Levin, Shriberg, Miller, McCormick, & Levin, 1980), of translations for both good and poor vocabulary learners (Pressley, Levin, Nakamura, Hope, Bispo, & Toye, 1980), and of definitions of new English words relative to more traditional vocabulary-learning techniques (Pressley, Levin, & Miller, 1982), even when using as stimuli a variety of nouns, verbs, and adjectives (Miller, Levin, & Pressley, 1980). The method has also been shown to enhance recall of definitions of new English vocabulary words relative to recall by control groups using either contextual analysis or a semantic mapping strategy (Levin, Johnson, Pittelman, Hayes, Levin, Shriberg, and Toms-Bronowski, 1984). As well, the method has been modified to facilitate the recall of both the familiar translation and the grammatical gender tag of German nouns (Desrochers, G  linas, & Wieland, 1989; Desrochers, Wieland, & Cot  , in press). In the majority of these empirical investigations of the keyword method, one member of the to-be-associated pair of words is unfamiliar to the learner, for example a new native language vocabulary word or a foreign vocabulary word.

The extensive nature of keyword research can be better appreciated by referring to several reviews of studies of the keyword method (see Bellezza, 1981; McDaniel & Pressley, 1987; Paivio & Desrochers, 1981; Pressley, Levin, & Delaney, 1982).

Effects on the Recall of the Unfamiliar Vocabulary Item

In a paper describing the keyword method, Atkinson (1975) speculates that the method might be applied to the learning of foreign vocabulary words, and the method's efficacy in facilitating recall of translations has prompted some researchers to encourage its use in applied language-learning settings. However, despite its empirically-demonstrated efficacy in facilitating recall of native language translations of foreign words and definitions of new native language vocabulary, the mnemonic keyword method has not proven effective in enhancing recall of foreign or otherwise unfamiliar words.

Learning a foreign language requires that the learner recall *both* the translation, given the foreign word, and the foreign word itself, given the translation. The first task involves comprehension and the production of an already well-integrated response, as in understanding either written text or spoken conversation. The second task is the more difficult of the two, that is, integration and production of a new response, as in writing or speaking. Therefore, the acquisition of the unfamiliar foreign word is a task which requires attention. Possibly because of its apparent lack of promise, this line of investigation has been small, all of the experiments having been conducted by Michael Pressley and his associates.

The first such experiment (Pressley, Levin, Nakamura, Hope, Bispo, & Teye, 1980) involved the incidental learning of Latin words. After being told that they would be tested for recall of translations, subjects were instead asked to print the foreign word when it was read to them. Three groups were tested: 1) a keyword group in which subjects generated their own keywords, 2) a keyword group in which keywords were provided, and 3) a no-strategy control group. Within the keyword provided group, half of the keywords were considered "same" in that the first syllable of the keyword was identical to the first syllable of the Latin word; the other half of the keywords were "different" in that the first syllable of the keyword and of the Latin word were not identical. Only perfect spelling of the foreign word was accepted as correct. No differences between groups were found on the "different" items, and on the "same" items, controls and keyword-generated subjects performed better than did the keyword-provided subjects. It was concluded that the keyword-provided subjects

probably had not processed the foreign word as thoroughly as had subjects in the other two groups, because they were not required to process the foreign word in order to generate a mediator, and had only to recognize which keyword was associated with each foreign word. The fact that no difference was found between the controls and the keyword-generated subjects was not encouraging, although it should be noted that these results were obtained in the context of an incidental learning task, therefore subjects had not studied with the goal of either recalling or even spelling the foreign words.

A subsequent series of experiments was conducted by Pressley, Levin, Hall, Miller, & Berry (1980) to investigate the efficacy of the keyword method in facilitating recall of foreign words. In Experiment 1, conducted with sixth graders learning Spanish words, subjects were informed that they would be tested on both forward and backward recall, and recall of the Spanish word was counted as correct if it were spelled either entirely correctly, or entirely correctly except for one letter. Two mnemonic keyword groups were included: Keyword (using imagery alone) and Keyword + repetition (using imagery and covertly rehearsing the Spanish word). It was expected that the latter group's backward recall might benefit from this extra processing of the Spanish word. Results of forward recall demonstrated a keyword advantage, as the two mnemonic keyword groups recalled more translations than did control groups, but results of backward recall revealed no difference between groups. It was noted however that keyword subjects did recall a higher percentage of keyword syllables of the foreign words than did controls, and that keyword subjects recalled more keyword fragments than did keyword + repetition subjects, possibly because repetition of the foreign word may have reduced the time subjects spent on generating the interactive image.

In Experiment 2, the researchers tested backward recognition, rather than recall. Sixth graders in either a mnemonic keyword condition or a control condition were told to expect to have to pick the correct foreign word from its translation. The previously studied foreign words were included in a list of an equal number of distractors, and each distractor shared the same keyword syllable as one of the studied foreign words. The two groups did not differ in their ability to choose the correct foreign word from its definition, however keyword subjects chose more distractors

which shared the keyword syllable with the correct response. It is unclear whether or not the subjects knew before studying the pairs that they would have to pick out the correct foreign word from a list of distractors with the keyword syllable in common, so it is impossible to speculate on the results had the subjects known the exact nature of the task before studying the list. It may be that subjects understood the test to be a direct matching task (without distractors, or with random distractors) and therefore may have neglected to process the entire foreign word, assuming that recall of the keyword would provide the keyword fragment which would alone be adequate to match the correct foreign word.

In the third experiment of the series (experiment 3a), sixth graders were tested for recall of Spanish words over two study-test trials. Keyword subjects were given four trials in which to produce the foreign word in response to its keyword prior to the first study-test trial, and controls were exposed to the Spanish word-translation pairs in order to compensate for the keyword subjects' treatment. No significant differences were found between the two groups, and no group by trial interaction was observed. In a follow-up to this experiment (experiment 3b), subjects were given only two trials in which to learn the foreign words in response to the keywords, followed by four study-test trials in which Spanish words were to be produced in response to their English translations. There was no overall effect for strategy group, however keyword subjects did improve their recall of the foreign words more quickly than did controls, and a significant difference between the two groups occurred on the fourth recall test.

In the fourth and last experiment in the series, university students were given four trials in which to learn to respond with the foreign word when cued with the keyword, followed by four study-test trials for recall of the Spanish words cued by the English equivalents. When recall from the first two study-test trials only were analyzed (due to a ceiling effect on later trials) no differences in overall recall were observed, although as in the previous experiment, keyword subjects improved more rapidly than did controls.

Based on the premise that response integration might have been inhibited in the previous experiments due to the unfamiliar orthographic patterns of the foreign word stimuli, Pressley and Levin (1981) conducted a series of three experiments with

college students, using as stimuli unfamiliar English words and their definitions. They found that, although keyword subjects again recalled more keyword segments of the unfamiliar words than did controls, recall of the entire words did not differ between groups. The authors concluded that, even for words having familiar and regular orthographic patterns, response integration was still inadequate.

In order to overcome this problem of response integration, in a second experiment the investigators prefamiliarized all subjects with the form of the unfamiliar English words by having subjects learn each new word in response to its first syllable (Pressley & Levin, 1981). This syllable also served as the keyword for keyword group subjects. Subjects practiced this task for eight trials, or until they provided each word correctly on one trial, and then underwent one study-test trial. Keyword subjects did recall more of the unfamiliar words than did controls, indicating that when response integration is not an issue, the keyword method facilitates association between new words and their definitions.

In the third experiment of the series, in order to avoid entirely the issue of response integration, Pressley and Levin (1981) had subjects learn uncommon definitions to common English words, thereby having each word serve as its own keyword (e.g., *mail*, meaning the shell of a turtle, had (postal) mail as a keyword). Keyword subjects did recall more of the vocabulary words than did controls when given their uncommon definitions.

The conclusions drawn from these experiments were that the mnemonic keyword method neither helps nor hinders recall or recognition of foreign or otherwise unfamiliar words, but the method only facilitates their recall when these words are well learned prior to associating them with their meanings. Thus, when the task is merely to associate an integrated word with its meaning, the keyword method is effective, but it is not effective in enhancing recall of new (unmapped) portions of the unfamiliar word. Several methods have been used in these experiments to induce response integration, either before or during the study trial in which the association is formed between the unfamiliar word and its meaning, however, all of these procedures are laborious and time-consuming, and are incompatible with the objective of using a memory strategy; that is, to facilitate learning.

A Theoretical Account of the Encoding and Retrieval Processes Involved in the Use of the Keyword Method

If the ability to respond with a native-language translation when presented with an unfamiliar foreign word is viewed as evidence of language-learning, then it might seem reasonable to assume that any method which facilitates the formation of an associative link between a foreign word and its translation at the time of study should serve equally well to facilitate recall of the translation, given the foreign word, and recall of the foreign word, given its translation. As the results of studies of backward recall indicate, this associative symmetry has not been demonstrated in empirical research with the mnemonic keyword method. This lack of associative symmetry may be examined in light of the distinctions between the recall task requirements of forward versus backward recall as analogous to the tasks of comprehension as opposed to production, respectively.

According to the organization-redintegration hypothesis (see Desrochers & Begg, 1987) the mnemonic keyword method serves to establish item-specific information for either or both members of an associated pair (i.e., a keyword for the unfamiliar word) and then associate it by means of relational information (i.e., an interactive image) with the translation or meaning of the foreign word so that the translation can be redintegrated from the item-specific information retrieved from the test cue. These processes are effective in facilitating recall of the translation, a well-integrated response. Further analysis of the requirements of the task of recalling the less familiar foreign word may demonstrate why this method has not proven effective for backward recall.

When the study and recall task requirements of forward recall are compared to those of backward recall, it becomes apparent that the two are not symmetrical. It is this asymmetry of requirements which accounts for the fact that keyword effects have consistently been observed in experiments requiring forward recall, however, only very limited keyword effects have been found in experiments involving backward recall; those aspects of the backward recall task which are not included in the forward recall task are ones for which the encoding procedures of the traditional keyword method have not proven to be particularly effective.

The following is a brief description and analysis of the use of the keyword method in a forward recall task as contrasted with the use of the keyword method in a backward recall task. Diagrammatic summaries of the steps of the keyword method in the study phase for forward and backward recall and in the recall phase for forward and backward recall are illustrated in Figures 1.1 and 1.2 respectively.

The Study Phase

The first steps in using the mnemonic keyword method for associating an unfamiliar word with its translation is the same for both the forward and backward recall task. In the first step, a printed form of the foreign word-translation pair is presented to and attended by the learner. In the second step, a "keyword" or mediator (a native-language word, some portion of which resembles some portion of the foreign word) is either presented to or generated by the learner. The keyword is said to "map" the portion of the foreign word which it resembles. This step involves the formation of an orthographic and/or acoustic link between the foreign word and the mediator.

It is at this point that the requirements of the two tasks begin to diverge. For both tasks it is necessary to notice the similarity between the keyword and the foreign word, to form the acoustic and/or orthographic link, and to create an interactive mental image in which both the keyword and translation referents interact, to form a semantic link between these objects. For an individual who studies in order to recall the foreign word, this step is necessary, but not sufficient, as the individual must also attend to and in some way encode the exact orthographic structure of the foreign word in order to later retrieve it at recall. The additional step of learning a new verbal response makes the task of recalling the foreign word more difficult than that of recalling the translation.

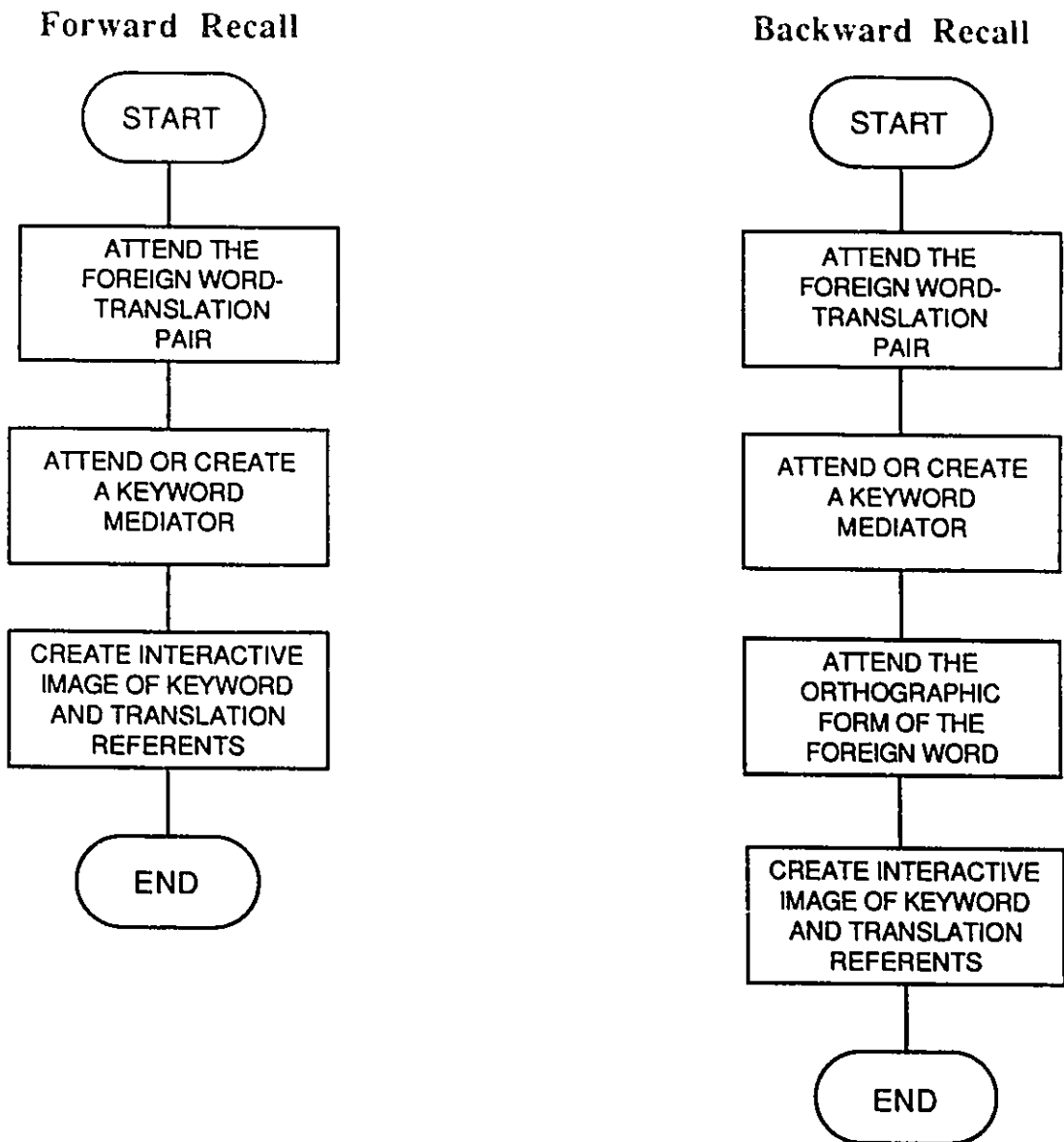


Figure 1.1 The study phase of the mnemonic keyword method for forward and backward recall.

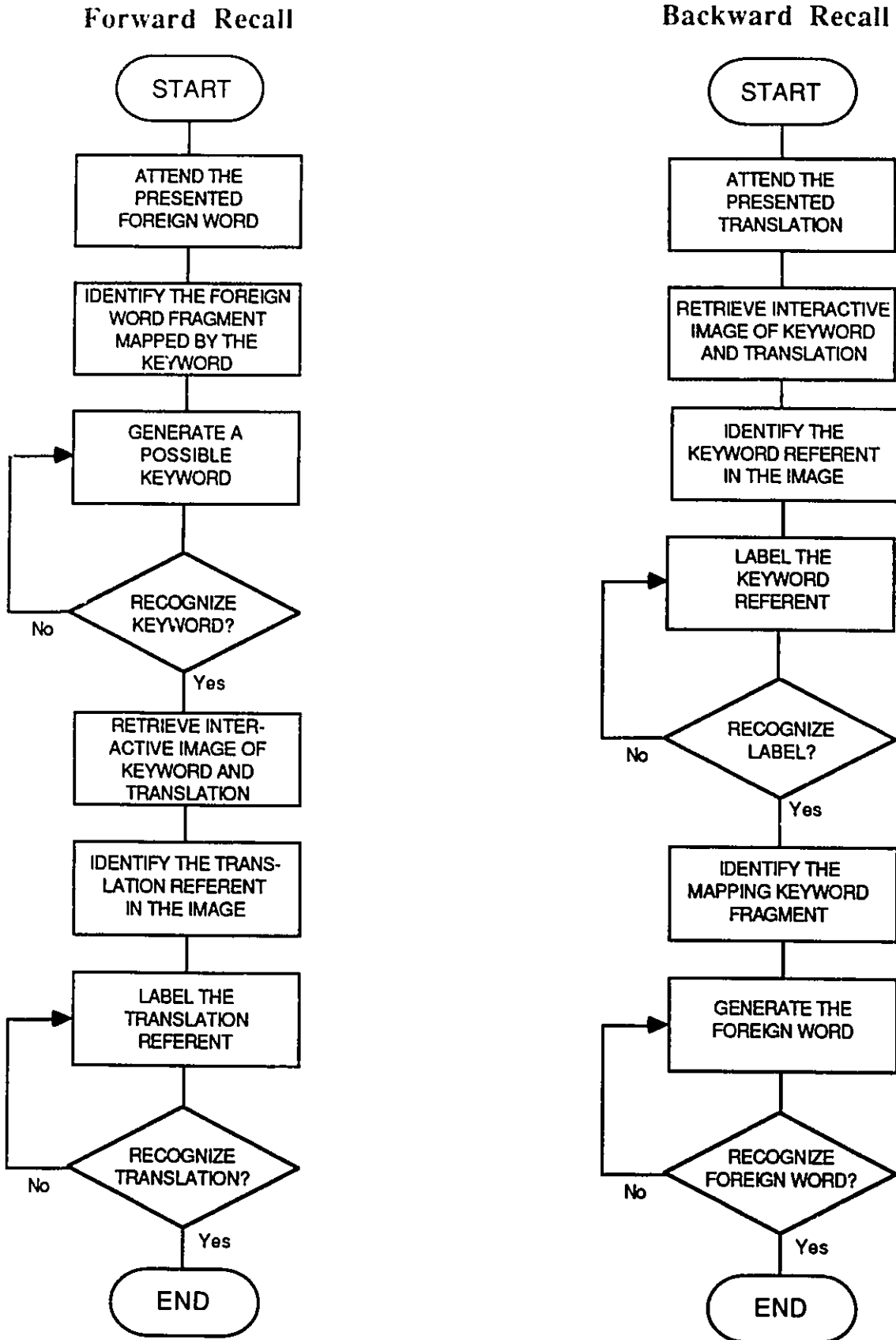


Figure 1.2 The recall phase of the mnemonic keyword method for forward and backward recall.

The Recall Phase

It is during the recall phase that the requirements of the backward and forward recall tasks differ most markedly. In the forward method the learner is presented with the foreign word and must derive from it the keyword in order to retrieve the interactive image, whereas in the backward method the learner is presented with the translation which can be used directly to cue retrieval of the interactive image.

In the forward recall task, in order to retrieve the image, the learner must recognize the fragment of the foreign word that is mapped by the keyword, and subsequently use it to recall the keyword itself. The generated keyword must then be evaluated for recognition. For example, a foreign word fragment "ker" might evoke the possible keywords "kernel", "kerchief" or "kerosene", therefore the learner must test and either accept or reject the generated keyword before he or she can use the keyword as a cue to retrieve the mental image containing the keyword and translation referents. Once the image has been retrieved, the learner must identify the translation referent in the image, assign a name or label to this object, and then evaluate this label in order to decide if it is recognized as that originally presented with the foreign word at the time of study. If it is the same, the learner has completed the task of recalling the translation, and if not, the generation and recognition steps must be repeated until the appropriate translation is identified.

For backward recall, the translation serves directly as an external cue to retrieve the interactive mental image which contains both the translation and keyword referents. However, once the image has been recalled, the object which represents the keyword must be correctly named or labeled in order to retrieve the keyword itself. The keyword label must then be tested for recognition, as more than one label might apply to a particular object. For example, a mental image of a man dressed in black and white stripes with a ball and chain attached to his leg might represent the word "criminal", "robber", "thief", "prisoner", "inmate", "crook", "burglar", or even other possible keywords. Once the keyword has been identified, the fragment which resembles a portion of the foreign word must be identified, particularly if it is a multisyllabic or compound word. Using the keyword fragment identified in the last step, the foreign word must then be reconstructed by first recalling the fragment of

the foreign word mapped by the keyword, by modifying this fragment if it differs orthographically from that of the keyword, and finally completing the foreign word by adding its remaining letters in correct order. This reconstructed foreign word must then be reviewed to determine whether or not it is recognized as identical to that presented during the study phase. If it is not recognized as identical, the learner repeats the reconstruction and recognition steps, and if it is, then the recall of the foreign word is complete.

In summary, in the forward recall task the learner needs to retrieve a familiar response in the native language (i.e., the translation or a close synonym). Although difficult, this task can be facilitated by the use of the mnemonic keyword method. In the backward task the learner must a) retrieve the exact keyword, as a synonym would not provide the necessary cue for retrieval of the foreign word, and b) then produce a new verbal response (the foreign word) using the keyword fragment as a retrieval cue. Of these two requirements of backward recall, the second is the most problematic. The task of assigning the correct label to the keyword object in the interactive image so that it may in turn serve as a retrieval cue for the unfamiliar word in backward recall is more difficult than recalling the keyword from the retrieval cue of the unfamiliar word in forward recall. It is not, however, as difficult as reintegrating an unfamiliar letter string from the initial fragment of the string. Only a few alternative labels for the imaged keyword object must be evaluated for recognition as having been previously presented during the study trial. However, a great number of possible letter combinations must be generated and then evaluated for recognition as having been presented as the unfamiliar letter string during the study phase.

Interpreted in the context of the organization-redintegration hypothesis, the problem in reintegrating the entire unfamiliar word stems from its not having been encoded as a unitary trace. Instead, only the keyword-mapped fragment of the foreign word is available once the item-specific information (i.e., the keyword portion of the integrated image) is accessed from the retrieval cue provided by the translation. This requirement of the backward recall task has not previously been addressed in studies of the efficacy of the keyword method for recalling foreign words, other than to have subjects learn the foreign word response through repetitive drills. In order

to use the mnemonic keyword method effectively and economically in backward recall tasks, this requirement must be addressed in the application of the method.

Modifying the Mnemonic Keyword Method for the Recall of Unfamiliar Words

Most mnemonic systems consist of a combination of two types of coding: *reduction* (discarding superfluous information in order to reduce that which must be stored) and *elaboration* (adding information in order to render the target information more memorable) (Baddeley, 1976; Baddeley & Patterson, 1971). In the mnemonic keyword method, creating an interactive mental image is a form of elaboration, however, processing the foreign word only to the extent that it may be used to retrieve the keyword is a form of reduction. The danger in any system of reduction coding is that the original stimulus will be reduced to the point that it is impossible to reconstruct. Although this reduction in processing may not be inherent in the keyword method, but rather a result of the learner's assessment of the retrieval requirements of the task, the consequence of reducing the unfamiliar foreign word to a fragment mapped by a keyword is a failure to reconstruct the unfamiliar word. This reduction of the foreign or unfamiliar word to a fragment used to retrieve the keyword may be one reason for the consistent failure to find a keyword effect for backward recall. This reduced processing of the foreign word may account for the observation that keyword-provided subjects were able to spell fewer foreign words than either keyword-generated or control subjects when the keyword and foreign word fragments were not identical (Pressley, Levin, Nakamura, Hope, Bispo, & Toye, 1980), although the fact that these subjects expected to be tested only on recall of the translations only renders any possible explanations of the results highly speculative. Had subjects been aware that they would be asked to recall the foreign word, they might have processed it differently within the context of the keyword method.

Ingredients of a Successful Imagery Mnemonic

A method that promotes integration of the unfamiliar word, as well as association of the foreign word with the keyword and translation, is needed to enable the learner to reconstruct the foreign word from the keyword. The means of devising such a technique may be inferred from several principles specified by Bower (1970, 1972) as essential to a successful imagery mnemonic. Bower contends that several items can be related to one retrieval cue, however that it seems essential that both the retrieval cues and the to-be-remembered items be visualized in a single, integrated image in which the items interact or are otherwise associated together. Finally, the subject must either be able to generate the retrieval cue for the image, or be provided with the cue. Let us evaluate the traditional mnemonic keyword method and its application to both forward and backward recall in the light of these essential principles.

The retrieval cue for recall of the image does not seem to be a problem either in forward or backward recall. In the forward recall task the retrieval cue (the keyword) is generated by the learner from the foreign word fragment mapped by the keyword. In the backward recall task the translation presented at the time of recall serves directly to retrieve the image. But although the mental image includes representations of the retrieval cue referent (the keyword) and the referent of one of the other items (the translation), it includes neither a direct representation of the remaining item (the foreign or unfamiliar word) nor a mediator (a keyword) for recalling it. This situation is problematic for backward recall in that a representation of one of the to-be-remembered items (the foreign word) is not included in the interactive image, nor is there a retrieval cue for the unfamiliar word beyond that provided by the keyword, which only resembles one portion of the entire novel letter string.

A Proposal for Its Enhancement

It would appear that one possible answer to lack of integration of the physical form of the foreign word would be to include an orthographic representation of the foreign word in the interactive visual image, thereby associating it with the keyword and translation referents, and increasing the probability of its retrieval as part of a composite memory trace. However, Bower's recommendation that the separate items be visualized together in a single interactive image referred to objects, not to letter strings, and it is difficult to predict the effect the incorporation of a letter string on its retrieval from an interactive image. However, some evidence of the possible effects of such an operation might be found in several areas of the literature such as the learning of printed word forms and task-appropriate processing.

Evidence of the Role of Mental Representation of Orthographic Forms of Words from Other Areas of Research

Spelling Research. There is little agreement by experts on how individuals produce written words and on the relation of word recognition and reading to the task of spelling, although it is agreed that all of these tasks require some degree of learning of printed word forms. Some researchers propose, in the tradition of the levels-of-processing approach to memory (Craik & Lockhart, 1972), that after first processing a printed word visually (for visual features) one then processes it phonemically (for sound) and finally semantically (for meaning). At each step in this serial processing the former representation of a word is relinquished in favour of the latter, so that it is the final encoding of a word that is best retained in memory (e.g., Hock, Throckmorton, Webb, & Rosenthal, 1981). Another position regarding printed word learning, however, the "word identity amalgamation theory" (Ehri, 1980a, 1980b) holds that visual representation of letter patterns is important in both reading and spelling behaviour. According to this theory, an orthographic image of a printed letter string is related to an individual's ability to recognize and to produce this string. The

lexicon is conceptualized as a repository of abstract word units, each of which has several identities: a phonological identity, a syntactic identity, a semantic identity, and an orthographic form which is established in memory as a visual image. "Amalgamation" refers to the processes by which the identity of a word becomes linked with the word's other identities in lexical memory. In order to acquire orthographic images, a reader must have some knowledge of how letters represent phonetic units, and through experience in associating a word's orthographic structure with its other identities, the printed form comes to evoke all of a word's identities simultaneously. The learner, when first encountering the printed form of a word which is already known in speech, uses a knowledge of letters as symbols for relevant phonological segments to assimilate the word's printed form to its phonological structure so that an orthographic image is formed which becomes the visual symbol for the word. Although Ehri does not specifically discuss in detail the process of amalgamation of a previously unknown word, it seems reasonable to assume that, according to this theory, when an unfamiliar printed letter string is encountered, the learner can associate the string's orthographic image only with its phonological identity (as decoded from the letters in the string), as its semantic and syntactic identities are unavailable for amalgamation unless they can be inferred or otherwise determined from the context in which the letter string appears.

In summary, Ehri proposes that orthographic images are basic to the process of learning printed words, both in word recognition and in spelling, and that orthographic images are acquired through experiences of visually reading specific words and through merging the various identities of words until the images symbolize these other identities. Research by Ehri and associates as well as by other researchers provides evidence which appears to support these claims.

For example, Ehri and Wilce (1979) found that children recalled CVC trigrams best when study aids were their correct visual spellings (either seen or imagined) rather than either incorrect visual spellings, rote verbal rehearsal, or hearing an oral spelling. In an experiment particularly relevant to this discussion, Ehri (1980b) asked second grade children to produce 8 pseudowords (four regular and four irregular spellings) in response to 8 animal pictures after they had learned to read the words as if they were the names of the animals. It was expected that, if the children had

recoded the pseudowords phonemically, they would produce phonetically-accurate spellings, but if they had encoded the pseudowords as orthographic images, they would produce the words as presented. Ehri noted that the children spelled a large proportion (69%) of the words as they had been presented, indicating that they had encoded the words as orthographic images rather than recoded them phonemically. Ehri (1980b) argues that orthographic images "may offer a more memorable code than sound for preserving unfamiliar words in memory" (p. 335), and that "orthographic images can be scanned like real words seen in print, that they include all of the letters in a word's spelling, not just boundary letters or letters mapping into sounds" (p. 238).

Another team of researchers, Marsh, Friedman, Welch, and Desberg (1980) have observed that although spelling strategies change as the individual's experiences with reading and spelling increase, "very proficient spellers appear to make heavy use of visual information" (p.353).

Word Recognition Research. Other researchers have also found that there is a visual component to recognition memory for verbal items. Kirsner (1973) used a continuous recognition memory test to determine whether or not a visual code is considered in a recognition decision for words and nonwords and concluded that information about the physical characteristics of verbal stimuli is retained over a period normally associated with long-term memory and is not due to visual rehearsal. The fact that recognition for nonwords was much poorer than for words, but still demonstrated an effect for visual identity prompted Kirsner to conclude that the visual code can be used in a recognition decision even in the absence of a clear verbal or semantic focus, and that although visual codes and verbal codes are completely or partially independent, they are closely linked. Other researchers have also found visual memory for words facilitates recognition memory (Hintzman & Summers, 1973) and word identification (Coltheart & Freeman, 1974). Healey (1981), employing a proofreading task, concluded that the visual similarity between the correct letter and the one substituted for it increased the percentage of proofreading errors, regardless of phonological considerations. Although proofreading is a somewhat different task

than recognition or recall, this study does indicate that a visual image in memory serves as a comparison for identifying errors in the printed material.

To summarize, it appears that visual images of the orthographic forms of printed words may facilitate their recognition, recall, and spelling, and that this may be even more true of unfamiliar letter strings than it is of familiar words. This concept may provide a basis for the modification of the mnemonic keyword method so as to include the encoding of the orthographic form of an unfamiliar letter string so that it may become associated with the phonological, syntactic, and semantic identities of the letter string.

Task Appropriate Processing Research. The concept of incorporating the orthographic form of the unfamiliar word into the composite mental visual image during study using the mnemonic keyword method might draw criticism as being too shallow a method of processing the unfamiliar word; however this concept appears to be compatible with empirical research in the area of transfer-appropriate processing. Morris, Bransford, and Franks (1977) employed the expression "transfer-appropriate processing" to contrast with the "levels of processing" model of encoding and retrieval (Craik & Lockhart, 1972), which held that deeper, more semantic processing of stimuli resulted in more durable memory traces. This levels of processing model predicted that when an orienting task requires semantic processing (e.g., a decision about an item's meaning), the item should be more easily recalled than when the orienting task requires shallow processing (e.g., a decision about the item's appearance). Morris et al. (1977) found, however, that when subjects are asked to attend to the rhyming patterns of words, those words were better remembered than were those words to whose meanings the subjects had attended, when the recognition task involved the subjects' ability to identify words which rhymed with those on the acquisition list. The authors concluded that the value of a particular level of analysis depends on the type of test that is given after the analysis has taken place. Bransford (1979) has stated that in order for a retrieval cue to be effective, "it must be congruent with information acquired during the initial learning task" (p. 76). And Stein (1978) observed that encoding structural properties of a word (letter case) resulted in better recognition given a case-oriented recognition test, but semantic processing resulted in

better recognition on a semantically-oriented recognition test. He concluded that nonsemantic levels of processing are not necessarily inferior to deeper semantic levels of processing when the test is appropriate to the type of processing performed. In taking a task-appropriate processing perspective on the problem of the processing of pseudowords, it seems that attending to the physical features of a letter string might result in enhanced retrieval of those features.

In summary, modifications to the mnemonic keyword method in order to facilitate recall of unfamiliar words might include changes which take into account the necessity to associate, in a single imaginal unit, some representation, either as an object (a keyword) or an orthographic image (the orthographic form of the unfamiliar word).

Introduction to the Experiments

The present report consists of two experiments. Both experiments used a study-test procedure in which university students studied a list of pseudoword-translation pairs and were asked to recall the pseudowords when cued with their arbitrarily associated translations. The purpose of the first experiment was to examine the effects of a modified version of the mnemonic keyword method for recall of unfamiliar words, in this case, pseudowords. The second experiment was designed to study the effects of training the self-generation and linking of mediators with translations on recall of unfamiliar words, and additionally, to compare the value of providing mediators in trained as opposed to untrained language learners.

The mnemonic keyword method for backward recall requires a somewhat complex series of activities (i.e., creating an interactive image of the keyword and translation referents, and reconstructing the foreign word from the keyword-mapped fragment), and might reasonably be expected to take some practice to master. Therefore, several study-test trials were used to assess the efficacy of mnemonic instructions relative to free-strategy instructions. In the first experiment, standard mnemonic keyword instructions were modified to include the orthographic form of the foreign word in the interactive mental image to facilitate integration of the entire pseudoword. In the second experiment, subjects were trained to generate keyword mediators for entire

pseudowords and to link these mediators to the pseudoword translations by means of interactive sentences, phrases, and/or images. The effects on pseudoword recall of providing keyword mediators to trained and to untrained learners was also examined in the same experiment.

CHAPTER 2

The Effects of a Modified Mnemonic Keyword Method on the Recall of Unfamiliar Words

The goal of this experiment was to investigate several aspects of learning related to the recall of unfamiliar words (backward recall) under three conditions of learning instructions, either instructions to use (a) a free strategy, (b) a standard mnemonic keyword method, or (c) a modified version of the standard mnemonic keyword method designed to facilitate integration of the unfamiliar word. In an attempt to enhance integration of the unfamiliar word, the standard mnemonic keyword method instructions were modified in order to incorporate the orthographic form of the unfamiliar word in the interactive image containing the keyword and translation referents. Bower (1970,1972) has suggested that several items can be related to one retrieval cue, but only if both the retrieval cue and the to-be-remembered items are visualized in a single integrated image in which the items interact or are otherwise associated. If so, then elaborative encoding which includes in a single image both the keyword and translation referents as well as the orthographic form of the unfamiliar word might be expected to enhance recall of the unfamiliar word. The specific aspects of learning of interest in this study are described below in the context of the individual empirical questions investigated.

Assessing the Effectiveness of the Keyword Method

The Relationship Between Strategy Effectiveness and Units of Analysis in Pseudoword Recall

The experiment presented in this chapter was designed to address two principal empirical questions, as well as two ancillary questions. The first principal question addressed is whether this variation of the standard mnemonic keyword method is effective in facilitating acquisition of unfamiliar words when cued with their meanings relative to either the standard keyword method or a freely-chosen strategy. Participants in each of the three groups received instructions to use a different learning strategy, either (a) a free strategy, (b) the standard mnemonic keyword strategy, or (c) the keyword + orthographic image strategy. The instructions and stimuli presented to these three groups are described in detail in the Method section of Experiment 1.

The most frequently-used measure of strategy effectiveness in the keyword literature has been recall of the translation for forward recall, and recall of the entire foreign word or of the entire foreign word less one letter for backward recall, or of the keyword-mapped foreign word syllable (Pressley & Levin, 1981; Pressley, Levin, Hall, Miller, & Berry, 1980; Pressley, Levin, Nakamura, Hope, Bispo, & Toye, 1980). In order to address the question of relative effectiveness of the control and keyword methods in this experiment, the most constraining measure of effectiveness, that of proportions of correctly-recalled pseudowords, was compared among these experimental groups. However, the task of correctly recalling entire unfamiliar words might be sufficiently difficult that no differences in this rather stringent dependent measure might be observed among groups, even if one or more groups recalled significantly greater portions of the unfamiliar words without recalling more entire words. Therefore, with respect to the first empirical question, the proportions of pseudoword letters recalled in their correct serial positions were also examined. It was hypothesized that the retrieval cue provided at the time of recall (i.e., the translation or meaning of the unfamiliar word) might serve to retrieve not only the

keyword, and therefore the mapped portion of the unfamiliar word, but also the orthographic image of the unfamiliar word itself. If so, then recall of entire pseudowords and/or of total pseudoword letters in their correct serial positions by subjects instructed to include the orthographic form of the foreign word in their interactive image should be enhanced relative that of the standard keyword and control groups.

The second major question to be examined pertains to the pattern of acquisition of the unfamiliar word. In what way does the trial-by-trial pattern of acquisition of portions of the unfamiliar word by subjects employing one or another version of the keyword method differ from those employing a free strategy? In order to answer this question, the proportions of correctly-recalled first and second halves of the pseudowords were compared. Provided that participants employing either of the keyword strategies recalled the associated keywords on early trials, the following pattern of recall was expected to occur. Keyword subjects would be expected to recall a greater proportion of the first halves of the unfamiliar words than would free-strategy subjects, and after the earlier trials, keyword subjects would then begin to recall more letters occurring in the second half of the pseudowords, as their enhanced recall of first halves on earlier trials would enable them to attend to the nonkeyword-mapped portion of the pseudoword. Free-strategy subjects, on the other hand, were expected to learn letters less systematically, therefore the disparity between recall of first as opposed to second halves would be smaller than that manifested by the keyword subjects.

The first ancillary question to be answered is one which has been addressed indirectly by previous keyword experiments: Do keyword subjects reliably recall the keywords which are designed to serve as retrieval cues for the foreign words? Previous experiments determined that keyword subjects recall or recognize more keyword-mapped fragments of foreign words than do controls, but did not report recall of the keywords themselves. Because the failure to recall keywords could account for keyword subjects' failure to display enhanced recall of foreign words relative to that of control subjects, this possibility merits investigation. For this reason, proportions of correctly-recalled keywords were examined for both keyword groups at each learning trial. A study on the use of the keyword method for forward recall

(Desrochers, Wieland, & Coté, in press) has demonstrated that keyword subjects, even when asked to encode the grammatical gender of the foreign word in addition to its translation with a list of 40 items, recalled a majority of keywords by the second recall test and recalled approximately 80% of keywords by a third trial. Unless the more difficult nature of the backward recall task inhibits subjects from learning keywords as easily as in the forward task, it was expected that keyword subjects would recall a high proportion of keywords even on early recall tests.

The second corollary question was asked as a heuristic tool: What methods do subjects recall having used to study the experimental list items? This question was asked in order to investigate the strategy use of both controls and keyword-instructed subjects. The strategies employed by free-strategy, or as they are sometimes called, "no-strategy" controls, have not previously been investigated in the context of backward recall, therefore the degree to which these subjects may use, or try to use, a keyword-like strategy is unknown. If, as has been found in previous backward keyword experiments, free-strategy subjects recall unfamiliar words as well as do keyword strategy subjects, perhaps it is because controls spontaneously employ strategies based on natural language mediation. If controls use keyword-like strategies, then empirical investigations such as these merely compare subjects who use a keyword method in response to instructions with other keyword subjects (free-strategy controls) who use the method spontaneously. If free-strategy subjects exploit other, equally effective, methods to study unfamiliar words and associate them with their meanings, it would be interesting to determine the characteristics of these methods in order to generate hypotheses as to why such strategies may be as effective as the keyword method in facilitating backward recall. The self-reports of strategy use were also expected to provide feedback to the researcher about the degree to which participants comply with experimental instructions. If subjects do not use the keyword methods as instructed, then the experiment cannot provide information about whether the methods

might be effective in enhancing recall of unfamiliar words. And if the mnemonic instructions are not followed, the interview responses might provide clues as to why subjects do not follow them.

Although it is an intriguing issue to explore, the task of ascertaining actual strategy use is a difficult one for several reasons. Several tactics were employed by the interviewer in this study in an attempt to minimize these problems. First, the information provided about strategy use by participants is necessarily based on retrospective self-reports produced in response to an interview at the end of four study-test trials. It is possible, even probable, that subjects may change their strategies from one trial to another after assessing the effectiveness of a previously-used strategy at the time of recall. Even without explicit feedback on their recall performance, adult subjects appear able to assess strategy effectiveness after attempted recall, and based on this self-monitored information, may substitute a new strategy for one judged to be ineffective (e.g., Pressley, Levin, & Ghatala, 1984). In this experiment, subjects were asked to recount only the strategy used during the final learning trial to study each item, as it was expected that this strategy would be the one judged by the subject to be the most effective of those attempted for that item. A second potential source of difficulty in assessing strategy use is that subjects may forget the strategy used to study a particular item or items, particularly if that strategy was ineffective and resulted in a weak memory trace. Thus, subjects may be unable to recount the least effective strategies used during the study phase of the experiment. Subjects in this experiment were encouraged to reflect carefully on their study strategies, even if the item was not recalled. A third possible difficulty is that subjects may be embarrassed to relate mediators which might be considered socially inappropriate by the interviewer. When subjects were reluctant to report a mediator or mediators, they were allowed to describe the mediator's properties (i.e., to what extent it resembled the foreign word and how it was associated with the translation) without being required to pronounce the "offensive" mediator.

Method of Experiment 1

Subjects

Sixty undergraduate students (43 women and 17 men) whose age ranged from 17 to 39 years (mean = 19.7 years), all of whom were proficient in English, participated voluntarily in the experiment. Fifty-five of them reported their mother tongue as English, 3 as French, and 1 each as Greek, Arabic, and Dutch. None had previously participated in a similar experiment. Subjects received \$5.00 for their participation.

Materials and equipment

The learning materials consisted of a practice list of three pseudowords, and an experimental list of 30 pseudowords. Each pseudoword was paired with an English word which served as a "translation" and, for the two keyword condition groups, with an English keyword. These materials were created and selected according to the procedures and criteria described below.

Pseudowords. Recalling unfamiliar words has proven to be a difficult task regardless of the strategy adopted to do so. It has been noted that the difficulty of learning foreign words "is a function of perceived similarity of an item with respect to its form" (Ludwig, 1984, p. 557) so that foreign words with letter combinations similar to those permitted in the native language would be the preferred stimuli in a task such as backward recall. The intent in designing pseudoword stimuli for this experiment was to create unfamiliar words which would substitute for genuine foreign language words but which would not be so unfamiliar in form as to render the learning task extraordinarily difficult. In order to create pseudowords that would appear "word-like" to English-speakers, yet not contain actual English words, six-letter pseudowords were chosen from a computer-generated list of all possible combinations

of first, third and fifth bigrams within specific log frequency counts based on the summed position-sensitive log bigram frequency counts for 6-letter words as calculated by Massaro, Venezky, Jastrzembski, and Lucas (1980). This measure is derived from counts of letter sequences which occur in the written English language, taking into account their position in letter strings of a particular length. For example, the bigram "ab" is found as the first two letters of a 6-letter word "X" times out of a much larger sample of words, and the log value of "X" is then calculated to yield the log positional frequency. A 6-letter string is evaluated by summing the log frequencies of the first, second, third, fourth, and fifth bigrams. This frequency measure has been found to be highly predictive of a variety of word and pseudoword perception data in research conducted by Massaro et al. (1980). The selection of bigrams for this study was made from the middle range of log bigram frequency values (1.47 - 2.40), the size of the range determined to be just large enough to contain the bigrams necessary to create the required number of pseudowords. All cases of first bigrams (first two letters) falling within the range were combined with all cases of third bigrams (third and fourth letters), and with all cases of fifth bigrams (fifth and sixth letters) within this range.

In order to simplify the pseudoword selection process, a computer-generation procedure was designed so that an initial screening of all possible pseudowords was conducted before the list of remaining pseudowords was compiled. A pseudoword was discarded by the computer if it contained either the same bigram in more than one position of the three designated bigram positions, or an occurrence of a double letter.

From those pseudowords which remained, a pseudoword was chosen as a stimulus only if it met both of the following criteria. The pseudoword must not contain an entire concrete English or French word (so as to avoid pseudowords which might be unusually easy to recall), and be able to be matched with a concrete English noun (to serve as a keyword) whose first three letters are identical to the first three letters of the pseudoword. In order to reduce possible intra-list interference, the final stimulus selection was made so that no two pseudowords had either a first or a fourth trigram (first half or second half of the pseudoword) in common with another in the list, and no more than two pseudowords shared the same initial letter. Although the

pseudowords varied somewhat in their ease of pronunciation, no word was chosen which was judged by the researcher to be unpronounceable by an English-speaker. With regard to the log frequency counts of Massaro et al. (1980), the final list of pseudowords ranged from 6.710 to 12.010 for summed position-sensitive log bigram frequency and from 18.273 to 21.794 for summed position-sensitive log single-letter frequency, ranges referred to by Massaro et al. (1980) as low positional log frequencies. The formation of pseudowords composed of orthographically legal letter strings, but with low summed positional log frequencies resulted in word-like letter strings which did not contain embedded English words.¹ A list of the pseudoword stimuli with their summed log single-letter and bigram frequencies is found in Appendix B.

Keywords. Each pseudoword was paired with a keyword which was (a) judged by the researcher to be imageable and (b) whose first three letters were identical to those of the pseudoword. Due to the orthographic restriction of having first trigrams identical with those of their respective pseudowords, it was not feasible to restrict the choice of keywords to those contained in established normative studies.

Translations. Because the mnemonic keyword method has traditionally involved the use of imagery elaboration, each pseudoword was matched with an arbitrarily-selected "translation" chosen for its high concreteness and imagery value according to the 7-point bipolar numerical scale ratings reported by Paivio, Yuille, and Madigan (1968). All translations (except for one, "mud") fell between the range of 6.0 and 7.0 on both concreteness and imagery ratings, where 1.0 and 7.0 are the lowest and highest possible ratings respectively. A high concreteness rating reflects the rater's judgment that the word refers to an object, material or person, and a high imagery rating reflects the reported ease with which the rater is able to form a mental image

¹Examples given by Massaro, Venezky, & Taylor (1979) of pseudowords with high summed positional log frequencies and which are also orthographically regular tend to contain embedded shorter English words: *manout*, *ramfer*, *genold*, *nagred*. Such high frequency pseudowords were judged to be unsuitable for this study, since the characteristics of the pseudowords would induce controls to use the embedded English words as mediators for the pseudowords.

of a word's referent. A translation was then arbitrarily assigned to a pseudoword/keyword pair with the restriction that no translation should be matched with a keyword so as to form a strongly associated pair, such as "jail-prisoner" or "curtain-window".

The stimulus items were presented on an Amdek 310A monochrome monitor controlled by an IBM XT microcomputer. The list was presented in a new random order at each trial and for each participant. The stimulus items were displayed in the following manner for both groups of keyword subjects:

ambawn (tree)
/ambulance/

The translation was placed to the right of the pseudoword, and the keyword was placed directly below the pseudoword so that their orthographic similarity could be easily noted. The keyword was omitted from the display shown to control subjects. Words were presented in lower-case letters only because lower-case letters possess more distinct physical features than do upper-case letters, therefore individual letters should be easier to identify from an orthographic image of lower-case letters than of upper-case letters.

Experimental materials also included one practice recall sheet and eight experimental recall sheets (two per study-test trial) on which the translations were used as cues for either the pseudowords alone (control group) or for both the pseudowords and keywords (both keyword groups). The practice recall sheet contained the three translations from the practice list, and the experimental recall sheets contained fifteen of the thirty translations in different random orders. To the right of each translation was a line divided into six spaces for printing the six letters of the pseudoword. The answer sheet was arranged like this:

TRANSLATION	KEYWORD	FOREIGN WORD
newspaper	_____	! ! ! ! ! ! ! !
letter	_____	! ! ! ! ! ! ! !

Half of the stimuli were presented on one sheet with the other half on a second sheet. Response sheets for both keyword groups contained a line for the recall of the keyword, whereas those for the control group did not.

Procedure

Subjects were randomly assigned to one of three experimental conditions in order of their appearance in the laboratory and were tested individually by the experimenter in a quiet room. At the beginning of the session they were informed that they would be asked to study a list of 30 pseudowords, constructed to conform to the orthographic structure of English. They were told that they should think of these pseudowords as foreign words, and that each pseudoword was to be presented with an English word that they could think of as its English translation. The use of pseudowords was explained by the need to control for variables such as word length and shape and by the difficulty of finding real foreign language words that were equally unfamiliar to everyone in the English/French bilingual environment of the University of Ottawa. The researcher then referred to the pseudowords as foreign words during the remainder of the experiment. Participants were also informed of the manner and rate of the presentation of the stimulus items and were advised that after each presentation of the entire list, they would be asked to recall, on the recall sheet which contained all of the translations, the pseudowords associated with each translation.

Subjects were shown the first of three practice items while they received specialized instructions on how to study the items (reported in detail below, and

reported verbatim in Appendix A). They were then shown two more practice items to study. The practice session was followed by a practice recall test of the three items, following which subjects were asked if they had any questions concerning the procedure. Subjects were also asked if they had any questions regarding the use of the instructed method. All questions were answered and further clarification was provided until subjects indicated that they felt comfortable with beginning the first study-test trial. Before initiating the first presentation of the experimental list, the experimenter encouraged subjects to do their best to memorize the list.

Participants were shown the experimental list four times, and each presentation was followed by a recall test. Items were presented for 10 sec. each, in a new random order on each trial. After each presentation of the list, subjects were provided with two recall sheets, each containing half of the translations in a different random order, and were given five minutes during which to recall as many of the foreign words as possible. Keyword subjects were also asked to recall the keyword associated with each foreign word-translation pair. In order to obtain as complete a picture as possible of the information recalled, subjects were encouraged to print as many of the letters of the foreign word as they could remember, even if they were not completely certain of either the identity or position of each letter. If they could not remember a letter at all they were to leave that space blank. After each recall test, subjects were reminded to follow the instructions given by the experimenter on the next trial.

The three experimental groups differed in (a) whether or not they were provided with a keyword during the list presentation (i.e., only subjects in the two keyword groups were provided with keywords), (b) the information they were asked to recall (keyword subjects were asked to recall both the pseudoword and the keyword, whereas control subjects were asked for only the pseudoword) and (c) the instructions they were given. Subjects in the control group were instructed to study the list in any way that they wished. Standard keyword subjects were instructed to notice the similarity in spelling between the first parts of the keyword in order to form an acoustic link between the keyword and the foreign word, and then to form a mental image in which objects representing both the translation and the keyword interact in some way so as to establish a semantic link between the keyword and translation

referents. These subjects were also told how they could use the translation provided on the recall sheet to retrieve the interactive mental image containing the translation, to identify in their image the keyword, and then use the keyword to identify the first part of the foreign word. Subjects were reminded that, although the keyword could help them to recall the first three letters of the foreign word, they would have to work hard in order to recall the rest of the foreign word. Subjects in the keyword + orthographic image condition were given the same instructions on the creation of the interactive image and its use in recalling the foreign word, but with the following addition: These subjects were instructed first to construct their interactive image, and then to add the orthographic form of the foreign word to the image, and to pay attention to both the individual letters and to the overall shape of the word as they mentally viewed it in the image.

After the fourth recall test, subjects were asked in a post-experimental interview to describe to the experimenter how they had studied the items in order to associate them and to recall the spelling of the foreign word. The interviews were tape-recorded. Subjects were given assurance of the confidentiality of the interview responses, both verbally and in a written consent form which subjects were requested to sign (see Appendix C). This assurance was given both to ensure that subjects were treated in an ethical manner, and to encourage subjects to provide honest descriptions of their methods and possible mediators employed to study the items. Interview questions differed slightly for each experimental group. Control subjects were asked whether they had a particular method or strategy that they had used more than any other to link the foreign word with its translation and to recall the foreign word itself, and if so, to describe this primary strategy briefly. They were then asked to describe how they studied each set of items, one at a time. They were asked to answer two questions: 1) was there anything about the foreign word which had helped them to remember it?, and 2) how had they tried to link the foreign word with its translation? Standard keyword subjects were asked whether or not they had used the keyword method, (i.e., had they formed an interactive image of both the keyword and the translation), and if not, what had they done to remember the spelling and translation of the foreign word. Keyword + word imagery subjects were, in addition, asked to

report whether they had included the orthographic form of the foreign word in the image. The initial instructions for the interview for subjects in each experimental condition can be found in Appendix C. The interviewer asked for this information, one item set at a time, by providing in alphabetical order the pseudoword and translation (and keyword for keyword subjects) to serve as a probe for each item set. Depending on the extent of the information that was volunteered by the subject, the interviewer sometimes probed further in order to determine what method or methods were employed by the subject. After the completion of this interview, the subject was informed of the purpose of the experiment. Written feedback on the global results of both experiments were provided to each subject after the completion of the second experiment (to be presented in Chapter 3).

Results and Discussion

The proportions of correctly recalled items were used in all of the analyses reported in this section. The effects of mnemonic instructions (free-strategy control, standard keyword, and keyword + orthographic image) on recall of pseudowords and on recall of individual letters were independently examined by means of analyses of variance, as were the differences between the recall of first halves versus second halves of the pseudowords. The effects of strategy instructions on recall of keywords by the two keyword groups were also examined in an independent analysis of variance.

The ANOVAs performed on the recall of the pseudowords, letters, and keywords involved one between-subjects variable, mnemonic instructions (3 levels), and one within-subjects variable, trials (4 levels). The analyses conducted on the halves of the pseudowords involved the same variables, with the addition of the within-subjects variable of halves of the pseudowords (2 levels). The number of degrees of freedom involving the within-subjects variables were adjusted according to the Greenhouse-Geisser algorithm implemented in program P4V of the BMDP statistical software (Dixon, 1983), and were rounded off to the nearest integer in this section. Tests of simple effects were also performed using the BMDP P4V program.

Individual differences between means were assessed using Tukey's HSD test (Kirk, 1968).² The .05 level of significance was applied to all statistical tests, and when appropriate, greater levels of significance attained are noted. Summaries of ANOVAs and tests of simple effects are found in Appendix E.

The method of assessing and analyzing the post-experimental interviews to determine the strategies used and their relative efficacy will be described in detail after the results of the analyses of the recall data have been reported.

Recall of Pseudowords and Total Correct Letters

The analysis of the mean proportions of correctly recalled pseudowords revealed a main effect of trials only, $F(1,84)=284.02$, $MSe=.014$, $p<.0001$, indicating that subjects in all groups improved recall of pseudowords with practice. No other effect was found. Similarly, only a main effect for trials was observed in the analysis of mean proportions of correctly recalled letters, $F(2,92)=438.90$, $MSe=.008$, $p<.0001$. The mean proportions of correctly-recalled pseudowords and letters of the pseudowords are reported in Table 2.1.

²The required post hoc comparisons of means between trials 1 - 2, 2 - 3, and 3 - 4 were compared with *t* tests using the P3D program of the BMDP statistical software (Dixon, 1983). As it was expected that recall would improve with trials, and that expectation was supported, $p<.0001$ in almost all cases, these comparisons will not be reported in the text. Results of *t* tests are reported in Appendix E. The two cases in which differences between trials were not significant (i.e., recall of first halves by the two keyword groups did not increase significantly from trial 3 to trial 4) are reported in the text as well as in the appendix.

Table 2.1 Mean proportions of pseudowords and of letters recalled in Experiment 1.

Condition	Pseudowords					Letters				
	T1	T2	T3	T4	Mean	T1	T2	T3	T4	Mean
Free-strategy control	.06	.26	.46	.64	<u>.36</u>	.15	.40	.62	.77	<u>.48</u>
S.D.	.05	.20	.29	.30	.32	.11	.23	.27	.25	.32
Standard keyword	.03	.18	.45	.66	<u>.33</u>	.30	.53	.70	.80	<u>.58</u>
S.D.	.04	.17	.26	.25	.32	.13	.17	.21	.21	.26
Keyword + orthographic	.02	.15	.37	.59	<u>.28</u>	.26	.51	.69	.81	<u>.56</u>
S.D.	.03	.11	.22	.21	.27	.09	.09	.11	.10	.23
Overall Mean	.04	.20	.43	.63	<u>.32</u>	.24	.48	.67	.79	<u>.54</u>
S.D.	.04	.17	.26	.21	.27	.13	.18	.21	.20	.28

Recall of First and Second Halves of Pseudowords

The mean proportions of first and second halves of pseudowords recalled by the three experimental groups at each trial is presented in Table 2.2. An analysis of the differences between recall of the first and second halves of the pseudowords yielded six significant effects: (a) a main effect of trials, $F(2,97)=473.64$, $MSe=.015$, $p<.0001$, (b) a main effect of halves, $F(1,57)=435.08$, $MSe=.034$, $p<.0001$, (c) a main effect of mnemonic instructions, $F(2,57)=6.65$, $MSe=.172$, $p<.01$, (d) a Halves x Mnemonic instructions interaction, $F(2,57)=78.27$, $MSe=.034$, $p<.0001$, (e) a Halves x Trials interaction, $F(1,84)=24.37$, $MSe=.011$, $p<.0001$, and (f) a three-way Halves x Trials x Mnemonic instructions interaction, $F(3,84)=6.39$, $MSe=.011$, $p<.0001$. Main effects and 2-way interactions for trials, halves, and mnemonic instructions are interpreted in the context of the significant three-way interaction containing these variables.

Table 2.2 Mean proportions of first and second halves of pseudowords recalled in Experiment 1.

Condition	First Halves					Second Halves				
	T1	T2	T3	T4	Mean	T1	T2	T3	T4	Mean
Free-strategy control	.11	.37	.57	.74	<u>.44</u>	.08	.29	.52	.67	<u>.39</u>
S.D.	.09	.22	.27	.32	.32	.07	.22	.30	.30	.33
Standard keyword	.53	.86	.94	.97	<u>.82</u>	.03	.18	.46	.67	<u>.34</u>
S.D.	.27	.14	.08	.03	.24	.04	.17	.26	.25	.32
Keyword + orthographic image	.45	.81	.93	.97	<u>.79</u>	.02	.15	.37	.59	<u>.29</u>
S.D.	.18	.14	.08	.05	.24	.03	.11	.22	.21	.27
Overall Mean	.36	.68	.81	.89	<u>.68</u>	.04	.21	.45	.64	<u>.34</u>
S.D.	.27	.28	.24	.16	.32	.06	.18	.26	.25	.31

An analysis of simple interaction effects revealed that the combined effects of trial and method was significant only for first halves $F(3,91)=6.00$, $MSe=.012$, $p<.001$. Comparisons between group means indicated that the following ordering between means for recall of first halves at each trial (with a critical difference of .18, .166, .16, and .15 for $p<.01$, $df=57$, at trials 1, 2, 3, and 4 respectively): standard keyword = keyword + orthographic image > free strategy control. Results of t tests indicated that, although recall of first halves for the control group increased from each trial to the next ($p<.0001$), recall of first halves by the standard keyword group and the keyword + orthographic image group did not increase significantly between trials 3 and 4 ($p<.0126$ and $p<.0141$ respectively, with the alpha level of .05 corrected for 9 comparisons requiring $p<.0055$ for significance).

Analysis of simple interaction effects indicated that the effect of halves in this three-way interaction was significant only for the standard keyword group, $F(1,84)=21.79$ and for the keyword + orthographic image group, $F(1,84)=14.94$, both $MSe=.011$, $p<.0001$. Analysis of simple effects of halves at each trial indicated that the two keyword groups recalled more first than second halves of the pseudowords on each trial.

Recall of Keywords

The analysis of the recall of keywords by the two keyword groups revealed an effect of trials only, $F(2,57)=164.62$, $MSe=.001$, $p<.001$, as recall of keywords improved with practice. No other differences between means were observed.

The mean proportions of keywords by both keyword groups recalled are reported in Table 2.3.

Table 2.3 Mean proportions of keywords recalled in Experiment 1.

Condition	Keywords				
	T1	T2	T3	T4	Mean
Standard keyword	.60	.87	.96	.98	.85
S.D.	.05	.03	.02	.01	.02
Keyword + orthographic imagery	.49	.84	.95	.97	.81
S.D.	.04	.03	.02	.01	.02
Overall Mean	.55	.86	.96	.98	.83
S.D.	.21	.15	.07	.04	.22

The absence of a main effect of method on recall of either pseudowords or total correct letters indicates that, as in previous backward keyword experiments, instructions to use the standard keyword method were ineffective in facilitating recall relative to instructions to use a freely-chosen strategy. Furthermore, instructions to use a modified version of the keyword method in which the orthographic form of the unfamiliar word was included in the interactive image were also ineffective in aiding recall of the unfamiliar words. From the recall data alone it is impossible to ascertain whether the absence of an effect of mnemonic instructions in the latter keyword group was due to the ineffectiveness of the method itself, or to the failure on the part of

subjects to follow instructions. If the instructions were followed, then the results do not support the hypothesis that instructions to include the orthographic form of the unfamiliar word in the standard interactive image containing the keyword and translation referents facilitates recall of the unfamiliar word or its component letters. However, if the orthographic imagery instructions were not followed, this experiment may not have provided an adequate test of the potential effects of these instructions. A third possibility, that subjects in the keyword + orthographic imagery group did initially follow these instructions, but then adopted a different strategy because they did not believe the orthographic imagery instructions to be helpful when they attempted recall on early trials, must also be considered. Previous studies have found that subjects may choose one instructed strategy over another (Pressley, Levin & Ghatala, 1984) or to abandon portions of an instructed strategy (Turner, 1983) after taking a test of retrieval, presumably because they are able to subjectively assess how well the strategy is working for them after attempting to retrieve the studied items.

Although this experiment was not intended as a direct test of the existence of the orthographic image, the results are suggestive of a failure either to establish such an image, or to recall it as part of an interactive mental image. If this study did provide an adequate test of the orthographic imagery instructions, and the instructions did not facilitate recall, possible explanations for this failure bear examination. If orthographic images play a role in spelling and/or word recognition, they may do so only after, but not prior to or concurrently with, integration of a novel word form. That is, the retrieval of orthographic images may be a consequence of having integrated the word, rather than a tool for doing so. Furthermore, the visual properties of individual letters, even when combined into an unfamiliar word, do not seem to be as easily retrieved in an image as are meaningful objects. The problem of recalling an entire unfamiliar word by forming a visual image of a sequence of individual letters may lie in the difficulty of encoding such information in a unitary memory trace. The pieces of item-specific information (i.e., the individual letters in serial order) contained in a 6-letter word may be too numerous to encode as a unitary trace unless relational information is present to convert these disparate items into fewer items which are related to each other. It is possible that information about

the orthographic form of an unfamiliar word could be included in a mental image, but only if this information were linked in a more meaningful fashion with the translation than was the case in the imagery instructions used in this experiment. Tuttle (1981), for example, suggests the use of a "word picture" which illustrates not only the word's meaning, but also its spelling. He gives the example of representing the Spanish word, *ojo*, eye, as "OjO", which looks like two eyes with a nose between them. Although the use of a word picture may prove useful for select foreign words, this strategy could not accommodate the orthographic forms of the majority of foreign words.

Similarly, the expectation that keyword subjects might enjoy enhanced recall of second halves of the pseudowords on later trials relative to that of controls was not realized. Although keyword subjects exhibited superior recall of the keyword-mapped first halves on early trials, this advantage did not result in an increased rate of learning the unmapped second halves on later trials relative to that of controls. The dissimilar patterns of recall of first versus second halves by the two keyword groups compared with the control group in this study replicates the discrepancy between keyword subjects' recall of the keyword-mapped fragment of the unfamiliar word and their relatively poor recall of the unmapped portion found in previous experiments (Pressley, Levin, Nakamura, Hope, Bispo, & Toye, 1980; Pressley & Levin, 1981).

The possibility that keyword subjects fail to recall the unfamiliar word because they fail to recall the keyword itself was disconfirmed by the high rates of keyword recall observed in this study. Keyword subjects clearly recalled a majority of keywords on the first trial and most of the keywords by the second trial. Therefore, failure to recall keywords cannot be the source of these subjects' unremarkable recall of unfamiliar words.

In spite of recalling the keyword, and therefore the mapped first half of the unfamiliar word, keyword subjects failed to recall a greater proportion of the rest of the unfamiliar word than did nonkeyword subjects. These results are at first puzzling, as the keyword subjects would seem to possess an advantage over nonkeyword subjects in their early recall of the first portion of the foreign words. The asymmetry in recall of keyword-mapped and unmapped halves of the pseudoword underscores

the problem in reintegrating an unfamiliar word. In the keyword method, only the keyword-mapped portion of the unfamiliar word is encoded with the translation in a single memory trace, therefore only the keyword-mapped fragment is available once the item-specific information (the keyword) is accessed by the retrieval cue provided by the translation. Clues to why keyword subjects fail to benefit from their early recall of keyword-mapped portions of the unfamiliar words were sought in the self-report data.

Descriptive Analyses of the Post-Experimental Interview Data

The taped post-experimental interviews were transcribed verbatim. The transcribed interviews were then coded to yield (a) the type of strategy used to encode the first half of the pseudoword, (b) the type of strategy used to encode the second half of the pseudoword, and (c) the method of associating one or more verbal mediators, if any, with the pseudoword translation. This information was used to examine the proportions of strategies reportedly used and the relative effectiveness of the reported strategies by subjects in each of the three experimental conditions. In addition, participants in the control condition who identified the primary strategy adopted to study the items as a keyword-like strategy were compared to those who identified their primary strategy as a nonkeyword strategy. The rates of actual strategy use reported by these two subgroups of controls were examined to discover how accurately controls were able to identify their most frequently-used strategy. The interview data were not subjected to statistical comparisons, but are presented in the form of descriptive statistics.

Initial Coding of Interview Data. Subjects' reported strategies for studying the pseudowords and their translations were initially coded in some detail for specific information about the types of keywords used, if any, and the methods of associating these keywords with the translation. It was expected that this preliminary assessment of strategy use might serve to identify those strategies spontaneously employed by

controls and the relative frequency of use of the keyword method and other methods by keyword-instructed subjects.

The initial categories of encoding the first half were (a) provided keyword, (b) self-generated keyword, (c) two keywords (both the provided as well as a self-generated keyword), (d) other method of encoding only, and (e) no response obtained. The categories of encoding the second half included (a) self-generated keyword, (b) word imaged in the interactive image only, (c) other method of encoding only, and (d) no response obtained. The categories of linking the mediators and the translation were (a) visual imagery primarily, (b) verbal association primarily, (c) no association made between a mediator and the translation or (d) no response obtained. The "other methods" category included all methods of encoding which did not include a meaningful keyword mediator, for example rote rehearsal or spelling out the pseudoword. The "no response obtained" category was applied to the few instances in which, for technical or other reasons, an item was skipped or the response was inaudible on the tape. "No response obtained" responses were excluded from the data sets.³

A keyword was judged to have been used for a first and/or second half of a pseudoword if a subject reported using a mediator or mediators, whether a concrete noun or any other actual word, which had at least one letter⁴ in common with the half or halves of the pseudoword. A "meaningful association" was any reported link between one or more of the pseudoword's mediators and its translation. This link could take the form of an interactive image, a sentence, phrase, some characteristic(s)

³A total of 7 and 8 responses (.004% each) in the standard keyword condition and the keyword + orthographic image condition respectively were classified as "no response obtained" and were omitted from further calculations. No responses were omitted from the control condition.

⁴Although this criterion for determining a mediator may seem liberal, in fact most mediators did map at least two of the three letters in the half pseudoword to which it was applied.

shared by mediator(s) and translation.⁵ Further descriptions of the scoring criteria and relevant categories of mediators and associations used in the coding of the interviews is found in Appendix C.

These detailed categories were used to get a preliminary estimate of the proportion of subjects in each condition who used these methods to encode and associate the pseudoword with its translation. The results of the initial coding of strategies reportedly used by subjects in the three experimental conditions are shown in Table 2.4.

As expected, subjects in the two keyword groups reported a high proportion of provided keywords to study the first half of the pseudoword (standard keyword .81 and keyword + orthographic image .87). It is also interesting to note that subjects in both keyword groups reported using two keywords for .15 of all first halves studied. The fact that keyword subjects sometimes used an additional keyword may indicate that they considered their own keyword more useful than that provided, or may simply reflect, in the case of some item sets, an effect of the lexical materials to elicit further mediators. Controls reported studying a majority of first halves using a self-generated keyword (.56). Although these reports cannot be directly compared to results of other studies, it is interesting to note that control subjects in other studies have reported similar rates of spontaneous keyword strategy use (Hall, Wilson, & Patterson, 1981; Pressley, Levin, Digdon, Bryant, McGivern, & Ray, 1982), although other studies have reported lower rates of spontaneous use (e.g., Pressley, Levin, Kuiper, Bryant, & Michener, 1982). Perhaps the rate of spontaneous use of a mediator-based strategy depends somewhat on the metacognitive assessment by subjects of the difficulty of the task. Subjects in the keyword groups reported using non-keyword strategies infrequently for the keyword-provided first half of the pseudoword (standard keyword .03 and keyword + orthographic image .01), whereas controls reported using non-keyword strategies far more frequently (.44) for first halves.

⁵The distinction drawn between visual imagery and verbal associations in this section was somewhat difficult to make, as a number of subjects expressed difficulty in determining whether they had used either imagery alone or a combination of a mental image plus a verbal descriptor of the image. Responses in which subjects reported using an image, either with or without a verbal descriptor were coded together in one category as "image alone or image + verbal. Responses in which subjects reported that they used verbal associations without imagery were coded as "verbal alone".

Table 2.4 Mean proportions of reported strategies used to study the experimental stimuli.

First Half of Pseudoword				
Condition	Provided Keyword	Self-Generated Keywords	Two	Other
Free-strategy control	---	.56	---	.44
Standard keyword	.81	.02	.15	.03
Keyword + orthographic image	.87	.01	.15	.01

Second Half of Pseudoword			
Condition	Self-Generated Keyword	Orthographic Image	Other
Free-strategy control	.53	---	.47
Standard keyword	.43	---	.56
Keyword + orthographic image	.32	.32	.36

Associative Link (Keyword + Translation)			
Condition	Image alone or Image + Verbal	Verbal Alone	None
Free-strategy control	.25	.29	.46
Standard Keyword	.89	.04	.07
Keyword + orthographic image	.94	.01	.05

Controls reportedly studied approximately the same proportion of second halves by using self-generated mediators (.53) and by non-keyword strategies (.47). These figures closely parallel their reported strategy use for the first halves of the pseudowords. Approximately .43 of the second halves were reportedly studied by standard keyword subjects with a self-generated keyword, and over half .56 were reported as studied with non-keyword strategies. Evidence of the difficulty and/or ineffectiveness of the modification of the keyword method was provided by the fact that keyword + orthographic image subjects reported using the suggested strategy (orthographic imagery) for fewer than one third of the second halves of the pseudowords (.32). They reported using self-generated keywords equally as often (.32), and other strategies slightly more often (.36) than orthographic imagery.

Control subjects reported using imagery (or imagery plus verbal) association (.25) approximately as often as verbal association (.29) to associate mediators with translations, and reported having no associations between the mediator(s) and translation for .46 of the items.. Subjects in the two keyword groups reported using imagery (or imagery plus verbal) association to link mediators with translations for most of the pseudowords (standard keyword .89 and keyword + orthographic image .94), using verbal associations for very few pseudowords (.04 and .01 respectively), and using no meaningful association to link mediators with translations for a small proportion of pseudowords (.07 and .05 respectively).

Subsequent Coding of Interview Data. The preliminary detailed categories were then combined into more comprehensive categories based on the reported type of strategy (keyword or non-keyword) used to study the first and second half of each pseudoword, and on the type of association (meaningful or non-meaningful) used to link one or more mediators with the translation. Counts of keywords reportedly used (provided, self-generated, or both types) were combined to form the keyword categories, and associations (imaginal or verbal) reportedly made between mediator(s) and translations were combined to form the meaningful association category. All other types of strategies were considered non-keyword and non-meaningful. This operation resulted in seven possible combinations for encoding and associating the two halves of each pseudoword with its translation:

<u>Code</u>	<u>First Half</u>	<u>Second Half</u>	<u>Association</u>
1. (KKL)	Keyword	Keyword	Meaningful association
2. (KOL)	Keyword	No keyword	Meaningful association
3. (OKL)	No keyword	Keyword	Meaningful association
4. (KKO)	Keyword	Keyword	No meaningful association
5. (KOO)	Keyword	No keyword	No meaningful association
6. (OKO)	No keyword	Keyword	No meaningful association
7. (OOO)	No keyword	No keyword	No meaningful association

Further information about the decision criteria for coding initially-coded responses into these categories is provided in Appendix C. The mean proportions of reported use of strategies in these seven categories by condition can be found in Table 2.5.

Table 2.5 Mean proportions of reported strategies used by each experimental group to study the experimental stimuli in Experiment 1.

Condition	Strategy Type						
	KKL	KOL	OKL	KKO	KOO	OKO	OOO
Free-strategy control	.42	.07	.05	.05	.02	.00	.39
Standard keyword	.43	.50	.00	.01	.04	.00	.02
Keyword + orthographic image	.32	.63	.00	.01	.03	.00	.01

It was expected that subjects in both keyword groups would report using the "keyword/no keyword/ meaningful association (KOL)" category more frequently than would subjects in the control group, because the former two groups were provided with a keyword for the first half of the pseudoword and were instructed to link it to the translation in an interactive image. This expectation was supported by the self-report data. The standard keyword group reported using the KOL strategy for .50 and the keyword + orthographic imagery group for .63 of pseudowords, however these groups also reported using an additional keyword (KKL strategy) to study the second halves for .43 and .32 of the pseudowords respectively. The two primary strategies reportedly used by controls were mediators for both halves plus a meaningful association between mediator(s) and translation (KKL) for .42 of pseudowords and non-keyword strategies (OOO) for .39 of pseudowords. The keyword strategies which did not include mediators for both halves of the pseudoword and/or a meaningful link between mediator(s) and translation, other than the standard keyword strategy (KOL) accounted for a very small proportion of reported strategies used to study the pseudowords (range between .00 and .05). Therefore, these remaining partial keyword strategies (OKL, KKO, KOO, and OKO) were subsequently grouped together for the purpose of calculating the probability of successfully recalling the first half, the second half, and the whole pseudoword given that a particular strategy was reportedly used to study the item.

A Comparison of Reported Primary Strategy Use with Reported Strategy Use for Individual Items. The incidence of control subjects who reported their primary study strategy as a keyword-like strategy was compared with the incidence of those who reported a nonkeyword strategy. Seventy-five percent of controls reported that they had used primarily a keyword-like strategy, and the remaining 25 percent reported that they had relied on a nonkeyword strategy. A comparison of reported primary strategy with proportions of items reportedly studied with the categories of strategies previously described (KKL, KOL, etc.) yielded some interesting findings. Of these categories, the first three, KKL, KOL, and OKL were considered as keyword-like strategies, as they consisted of a keyword for at least one half of the pseudoword plus a meaningful link between a keyword and the translation. The remaining strategies

were considered nonkeyword strategies because they lacked an integral component of the keyword method, that of a semantic link between keyword and translation. Of the 75% of controls who reported using a keyword strategy more than any other, actual use of a keyword strategy as reported for individual items ranged from .10 to .93 of items (mean = .58 of items). Clearly, some controls overestimated their reliance on a keyword method, yet identified it as their primary strategy, possibly because they recognized it as an appropriate and beneficial strategy. An even more interesting and less easily explained result of this enquiry was that, of the 25% of controls who reported relying mainly on a nonkeyword strategy, reported use of a keyword strategy ranged from .33 to .57 of items (mean = .43 of items).

An examination of reported strategy use by all controls, regardless of their reported primary strategy, revealed that a keyword-type strategy was reportedly used on an average of .61 of items, a rate that is substantially higher than the .31 of items reported by the subjects in a forward recall task (Pressley, Levin, Kuiper, Bryant, & Michener, 1982). Of those .61 of items, .07 were instances in which the mediator was not meaningfully associated with the translation, and this proportion was similar whether subjects reported using a keyword-like (.08) or a nonkeyword strategy (.07) as their primary strategy.

Conditional Probabilities of Recalling Halves and Pseudowords Given the Strategy Reportedly Used to Study Items. The probability of successful recall of the first half, second half, and entire pseudoword on the fourth trial conditionalized on the reported use of the four combinations of categories of encoding and association (KKL, KOL, Partial Keyword, and OOO) were then calculated. These conditional probabilities, along with the frequency of reported usage of each strategy, are reported in Table 2.6.⁶

⁶ The left-hand side of the table contains the counts of correctly-recalled items for each reported use of individual strategies, by condition. These figures were divided by the total reported frequency of strategy use, also found in the lower left-hand side, to yield the conditional probabilities of correctly-recalled items given the reported use of a particular strategy, found on the right-hand side of the table.

Table 2.6 Frequency of reported strategy use and probability of recall of first and second halves and whole pseudowords conditionalized on type of strategy reported.

Condition	Frequency				Conditional Probability				
First Half									
		Partial				Partial			
	KKL	KOL	KW	OOO	KKL	KOL	KW	OOO	
Free strategy	218	30	40	137	.86	.75	.53	.59	
Std. keyword	249	292	24	14	.99	.97	.92	.93	
Keyword + image	180	367	18	6	.97	.98	.75	.86	
Total	647	689	82	157	Mean	<u>.94</u>	<u>.96</u>	<u>.65</u>	<u>.62</u>
Second Half									
		Partial				Partial			
	KKL	KOL	KW	OOO	KKL	KOL	KW	OOO	
Free strategy	202	26	55	121	.80	.65	.72	.52	
Std. keyword	210	165	10	10	.83	.55	.38	.67	
Keyword + image	152	188	10	0	.82	.50	.42	.00	
Total	564	379	75	131	Mean	<u>.82</u>	<u>.53</u>	<u>.60</u>	<u>.52</u>
Whole Pseudoword									
		Partial				Partial			
	KKL	KOL	KW	OOO	KKL	KOL	KW	OOO	
Free strategy	196	23	52	115	.77	.57	.68	.50	
Std. keyword	210	163	10	10	.83	.54	.38	.67	
Keyword + image	150	188	10	0	.81	.50	.42	.00	
Total	556	374	72	125	Mean	<u>.80</u>	<u>.52</u>	<u>.57</u>	<u>.49</u>
Frequency of strategy use									
Free strategy	253	40	76	231					
Std. Keyword	252	300	26	15					
Keyword + image	186	375	24	7					
Total	691	715	126	253					

The conditional probabilities for experimental conditions are somewhat difficult to interpret because they are based on a wide range of frequencies of successful recall and reported strategy use. Examination of the mean conditional probabilities for each strategy category however, reveals several salient points concerning these data. First, the probabilities of recalling a first half given the use of a strategy which utilizes a keyword to map the first half (KKL = .94, KOL = .96) is greater than those given the use of partial keyword strategies and non-keyword strategies (.65 and .62 respectively). Second, the probability of recalling a second half given the use of a keyword to map the second half (KKL = .82) is greater than those given the use of a keyword strategy which does not have a keyword to map the second half of the word (KOL = .53), and than partial keyword strategies (.60) and non-keyword strategies (.52).

Finally, the probabilities of recalling an entire pseudoword closely resemble those of recalling the second half. That is, the probability of recalling the entire pseudoword is higher when mediators mapping both halves of the pseudoword are associated to the translation (KKL = .80) than when only the first half is mapped by a keyword (KOL = .52), when another partial keyword strategy is used (.57), or when a non-keyword strategy is used (.49).

The procedure of gathering self-reports in response to "interpretive probing", in which subjects are probed at the completion of an experimental session consisting of several learning trials, may be open to criticism on several grounds, one of which is incompleteness of reported information (see Ericsson & Simon, 1980, 1984). Although it is true that there is no objective means of determining the extent of unreported data, Ericsson and Simon (1980) suggest, "Incompleteness of reports may make some information unavailable, but it does not invalidate the information that is present" (p. 243). Judging by the relatively low rates of compliance to the orthographic imagery instructions reported by subjects in that condition, as well as by other trends in the self-report data, it seems unlikely that subjects in this study biased their reports in order to present themselves favorably to the interviewer. Further evidence that self-reported strategy use data was for the most part accurate, can be found in the consistency of the conditional probability data. The high rates of recall for first halves for which a first-half keyword was reportedly used, as well as the

relatively high rates of recall of second halves and whole pseudowords for which keywords were used to map both portions of the pseudoword compared with lower recall rates for most items for which non-keyword strategies were used suggest that strategies were reported accurately. The only anomalous results in these data is found in the relatively high probability of recalling first halves conditionalized on the reported use of a nonkeyword strategy by subjects in the two keyword groups, however it must be noted that these conditional probabilities are based on a small number of responses, therefore these probabilities may be distorted. It is possible that the characteristics of these few stimuli made them easier to remember without the aid of a mediator than other stimuli (Ludwig, 1984), or that these words were recalled through a process of elimination after most of the first halves were encoded using keywords.

The self-report data was not subjected to inferential statistical analyses, nevertheless differences in the magnitude of the probability of recall of whole pseudowords conditionalized on various reported strategies are notable and may be used to generate hypotheses concerning the relative merit of various strategies. Recall of unfamiliar words was consistently greater when subjects reported having used a keyword strategy in which both halves of the pseudoword were mapped by mediators, at least one of which was associated in a meaningful way with the translation. This finding is consistent with a redintegration hypothesis interpretation of the effectiveness of the keyword method. The use of mediators to map both portions of the pseudoword should provide item-specific information about the orthographic structure of the entire pseudoword, and relational information resulting from linking these mediators with the translation should promote the retrieval of the mediators given the translation as retrieval cue. The degree of reduction of the pseudoword is decreased as more mediators are added to map the remainder of the pseudoword, but the degree of elaboration needed to associate the mediators is increased. The task of elaboration needed to associate mediators, then, should require more effort, but as a result, the process of redintegrating the unfamiliar word following retrieval of its mediators should be facilitated. This interpretation raises the question of whether the increase in cognitive effort needed for elaboration does indeed facilitate redintegration,

resulting in enhanced backward recall relative to that when a mediator which maps only a portion of the foreign word is used.

The reports by controls that they often attempt to find mediators to map the entire pseudoword, whereas keyword subjects do not, raises a second question. Why do keyword-instructed subjects report that they seldom use mediators to map the second half of the pseudoword? If the behavior of controls can be considered as representative of subjects' spontaneous mnemonic techniques, then it would seem as though providing a keyword and standard keyword mnemonic instructions in some way inhibits subjects from searching for mediators to map the second portions of the pseudowords. Keyword subjects are provided with a keyword for each first half of the unfamiliar words, and they also have the opportunity to self-monitor their recall performance on the early trials, so are aware that associating the keyword mediator is effective in aiding recall of the keyword-mapped portion of the pseudoword. It is difficult, given these apparent advantages, to understand why keyword subjects do not spontaneously adopt a second keyword to map the rest of the foreign word during the last learning trials in order to learn the second half of the unfamiliar word. This failure to transfer a successful strategy from one portion of the pseudoword to another is similar to results reported by researchers in the area of transfer of problem-solving strategies in which university students failed to transfer solutions from a training problem to an analogous problem unless they first received an explicit hint to use their experience with the former problem to solve the latter (Gick & Holyoak, 1980, 1983). It seems that individuals benefit from explicit instruction to apply known strategies to novel tasks or stimuli, even when the latter are closely related to the former both temporally and qualitatively.

The results of this experiment indicate that a promising direction in which to proceed for facilitating recall of unfamiliar words cued by their meanings is one in which the mnemonic keyword method is extended to include mapping the major portion of the unfamiliar word by natural language mediators. The failure of keyword subjects to consistently extend the method they were instructed to use may be due to several factors.

First, these subjects may be overly conscientious about carrying out the strategy instructions they are given, and rely too much on the keyword method to cue recall

of the entire pseudoword. Second, they may simply be unaware that they, too, can generate mediators and apply them to learning the second half of the pseudoword. Third, they may be unable to generate their own mediators with ease and/or to link them to the provided keyword and translation via the interactive image. This last possibility seems likely, given the responses of controls when asked if they had used a particular strategy more often than any other to study the pseudowords. These results indicate that, although subjects in all conditions may recognize the potential benefits of using a keyword strategy, they may not extend this strategy to include all portions of the pseudoword and/or may not be knowledgeable or skilled in generating and linking mediators with each other and with the translations.

General Discussion

The hypothesis that integration and retrieval of the unfamiliar word might be facilitated by instructions to include a mental representation of the orthographic form of the unfamiliar word in an interactive image containing the translation and keyword referents was not confirmed by the results of this study. Subjects in the keyword + orthographic image condition failed to display superior recall of either whole pseudowords or pseudoword letters relative to subjects in either the traditional keyword or the free-strategy condition. It not clear whether this failure to facilitate recall was due directly to a deficiency in the method, or to the lack of compliance to mnemonic instructions reported in the post-experimental interview by subjects in the keyword + orthographic imagery condition, or both. The strategy instructions may have been used on early trials, then abandoned due to the perceived ineffectiveness of the strategy when recall was tested. In any event, it appears that imaging an unfamiliar word does not result in adequate retrieval of the orthographic properties of the word.

As in previous backward keyword experiments, the only advantage enjoyed by keyword subjects relative to controls was their superior recall of keyword-mapped fragments of the unfamiliar words. Subjects in both the standard keyword and the keyword + orthographic imagery conditions recalled more first halves, but not second

halves, of pseudowords than did controls. Ceiling effects were observed for recall of first halves by the second test trial by subjects in the standard keyword condition and by the third trial by subjects in the keyword + orthographic imagery condition. In spite of their early mastery of the first halves of the pseudowords, keyword subjects failed to improve their recall of second halves relative to that of controls on later trials.

The possibility that the failure of keyword subjects to recall more pseudowords relative to controls is due to the former's failure to recall keywords was dispelled by measuring keyword recall directly in this experiment. The rates of recall of first halves by keyword subjects coincided with their high proportions of recall of the keywords.

The results of the strategy-use interview added to the interpretation of the recall results. Even controls reported using a keyword-type strategy to study a majority of the items. An item-by-item examination of reported strategy use revealed that subjects in all three conditions reported using mediators for the entire pseudoword for between .32 (keyword + orthographic imagery condition) and .43 (standard keyword condition) of items. Controls reported relying on a nonkeyword strategy for most of the remaining items. Keyword subjects used a keyword for the first half of the pseudoword only for most of their remaining items, and seldom relied on a nonkeyword strategy. The reported strategy use, although not directly confirmable, appear to be related to the recall data. The use of a mediator-based strategy for individual portions of the pseudoword is predictive of the successful recall of those mediator-mapped portions on the fourth trial, and the use of a nonkeyword strategy is predictive of relatively poorer recall.

The highest rates of recall of entire pseudowords was observed for items for which the entire pseudoword was mapped by one or more mediators which were meaningfully associated with the translation. Although a majority of control subjects reported using primarily a keyword strategy, they used this "complete-mapping" keyword strategy for fewer than .60 of items, indicating that skill in generating and associating mediators for an entire unfamiliar word bears improvement. Those controls who relied on a nonkeyword strategy were even less adept at generating and linking mediators. Even keyword subjects, who might be expected to master the

keyword-mapped first half of the pseudoword early enough to transfer the keyword strategy to the remainder of the pseudoword, did not use "complete mapping" for a greater proportion of items than did controls.

These results indicate that both knowledge of the usefulness of applying a mediator-based strategy to the entire unfamiliar word, as well as training in its implementation, might be a means of applying the mnemonic keyword method to a backward recall task. The second experiment was designed to address the problem of acquisition of knowledge and skill in generating and using keyword mediators for the recall of unfamiliar words.

CHAPTER 3

The Effects of Training the Generation and Association of Natural Language Mediators on the Recall of Unfamiliar Words

The second experiment was designed to investigate the effects of a brief training procedure in the generation and association of verbal mediators on the recall of unfamiliar words when cued with their meanings. The purpose of this training was to provide subjects with the skill to employ a keyword strategy in which the entire unfamiliar word was mapped by natural language mediators which were meaningfully associated with the translation. The potential benefits of using such a strategy were suggested by the results of Experiment 1. The probability of recalling a pseudoword, given the use of one or more mediators mapping the entire pseudoword plus the meaningful association of a mediator with the translation (KKL), was greater (.80) than for any other reported strategy including the standard keyword method (KOL), in which only the first half of the pseudoword is mapped by a keyword (.52). Keyword subjects' sole advantage over controls was their superior recall of first halves, which coincided with their more frequent use of a mediator for the first half of the pseudoword. These results suggest that use of a modified version of the keyword method, in which much of the unfamiliar word is mapped by mediators which are meaningfully associated with the translation, might be effective in promoting backward recall. The self-reports of strategy use in Experiment 1 indicated that the frequency of using this type of strategy by both keyword and control subjects might be improved. In order to determine how to encourage the use of a "complete" keyword strategy, several issues pertaining to memory strategy use in general, and to variables related to the imagery-based mnemonic keyword method in particular were examined.

Issues in Encouraging the Use of Mediators to Map Entire Unfamiliar Words

Diagnosis of the Need for Strategy Training

If subjects using the keyword method benefit by generating a mediator for the unmapped portion of the pseudoword, as do free-strategy controls by generating and associating mediators for the entire pseudoword, the question of how best to foster this method of study becomes central to a discussion of the application of the keyword method to backward recall. It is conceivable that simply instructing subjects to generate and associate mediators might be sufficient to promote the execution of these procedures. However, evidence that instruction is necessary, but not sufficient in this regard may be inferred from the results of Experiment 1, as well as from the results of previous studies.

For example, it is interesting to note that even though keyword subjects in Experiment 1 were provided with a keyword whose initial trigram was identical to the first half of the pseudoword, these subjects reported generating a mediator for the second half of the pseudoword no more frequently (.42 for standard keyword subjects), or even less frequently (.31 for keyword + orthographic image subjects) than did controls (.42), who were responsible for generating all mediators used. The failure of keyword subjects to consistently transfer their use of the keyword strategy to the second half of the pseudoword may be due to an inability to easily generate mediators for the second half of the pseudoword and link them to the provided keyword and translation.

An indication that the majority of free-strategy subjects recognized the suitability of a mediator-based strategy to this task was provided by the fact that 75% of controls claimed they had used primarily a keyword-like strategy. Despite this implied metacognitive knowledge on the part of controls, the actual proportion of items reportedly studied with mediators by those who reported natural language mediation as their primary strategy (.58), was not as high as might have been expected, while the reported use of a nonkeyword strategy (.34) was higher than might have been

expected, given that for every pseudoword there existed at least one English concrete noun with an identical initial trigram.

The meaningful association between a mediator and the retrieval cue, in this case the translation, is an integral component of the mnemonic keyword method. Reports by controls that mediators were generated, but not meaningfully associated with the translation for .07 of the item sets, provide further evidence that these subjects might benefit from improved skills in keyword strategy use. It seems likely that these discrepancies between the stated intent and actual frequency of use of a mnemonic keyword strategy are due to inadequate skills in implementing the method in subjects wishing to do so. It also seems probable that the remaining 25% of controls who reported primarily using a non-keyword strategy might benefit both from information regarding the nature, purpose, and effectiveness of the keyword method and from training in its implementation. Thus, it seemed probable that both keyword and control subjects could improve their use of mediators for backward recall. In an effort to identify an effective method of improving subjects' awareness of the usefulness of the keyword method and skills in employing the method, previous studies on the effects of various methods of teaching strategy use were examined.

Training versus Simple Instruction

Most studies have found subjects' memory performance to be better after training than after receiving simple instructions in strategy use, although it is sometimes difficult to differentiate between the two types of presentation. *Webster's New Collegiate Dictionary* (1979) defines "to instruct" as "to give knowledge or information to...to impart knowledge to in a systematic manner" (p. 594), while the same volume defines "to train" as "to form by instruction, discipline, or drill...to teach so as to make fit, qualified, or proficient" (p. 1229). Based on these definitions, it would appear as though all training should include instruction, but not the reverse. For the purpose of this discussion it is assumed that strategy *instruction* refers to the strategy use directions typically imparted to an experimental participant by a researcher with the intention of obtaining the subject's behavioral compliance to a strategy during the

experimental session. *Training* refers to the presentation of instructions as well as metacognitive information such as when, why, and how to perform the strategy, as well as practice (possibly with feedback) in performing the instructed behavior. Training, as operationally defined by various studies which purport to train strategy use, differs in duration and intensity, in the individual components of the training procedure, and in the amount and type of practice and feedback provided to subjects on their performance of the strategy. To further complicate the comparison between instruction and training, terms such as *direct explanation* (e.g. Roehler & Duffy, 1984), *informed instruction* (e.g. Brown, Bransford, Ferrara, & Campione, 1983), and *specific strategy instruction* (e.g. O'Sullivan & Pressley, 1984) are often operationally defined as consisting of several, if not all, of the components of a training procedure. Consequently, in the interests of clarity, instruction without metacognitive information, practice, or feedback will be referred to in this research study as *simple instruction*.

Although it is impossible to directly compare training procedures across research studies, training has generally been found to be superior to simple instruction in facilitating effective use of cognitive strategies. For example, training was shown to be more effective than simple instruction in helping university students recall, but not recognize, word list and prose passage information using the method of loci (Weinstein, Cubberly, Wicker, Underwood, Roney, & Duty, 1981). In addition, training has been proven to facilitate generalization and transfer of strategies (e.g. Heisel & Ritter, 1981; Negin, 1978; O'Sullivan & Pressley, 1984; Pressley, Borkowski, & O'Sullivan, 1984; Pressley, Symons, Snyder, & Cariglia-Bull, 1989; Snowman, 1987), particularly with children (O'Sullivan & Pressley, 1984). In order to train individuals to use any study strategy, however, it is imperative to determine the components of a successful training program.

Components of a Successful Training Procedure. Regardless of the term used to refer to training, there is convergence of opinion regarding the essential components of an effective training procedure. The first requirement of a training procedure is to provide the subject with detailed metacognitive information about a) how the strategy works, b) why it is effective, c) when (with what type of tasks) it is effective, and d) how to implement the strategy (Borkowski, Levers, & Gruenfelder, 1976;

Roehler & Duffy, 1984; Brown et al., 1983). Additional commonly-cited components of training are concrete examples, modelling, and practice (O'Sullivan & Pressley, 1984) plus corrective feedback provided to subjects, preferably on an individual basis and tailored to the individual's level of mastery of the strategy (e.g. Cohen & Aphek, 1981; Elliott-Faust, Pressley, & Dalecki, 1986; Pressley, 1976). Furthermore, it has been proposed that practice begin with simple procedures and become progressively more complex as the subject's skill in performing the strategy increases (cf. Pressley, Symons, Snyder, & Cariglia-Bull, 1989).

The Need to Define the Elements of a Strategy to be Trained

A study which, at first glance, seems to contradict those in which training facilitates performance of strategies, exemplifies a further issue in training strategy use to facilitate memory performance relative to simple instructions, that of the necessity of defining the components of a specific strategy to be taught (Turner, 1983). First and third-year prep high school students received either instructions or training (i.e. instructions plus practice) to perform a four-step strategy for learning French words and translation, and were then compared to each other and to controls on recall of translations when cued with the French words. Subjects were told to a) learn the English words first, b) make interesting connections between them, c) make very different connections for similar-sounding French words that look or sound alike, and d) cover up each side of the list and practice recalling the other member of the pair. After finding that only the instructed group performed better in recalling translations than did controls, post-experimental interviews revealed that instructed subjects had spontaneously dropped the least effective components of the strategy (learning the English words first, and concentrating on making interesting connections), while trained subjects persisted in conscientiously following all steps in the procedure. In so doing, they ran out of time to perform the final, and possibly most important, step of practicing recall of the paired associates. The authors concluded that, if training is to be effective, it is important to determine the essential elements comprising the specific strategy being trained.

Components of a Successful Keyword Strategy Training Procedure

Generation of Mediators. The components of keyword strategy use should reflect the essential processes involved in using the keyword method: the generation of keyword mediators to acoustically and/or orthographically map the entire unfamiliar word, and the meaningful association of those mediators with the translation of the unfamiliar word. These two processes are closely related; the question of how best to generate mediators for a particular unfamiliar word/translation pair will depend on both the physical form and the translation of the unfamiliar word. The sound and/or spelling of the unfamiliar word will help determine which native-language mediator or mediators best map the word, and the translation will determine the ease with which any mediator(s) can be semantically associated with it. The best mediator(s) to map an unfamiliar word may be more difficult to associate with the translation than are mediators which may bear less resemblance to the foreign word (cf. Desrochers & Begg, 1987). For example, Raugh and Atkinson (1975) report pilot work in which subjects, having been presented with series of keywords mapping entire Spanish words⁷ did not benefit from these keywords, "possibly because subjects had too much difficulty in forming an image complex enough to meaningfully relate all of the keywords and the English translation" (p. 15). In a case such as this, the learner may experience a cognitive trade-off, in which more or less cognitive effort must be expended in order to either associate the mediator(s) with the translation, or reintegrate the unfamiliar word from its mediator(s). Subjects must be trained to recognize this potential dilemma and to decide rapidly the area in which they prefer to expend the most cognitive effort. Furthermore, the best acoustic/orthographic match for an unfamiliar word may be not a concrete noun, but rather a series of familiar words (abstract or concrete, nouns or non-nouns) or letters which has meaning for that particular learner.

⁷For example, *pie-saw-hay* for *paisaje* (landscape) and *race-free-auto* for *resfriado* (a cold).

The Meaningful Association Between Mediator(s) and Translation. A second issue to be addressed in training is that of the type of association to be made between mediator(s) and translation. The imaging of mediators alone, without associating mediators and translation, has been found to be ineffective in facilitating recall of translations of foreign words (Lado, Baldwin, & Lobo, 1967). This is because item-specific information which aids the retrieval of a mediator cannot facilitate recall of the translation or of unfamiliar word without the relational information contained in the meaningful association of mediator(s) and translation. Therefore, it is imperative that mediators and translations be joined by a meaningful association of some type. There is evidence from several areas of research, including the strategy interviews of Experiment 1, that indicates that an insistence of the use of imagery for associating mediators may unnecessarily limit the applicability of the keyword method to the task of backward recall.

In order to extend keyword mapping to as much of the unfamiliar word as possible and at the same time facilitate the linking of mediator(s) and translations, subjects should be flexible in their choice of mediators, rather than restrict themselves to the use of imageable (usually concrete) nouns. It may be more important to find a non-imageable mediator than to leave part of the unfamiliar word unmapped due to the unavailability of an imageable noun mediator. One strategy related by several subjects in Experiment 1 can be used to illustrate this point. For the pseudoword *ELEWOS* (keyword, *ELEphant*; translation, *toast*), several keyword subjects reported that they had imaged an elephant eating toast and had covertly repeated a sentence such as "The *ELEphant WOS (was)* eating toast" in order to study this item. The image alone would probably not have been sufficient to retrieve the second mediator, *was* for *WOS*. With reference to the examples cited by Raugh and Atkinson, educated learners might choose mediators which are easily associable with the translation, and link them more meaningfully than as a complex interactive image containing each mediator and the translation. For example, "*I saw hay* on the landscape" as a sentence could be combined with a mental image of oneself looking over a hay-filled rural scene to associate *paisaje* with landscape. While the mapping of the pseudoword is not as close as that of *pie-saw-hay*, nor are all of the mediators concrete nouns, the elements of the sentence are more semantically-related to each

other and to the translation than is the series of nouns *pie*, *saw*, and *hay*. Any cognitive effort which would otherwise have been exerted to associate four unrelated nouns could be expended instead to notice the ways in which the mediators differ from the spelling of the Spanish word to facilitate recall of the word from the mediators. A further advantage of the meaningful sentence or phrase is that the mediators can be serially ordered according to their relative position in mapping the Spanish word so as to avoid having to recall the order of several mediators within a complex interactive image. Therefore, the use of meaningful sentences, or even phrases, may facilitate the serial ordering and linking of mediators from various words classes.

These examples introduce another issue concerning how best to associate mediators with each other and with the translation, that is, the relative merits of using imaginal or verbal associations. Several studies have investigated the efficacy of interactive sentences versus interactive images in associating a mediator with a translation. Some researchers maintain that interactive images are more effective than are linking sentences in facilitating recall of translations (Atkinson, 1975; Kasper & Glass, 1982); others have found sentences to be effective means of association, particularly when words to be linked are not concrete nouns (Bower & Wizenz, 1970; Cohen, 1987). The advantage of sentences is that they may be more versatile and operate under fewer constraints with regard to the types of words that can be associated (Pressley, Levin, & McCormick, 1980). Indeed, an over-reliance on interactive imagery could be detrimental to recall. Richardson (1978) found that reported use of imaginal strategies was predictive of successful recall of concrete, but not abstract material. Furthermore, results of another study indicated that subjects tended to use imagery to study both concrete and abstract nouns, even though the imagery strategy was only effective for concrete nouns, and may have reduced recall of abstract items (Richardson, 1985).

Given the range of mediators reported by the subjects in Experiment 1, it appears that individuals have an ability to meaningfully associate two or more mediators by means of interactive images, interactive sentences, simple word association (when one word elicits another due to their semantic and/or acoustic similarities), or combinations of all of these techniques. For example, for *AVAZEP*

(keyword, *AVAlanche*; translation, *garden*), some control subjects reported using the sentence "*HAVE A SIP* of tea in the *garden*" as their association of self-generated mediators, with or without a corresponding image to reinforce the sentence. Some keyword subjects reported using an image of an *AVALANCHE* flowing over a *garden*, with the added verbal information that an avalanche goes fast (i.e., *ZIPS* by) the garden. The word "zips" is used as a verb, and not a very distinctive one at that. Many more common words exist in English to depict the idea of moving quickly, so it is interesting that these subjects felt secure in their ability to retrieve this word as a consequence of retrieving their interactive image. Other subjects reported studying the word *SKUBEW* (keyword, *skunk*; translation, *apple*) by imagining a skunk interacting with an apple. The memory of the skunk then cued the retrieval of a salient attribute of skunks (the unpleasant smell) to which people often say "PEW", a colloquial expression. An even simpler association which some subjects found to be intrinsic in a mediator involved using the word *EMPIRE* to map the word *EMBTUR* (translation, *queen*). The relation of both empire and queen to the concept of royalty was noted by many subjects, regardless of whether they had been provided with the keyword, *EMBroidery*.

In addition to being more versatile in the accommodation of a variety of word types, verbal associations may also prove useful to individuals who experience difficulty generating interactive images (Cohen, 1987; Katz, 1987). Paivio and Harshman (1983) found that approximately 10% to 15% of subjects who responded to a questionnaire on their imaging behavior reported that they did not use images in circumstances in which the majority of people would tend to do so (e.g. reminiscing). These individuals may find themselves at a disadvantage when instructed to associate words by means of interactive imagery. For example, Ernest and Paivio (1971) found that individuals classified as high imagers were able to generate images to words faster than were low imagers. It would follow that low imagers would need proportionately more time than would high imagers to generate an interactive image containing two or more referents, and once formed, this image might be indistinct and/or difficult to retrieve. Low imagers might be unable to carry out imagery instructions within the permitted study interval in laboratory experiments involving imagery-based memory strategies, and in the classroom, they might become discouraged from using an

imagery-based mnemonic technique as a regular method of study. Low imagers benefit from a modified version of such a technique which relied on verbal, rather than imaginal, processes.

Based on the foregoing evidence that interactive imagery association may not be unequivocally superior to verbal association, the decision was taken to train subjects to use imagery and/or verbal association to link mediators together and with translations, rather than to use imagery exclusively.

Empirical Questions Addressed in Experiment 2

The second experiment was designed to answer three empirical questions:

1) Does training the generation and association of natural language mediators facilitate recall of unfamiliar words when cued with their English meanings?

2) Does providing a keyword to subjects trained to generate their own mediators affect the recall of unfamiliar words relative to that of untrained subjects, and if so, in what way?

3) Do individual differences in the ability to identify mediators in unfamiliar words affect performance on backward recall, and if so, do these differences interact with mnemonic instructions and training?

In order to study these questions, the present experiment was designed to examine the effects of training (trained or not trained), method (either keyword or control), and trial (3 study-test trials) on recall of pseudowords, letters, and pseudoword halves when cued with their English translations. Half of the participants were trained to generate and associate natural language mediators, and the other half were not trained. Within each group, half of the participants were provided with a keyword mapping the first three letters of each pseudoword, and the remaining participants did not receive keywords.

Effects of Training. In order to examine the effects of training on the recall of unfamiliar words, trained and untrained subjects were compared on recall of pseudowords, as well as on the less rigorous criteria of proportion of correct letters and of first and second halves of pseudowords, as in Experiment 1. It was hypothesized that recall of these items might be enhanced by even a relatively brief, individually-administered training session. Trained subjects were expected to recall a higher proportion of these items than were untrained subjects, and/or to make faster gains in recall scores from one trial to the next.

The backward recall performance of subjects provided with a keyword for the first part of the pseudoword, and who were either trained or not trained, were also compared. Recall of first halves was not expected to be greater for trained than for untrained keyword subjects, since provision of a keyword for the first half of the pseudoword should make skill in generating a keyword superfluous. However, trained keyword subjects were expected to demonstrate recall of second halves of pseudowords superior to that of untrained keyword subjects, because trained subjects were expected to be more adept at generating mediators for the second halves of the pseudowords. The superior recall by trained keyword subjects of second halves would also result in a smaller difference between recall of first and second halves by trained than by untrained keyword subjects.

Effects of Providing Keywords to Trained Subjects. The experiment was also designed to examine the effect of providing a keyword for a portion of the unfamiliar word, as is often the case in the standard keyword method, to those who have been trained to generate their own verbal mediators. The recall of pseudowords, correct letters, and halves of pseudowords were compared between the two groups who were trained to generate their own mediators, one of whom was provided with keywords which exactly mapped the first half of the pseudoword (trained keyword condition), and one of whom did not (trained control condition). The nature of the relationship between training and provision of a keyword and recall of unfamiliar words could not be anticipated, as a variety of scenarios were possible. The recall performance of trained subjects might be assisted, hindered, or unaffected by the provision of a first-half keyword.

Trained keyword subjects might be helped, in that having access to a provided mediator might allow subjects to concentrate on searching the remainder of the pseudoword for a second mediator to map the second half of the pseudoword, giving keyword-provided subjects a head start in recalling the entire pseudoword.

Conversely, trained controls, who must rely exclusively on self-generated keywords, might perform better than keyword-provided subjects for two reasons. First, the task of generating mediators might require subjects to process the unfamiliar word more thoroughly than might employing a provided keyword. There is some evidence that self-generated keywords may be more effective in facilitating recall of unfamiliar words, particularly when keywords are not orthographically identical to the mapped segment of the unfamiliar word (Pressley, Levin, Nakamura, Hope, Bispo, & Toye, 1980, experiment 5). If generating keywords necessitates attending to and processing the unfamiliar word more thoroughly than does using provided mediators, then the unfamiliar words may be more memorable under a self-generation condition than under a keyword-provided condition.

A second possible advantage of generating one's own mediators is that the keyword method requires that the keyword be meaningfully linked with the translation of the unfamiliar word. If more than one mediator is used in order to encode the entire word, the task of linking these mediators, both to each other and to the translation, becomes a more complex task than linking only one mediator with the translation. If the participant generates his or her own mediators, as suggested by the orthographic or acoustic properties of the unfamiliar word, as well as by the semantic properties of the translation, the task of associating the mediators and translation may be easier than if the mediator or mediators are chosen arbitrarily by their orthographic similarity to the unfamiliar word and by their imageability. Self-generated keywords may have an intrinsic relationship to each other and to the translation for an individual, and may therefore be more meaningful and memorable to the individual than are externally-provided mediators. Evidence that generating one's own mediator(s) may be advantageous comes from the reported strategy use data of the previous experiment. Subjects in both keyword groups reported adding a second keyword to the provided one for .15 of the first halves. Because recalling the provided keyword was required of keyword subjects, they tended to use *both* the

provided and their own keyword, however it is impossible to determine what effect, if any, having to associate both mediators with the translation may have had on recall of the pseudoword.

And finally, the preceding factors might interact, effectively counteracting the advantages of either having a provided keyword or generating all of one's own mediators. Given the range of possible relationships between training and keyword-provision, there is no compelling argument which may be invoked to predict an advantage in recall of pseudowords, letters, and/or halves by trained subjects employing experimenter-provided keywords or those employing self-generated keywords.

Effects of Individual Differences in Language Aptitude. The third issue addressed in this study was whether individual differences in the ability to generate verbal mediators might affect recall when keywords are either provided or self-generated, for trained versus untrained individuals. Since no standardized measurement of individual differences in this ability is commonly used, the researcher used Part III, Spelling Clues, of the *Modern Language Aptitude Test* (MLAT) (Carroll & Sapon, 1959). This section of the MLAT consists of fifty items, each of which contains a word spelled phonetically. The subject's task is to decipher the word, and then choose a synonym for it from among five alternatives.⁸ This section of the MLAT has been found to provide an effective assessment of language aptitude (Dinklage, 1971), particularly with regard to a person's sound-symbol association ability and knowledge of English vocabulary (Gliksman, Gardner, & Smythe, 1979). *Aptitude* refers to the person's present status in terms of capabilities which are predictive of reasonably rapid success in learning a foreign language. Because the generation of natural-language mediators involves the ability to find a native-language word that bears an acoustic and/or orthographic similarity to the foreign word, this subtest was

⁸An example of an item on Part III is "mblm". The choices provided are: A. blame, B. ambulance, C. blemish, D. symbol, E. flower. The correct answer is D, symbol, which is a synonym for "emblem".

employed as an estimate of subjects' pre-experimental aptitude for this task.⁹ Reported use of mediators has been found to be predictive of recall performance in the previous experiment as well as in other studies, therefore superior recall performance could be interpreted as evidence of successful mediator-based strategy use. The relationship between each subject's MLAT score and recall of pseudowords, letters, and both halves of pseudowords was examined.

It was predicted that the ability measured by the MLAT would be positively correlated to the successful use of a mediator-based learning strategy, reflected in generally higher recall scores for those scoring higher on the MLAT.

The possible interaction between training and MLAT correlations with recall performance was more difficult to anticipate. At least one keyword study (Pressley & Ahmad, 1986) found that teaching the keyword method did not improve recall of individuals who were already using the strategy spontaneously. It is possible that there is a higher rate of spontaneous keyword method use among subjects who have an aptitude for finding mediators than among those who do not possess this facility, and if so, then training a strategy that is already exploited might not have any effect. If individuals who obtain higher scores on the MLAT benefit less from training than do lower-scoring individuals then correlations between MLAT and recall scores should be greater in the untrained than in the trained conditions for low-aptitude individuals, while these correlations should be relatively equivalent for those with higher aptitude scores. Overall, this pattern should result in lower correlations in trained than in untrained conditions. Conversely, it is possible that only subjects who already possess the aptitude to decipher an unfamiliar word phonetically and relate it to a familiar word would benefit from training, as training might simply enhance this natural ability. In this event, equally high, or even higher correlations would be expected between

⁹This subtest alone was chosen as a measure of language aptitude, as the entire test requires at least 30 minutes (short version) to 70 minutes (long version) to administer. This duration of mental activity, added to the demands of the experimental task, might lead to fatigue in participants toward the end of the experimental session and depress recall scores. A second subtest, Part V, Paired Associates, was another plausible candidate for inclusion in an assessment of the ability to quickly learn foreign words and their meanings, but this subtest is in effect a test of forward recall in which the participant must choose the translation from several distracters when cued with the foreign word. This subtest was rejected on the grounds that its administration might predispose subjects to study primarily for forward as opposed to backward recall.

MLAT and recall scores for trained as compared with untrained groups. And finally, if training were equally effective (or even equally ineffective) for the majority of subjects, regardless of natural aptitude, then the correlations between MLAT scores and recall performance should be similar in the trained and untrained groups.

Finally, it was predicted that, for keyword subjects, correlations between MLAT scores and recall of first halves would be equivalent, since the provision of a keyword would preclude the need to generate one's own mediator; while the correlations between MLAT scores and second halves would differ. If training benefits low-aptitude individuals more than those with high-aptitude, then smaller correlations should be expected for second halves in the trained group. If, on the other hand, training merely enhances aptitude, the reverse relationship should be expected, that is, higher correlations between MLAT scores and second-half recall scores for trained keyword subjects relative to untrained keyword subjects.

Method of Experiment 2

Subjects

Eighty English-speaking undergraduate university students (19 men and 61 women) ranging in age from 18 to 42 years of age (mean = 20.1 years) participated voluntarily in the experiment. Seventy-two participants reported their mother tongue as English, 3 as French, 3 as German, and 1 each as Czechoslovakian and Portuguese. All subjects were proficient in English. None had previously participated in a similar experiment. Subjects received \$5.00 for their participation.

Materials and equipment

The learning materials consisted of the same set of 30 pseudoword-translation-keyword triads used in Experiment 1. Six of these pseudowords were selected for use in the training/pre-exposure phase of the experiment and the remaining 24 made up the experimental list. The list of experimental stimuli is found in Appendix B. The experimental list was presented in the same format and with the same equipment as that described in the first experiment. Three response sheets, each containing the 24 translations arranged in a different random order, were used for the three recall tests. These response sheets were similar to those used in the first experiment with the exception that all subjects, including keyword subjects, were asked to recall only the pseudoword.

Experimental materials not previously used in the first experiment consisted of a copy of the MLAT subtest entitled "PART III. SPELLING CUES" from the Modern Languages Aptitude Test Manual (Carroll & Sapon, 1959), a computer answer sheet, and the standard audio tape of instructions for the MLAT. During the training/pre-exposure phase, the experimenter used a single lined sheet containing the list of practice items. This sheet was used to note any mediators generated by subjects in order to provide them with feedback on their progress.

Procedure

Subjects were randomly assigned to one of four experimental conditions in order of their appearance in the laboratory and were tested in a quiet room. At the beginning of the session, all subjects were administered the MLAT spelling cues subtest, using the taped instructions and timed response period of five minutes. A transcript of the taped MLAT subtest instructions is provided in Appendix A. Subjects marked their answers on a computer answer sheet. The experiment then consisted of either a training or pre-exposure phase (to be described below), followed by three study-test trials. Half of the subjects experienced the training procedure and the other half the pre-exposure procedure. After training or pre-exposure, subjects

were told what to expect during the experiment and were presented with their instructions (also to be described below). Subjects were then presented with the 24-item list, at a rate of 10 sec. per item set, three times. Each presentation was followed by a 5-minute recall period.

Training or pre-exposure phase. The training procedure was designed to provide information, practice (beginning with simple and proceeding to more complex items), and verbal feedback on performance. The training procedure consisted of three distinct phases. During the first phase of the training session the experimenter and the subject sat facing the microcomputer while the experimenter explained how the use of natural language mediators can be used to help recall unfamiliar words and their meanings through the use of interactive imagery, a sentence or phrase, or a combination of both imaginal and verbal association. The experimenter then described a variety of methods of generating verbal mediators (keywords) in response to unfamiliar words such as finding native-language words which sound or are spelled like some portion of the foreign word, or using letter strings to suggest a series of related words. This introductory information provided to subjects is found in Appendix A, as are the instructions for the training and pre-exposure portions of the session.

Subjects then practiced at their own pace using the twelve first and second trigrams of the six pseudowords which had been chosen to serve as practice items. Feedback on subjects' performance was provided throughout the training procedure. In this first phase, a trigram was displayed on the screen for 10 sec., then the screen went blank until signaled by a touch of a key on the computer keyboard. Subjects were encouraged to generate as many mediators as possible in order to promote ease and flexibility in mediator-generation, and were given feedback on the mediators generated. Positive feedback was provided when mediators were orthographically similar to the practice trigram. When a subject generated a mediator which was acoustically similar, but not orthographically similar to its corresponding trigram, positive feedback was also provided, with the reminder that, if using such a mediator, one must remember to notice the differences in spelling between the keyword and the mapped trigram. If a mediator was generated which was judged by the tester to be

abstract (e.g. "caring") rather than concrete, the subject was advised that perhaps a different form of the word could be found (e.g. "caretaker"), or a different word (e.g. "car") could be found, which would be easier to associate and hence recall. If a subject displayed a marked difficulty in generating a mediator, a possible mediator was suggested after the subject had given up trying to find one of his or her own.

During the second phase, the recently-displayed trigrams were combined and displayed as six 6-letter pseudowords. Subjects were reminded that it is possible to use a single mediator which maps the entire word, or a series of mediators, each of which maps a portion of the word. For each item, subjects were asked to either generate a new mediator which would map both halves of the pseudoword (e.g. "curvy" for "curphy"), to associate the two keywords generated previously to the two trigrams (e.g. "curtain" and "physician"), or to even to generate new mediators for one or both halves of the pseudoword, depending on which alternative the subject thought was best-suited to mapping the particular item. Subjects were cautioned to keep mediators in the correct order, if using more than one mediator per pseudoword.

The third phase consisted of again displaying the six pseudowords, this time with two hypothetical translations. First one translation was shown with the pseudoword and subjects were prompted to generate a keyword or to use previously-generated keywords, and to explain how they might associate the keyword(s) and translation. The subjects then generated and associated mediators in response to a second translation displayed with the same pseudoword. The idea was proposed that one mediator may be more appropriate to one translation than to another, due to differences in ease of association. The costs and benefits of generating mediators which are either easier to associate or closer in spelling to the foreign word were also examined during this phase of training.

Untrained subjects also viewed the training stimuli, but did so with the explanation that, because they would be learning pseudowords, this pre-exposure phase would help them to become accustomed both to the type of words they would later be asked to recall and to the pace of their presentation. The twelve trigrams, the six pseudowords, and the pseudowords with their two alternate translations were then presented, one at a time, for 10 sec. each.

Learning phase. Once they had undergone either the training or the pre-exposure procedure, half of the trained and half of the untrained subjects were then randomly assigned to either a keyword or no-keyword (control) group, resulting in four experimental conditions which differed in whether or not they were shown keywords with the pseudoword-translation pair, and in the instructions they were given on how to study the stimulus items. Subjects in the two control groups were not provided with keywords. Subjects in the Untrained control condition were asked to study the items however they wished. This group was essentially identical to the Control group in Experiment 1. Subjects in the Trained control group were encouraged to generate and use their own mediators by associating them with the translation referent either through interactive imagery, verbal associations, or both and to pay attention to the way in which the foreign word might differ in spelling from the mediator(s). Keyword subjects were provided with a keyword for the first half of each pseudoword as in the first experiment. Untrained keyword subjects were told how to use the keyword method to associate this keyword with the translation referent through the use of interactive imagery or verbal associations, or a combination of both. They were cautioned that, although the provided keyword would help them to recall the first half of the foreign word, they would have to try hard to recall the second half of the word. This group was essentially identical to the Standard keyword group in the first experiment. Finally, Trained keyword group subjects were asked to use the keyword provided and to also try to generate one or more mediators for the remainder of the foreign word, and to associate both with the translation, either by the use of interactive imagery, verbal associations, or both. Subjects in this group were also asked to pay attention to the differences in spelling between the foreign word and its mediators. Subjects were then encouraged to ask for clarification if needed, clarification was given, and after the subject indicated readiness to proceed, the study-test trials were initiated. As in the first experiment, all subjects were encouraged to write down any letters that they remembered, even if uncertain, but to leave blank any letters that they did not recall. The instructions provided to subjects are found in Appendix A.

The study-test trials were essentially identical to those in Experiment 1, with the following exceptions: (a) the stimulus list consisted of only 24 pseudowords, the other 6 pseudowords having been used as training items, (b) only 3, rather than 4 study-test trials were presented, and (c) keyword subjects were not asked to report the provided keywords on the response sheets.

As in the first experiment, a post-experimental interview was conducted in order to examine subjects' retrospective reports of the methods used to memorize each pseudoword and associate it with its translation, and with its keyword when applicable.

The interview format was the same as that for the first experiment, and the exact questions asked are reported in Appendix A. Interview questions varied somewhat depending the experimental condition. Untrained control subjects were asked the same interview questions as were free-strategy controls in the previous experiment, while trained controls were asked only whether there was anything about the foreign word which helped them to remember it, and how did they try to link the foreign word with its translation. Untrained keyword subjects were asked if they had formed an interactive image with the translation and keyword, and were also asked how they had studied the second half of the foreign word. Trained keyword subjects were asked whether they had formed an interactive image using the keyword provided, the translation, and any other mediators that they might have generated. If they had not generated a mediator for the second half of the word, they were asked to describe the study method they had employed. After the interview, all subjects were informed of the purpose of the experiment and eventually received a written summary of the results of the two experiments.

Results and Discussion

As in Experiment 1, the proportions of correctly recalled items were used in all of the analyses reported in this section. The effects of having a keyword provided during the presentation of the pseudoword-translation pairs (keyword and control), and of training (trained and untrained) on recall of pseudowords, of total letters in correct position, and of total first compared to total second halves of the pseudowords were examined in separate analyses. The ANOVAs performed on the recall of the pseudowords, letters, and halves of pseudowords involved two between-subjects variables, keyword (2 levels) and training (2 levels), and one within-subjects variable, trials (3 levels). Degrees of freedom involving the within-subjects factors were adjusted and reported as in Experiment 1, according to the Greenhouse-Geisser algorithm as implemented in the P4V program of the BMDP statistical software (Dixon, 1983). Tests of simple effects were also analyzed by means of the P4V program.¹⁰ Summaries of ANOVAs and tests of simple effects are found in Appendix E.

The distribution of MLAT scores were analyzed to determine if groups differed with regard to this variable, and tests of homogeneity of slopes were conducted to compare the slope of regression lines of MLAT and each of the dependent measures between selected pairs of conditions.

The post-experimental interview data was assessed in a series of procedures similar to those carried out in Experiment 1.

¹⁰As in the previous experiment, required post hoc analyses involving differences between trials were subjected to *t* tests using the P3D program of the BMDP statistical software. All comparisons were highly significant ($p < .0001$), and are not reported in the text, but are reported in Appendix E.

Between-Groups Differences in Language Aptitude

An analysis of variance revealed no differences between groups on the basis of MLAT scores, either for method (control or keyword), $F(1,76) < 1$, or for training (untrained or trained), $F(1,76) = 1.40$, $p < 0.241$. Nor was there a Method x Training interaction for MLAT scores, $F(1,76) < 1$, $MSe = 57.31$ for all tests. As no between-groups differences were observed on this measure, no further steps were taken to control for MLAT score when analyzing recall performance. The descriptive data demonstrates that large variations between subjects were present on language aptitude as measured by this MLAT subtest.¹¹ The means, standard deviations, and ranges of MLAT scores for subjects in each condition is reported in Table 3.1.

Table 3.1 MLAT scores of subjects in four experimental conditions in Experiment 2.

Condition	Mean	SD	Range	
			Maximum	Minimum
Control				
Untrained	16.80	6.12	30.00	6.00
Trained	18.75	6.95	38.00	7.00
Keyword				
Untrained	16.85	6.24	27.00	5.00
Trained	18.90	10.22	45.00	6.00

¹¹The highest possible score on this subtest is 50, however the means and standard deviations for university students are not available for individual subtests, therefore no conclusions as to the performance of these individuals relative to that of the 1300 university students on which the MLAT was standardized can be drawn.

Recall of Pseudowords and Total Correct Letters

The mean recall proportions of pseudowords and of total correct letters by individual condition are reported in Table 3.2.

Table 3.2 Mean proportions of pseudowords and of letters recalled in Experiment 2.

Condition	Pseudowords				Letters			
	1	2	3	Mean	1	2	3	Mean
Control								
Untrained	.05	.22	.41	<u>.23</u>	.16	.40	.60	<u>.39</u>
S.D.	.07	.18	.26	.23	.11	.21	.23	.26
Trained	.06	.29	.55	<u>.30</u>	.23	.53	.74	<u>.50</u>
S.D.	.08	.23	.29	.29	.15	.19	.20	.27
Keyword								
Untrained	.02	.19	.39	<u>.20</u>	.26	.51	.68	<u>.48</u>
S.D.	.03	.21	.32	.27	.16	.20	.21	.26
Trained	.09	.35	.61	<u>.35</u>	.22	.52	.77	<u>.50</u>
S.D.	.08	.20	.23	.28	.10	.21	.16	.27
Overall Mean								
Overall Mean	.05	.26	.49	<u>.27</u>	.22	.49	.70	<u>.47</u>
S.D.	.07	.21	.29	.27	.13	.21	.21	.27

The analysis of the proportion of correctly-recalled pseudowords yielded main effects for both trials, $F(1,97)=221.62$, $MSe=.017$, $p<.001$ and training, $F(1,76)=8.74$, $MSe=.087$, $p<.01$, as well as a Trials X Training interaction, $F(1,97)=6.12$, $MSe=.017$, $p<.01$. As predicted, trained subjects recalled more pseudowords overall than did untrained subjects (.33 vs. .22 respectively). The differences between recall of pseudowords by trained and untrained subjects attained significance at each trial,

$F(1,76) > 6.09$, $p < .016$, as trained subjects consistently recalled more pseudowords than did untrained subjects. However, the significance of training at the first trial may be an artifact of the small error term resulting from floor effects for recall on this trial (see Figure 3.1).

The analysis of the proportion of correctly recalled letters provided a main effect of trials, $F(2,128) = 764.62$, $MSe = .0059$, $p < .001$, as well as a Trials X Training interaction, $F(2,128) = 7.46$, $MSe = .0059$, $p < .01$. Trained subjects recalled significantly more letters than did untrained subjects only on the third trial, $F(1,76) = 6.12$, $p < .016$ (see Figure 3.2).

The effect of training on recall of pseudowords at each trial, compared with the effect of training on recall of letters only by Trial 3 indicates that while trained subjects may enjoy less advantage over untrained subjects on recall of letters than on entire pseudowords, training does facilitate recall of pseudowords as entire units. These results of pseudoword and letter recall support the contention that a brief training session facilitates recall of unfamiliar words, whether or not a keyword is provided. The relative benefits of providing keywords to trained and to untrained subjects will be examined further with regard to recall of pseudoword halves.

Recall of First and Second Halves of Pseudowords

The preliminary analysis of the effects of training, method, and trials on recall of first and second halves of pseudowords resulted in seven significant effects: (a) a main effect of trials, $F(2,115) = 587.31$, $MSe = .015$, $p < .001$, (b) a main effect of halves, $F(1,76) = 354.29$, $MSe = .015$, $p < .001$, (c) a Trials x Halves interaction, $F(1,106) = 3.91$, $MSe = .013$, $p < .05$, (d) a Trials x Training interaction, $F(2,115) = 11.57$, $MSe = .015$, $p < .001$, (e) a Half x Method interaction, $F(1,76) = 144.02$, $MSe = .015$, $p < .001$, (f) a Half by Training interaction, $F(1,76) = 31.85$, $MSe = .015$, $p < .001$, and (g) a Half x Method x Training interaction, $F(1,76) = 70.10$, $MSe = .015$, $p < .001$. The proportion of first halves and of second halves recalled by subjects in each condition is reported in Table 3.3.

RECALL OF WHOLE PSEUDOWORDS

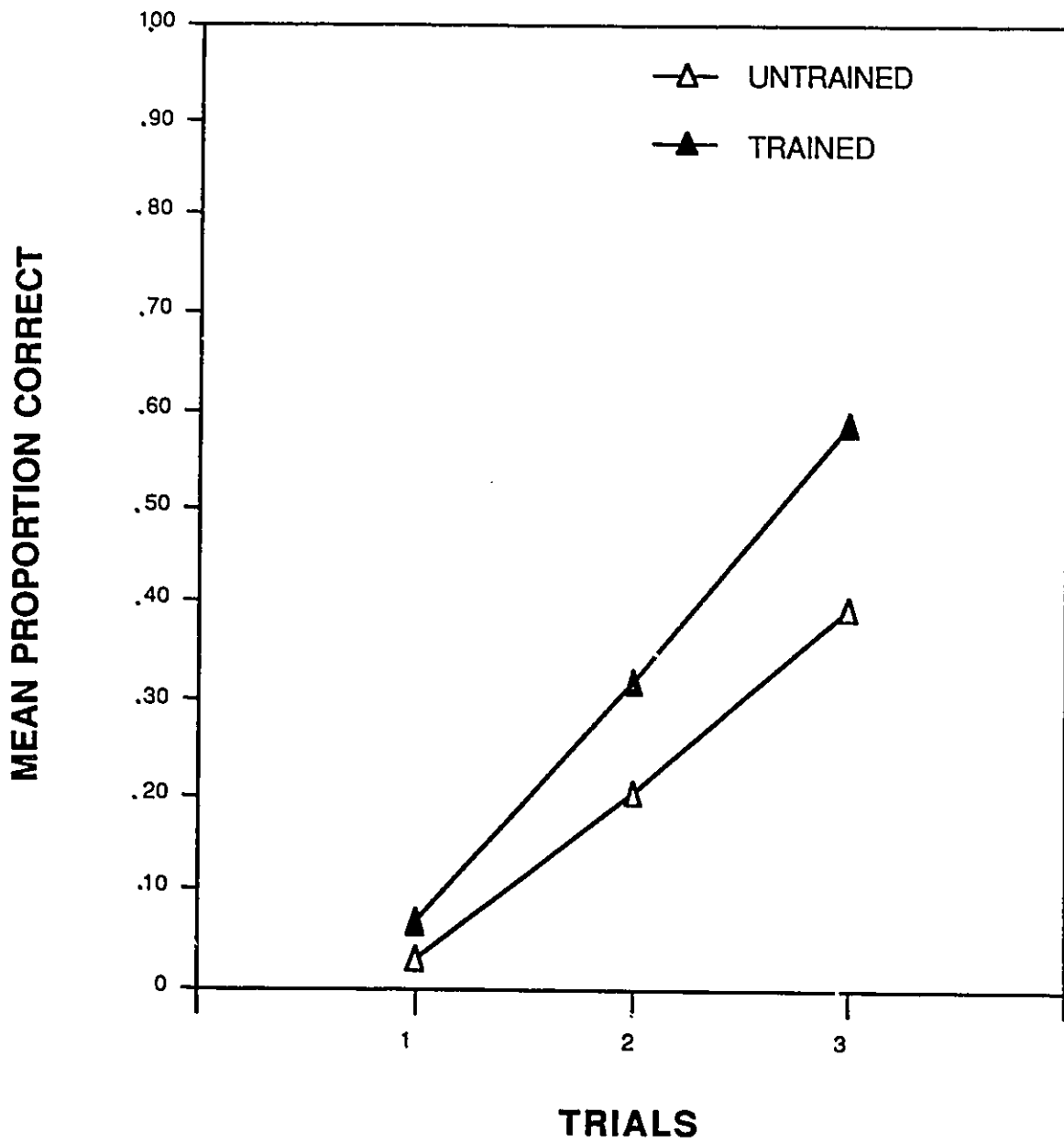


Figure 3.1 Proportion of pseudowords recalled by trial in Experiment 2

RECALL OF LETTERS OF PSEUDOWORDS

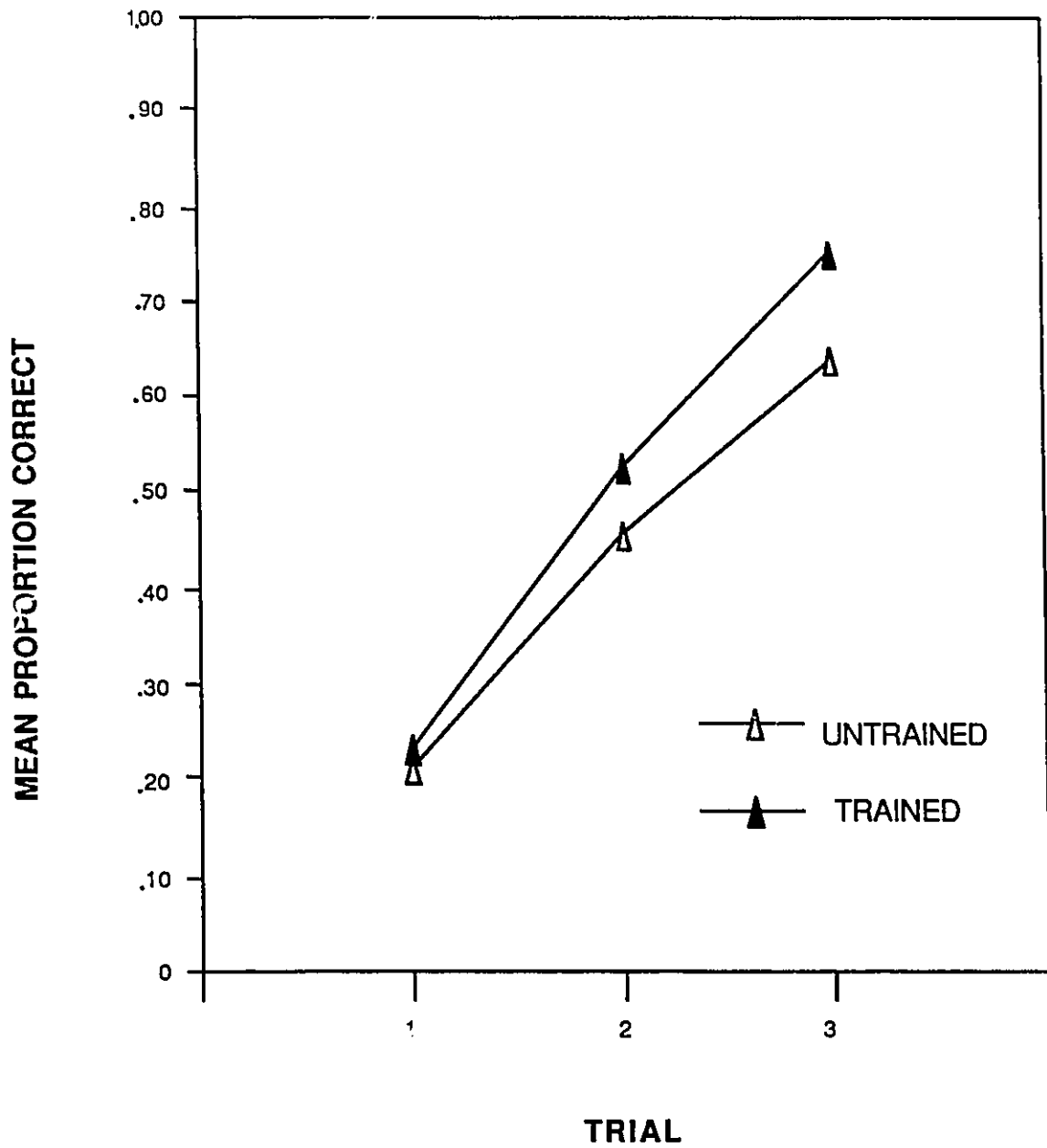


Figure 3.2 Effect of training on recall of letters in Experiment 2

Table 3.3 Mean proportions of first and second halves of pseudowords recalled in Experiment 2.

Condition	First Halves				Second Halves			
	T1	T2	T3	Mean	T1	T2	T3	Mean
CONTROL								
Untrained	.12	.34	.52	<u>.33</u>	.07	.28	.49	<u>.28</u>
S.D.	.10	.21	.25	.25	.09	.20	.27	.26
Trained	.17	.50	.71	<u>.46</u>	.10	.35	.60	<u>.35</u>
S.D.	.15	.20	.22	.29	.10	.23	.26	.29
KEYWORD								
Untrained	.47	.76	.88	<u>.70</u>	.02	.19	.40	<u>.20</u>
S.D.	.30	.25	.17	.28	.03	.21	.33	.27
Trained	.27	.62	.82	<u>.57</u>	.12	.38	.64	<u>.38</u>
S.D.	.16	.20	.14	.28	.08	.20	.22	.28
Overall Mean	.26	.55	.73	<u>.52</u>	.08	.30	.53	<u>.30</u>
S.D.	.26	.26	.24	.31	.09	.22	.28	.28

Analyses of the Trials x Training interaction indicated that the difference between recall of halves by trained and untrained groups was significant on Trial 3 only, $F(1,76)=5.78$, $MSE=.098$, $p<.019$, a result which paralleled the effect of training on recall of letters (see Figure 3.3).

The Halves x Method interaction, as well as the Halves x Training interaction were examined within the context of the analysis of the three-way Halves x Method x Training interaction (see Figure 3.4).

This interaction was examined by means of a series of tests of simple interaction effects and simple simple effects. The most striking feature of this interaction is the similarity in the pattern of recall of first and second halves among three of the groups (untrained and trained controls and trained keyword) relative to the fourth (untrained keyword group). The first three groups recalled somewhat more first than second halves, and the ordering of these groups along the recall axis is the same for first and

RECALL OF HALVES OF PSEUDOWORDS

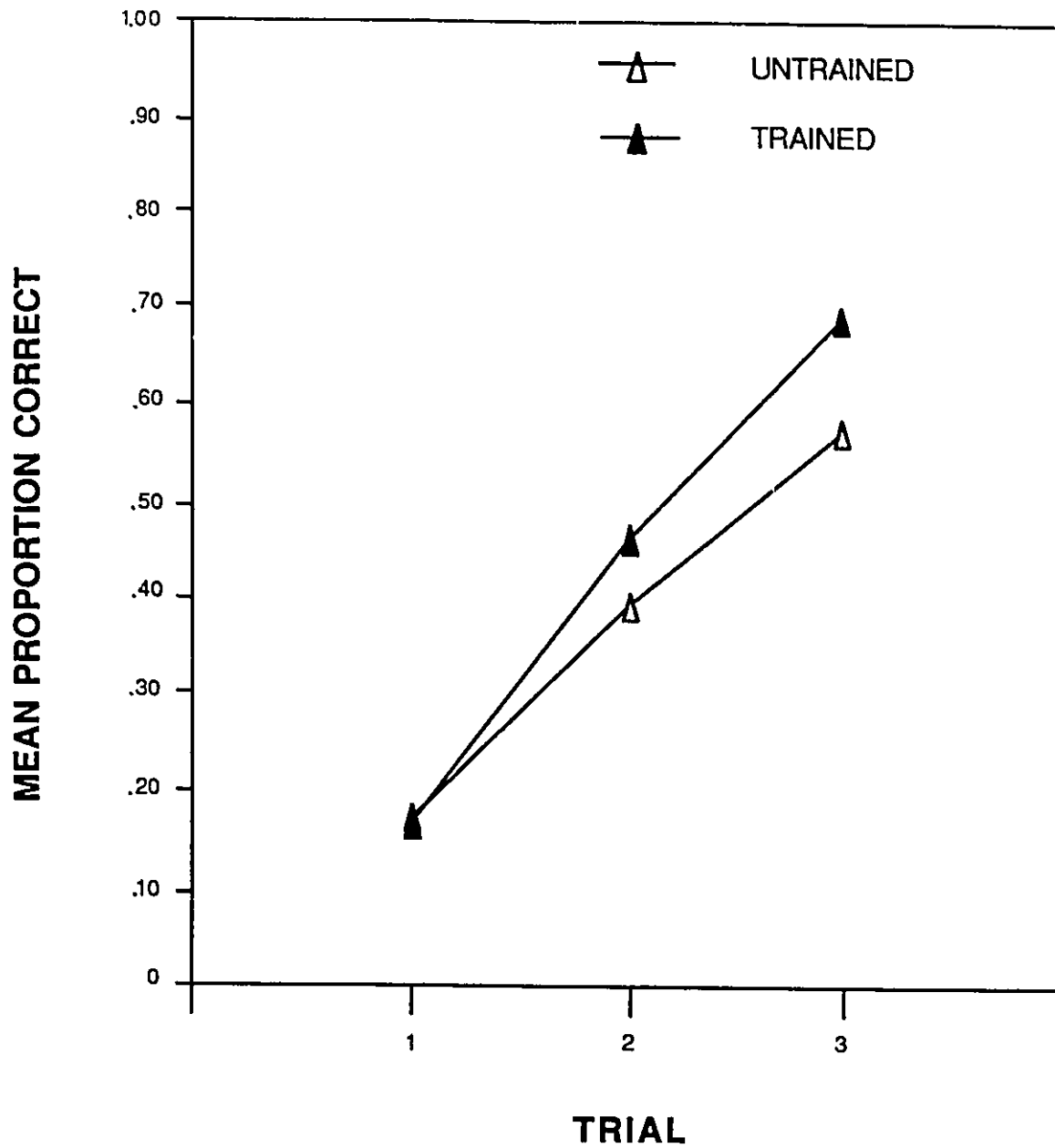


Figure 3.3 Effect of training on recall of pseudoword halves in Experiment 2

RECALL OF HALVES OF PSEUDOWORDS

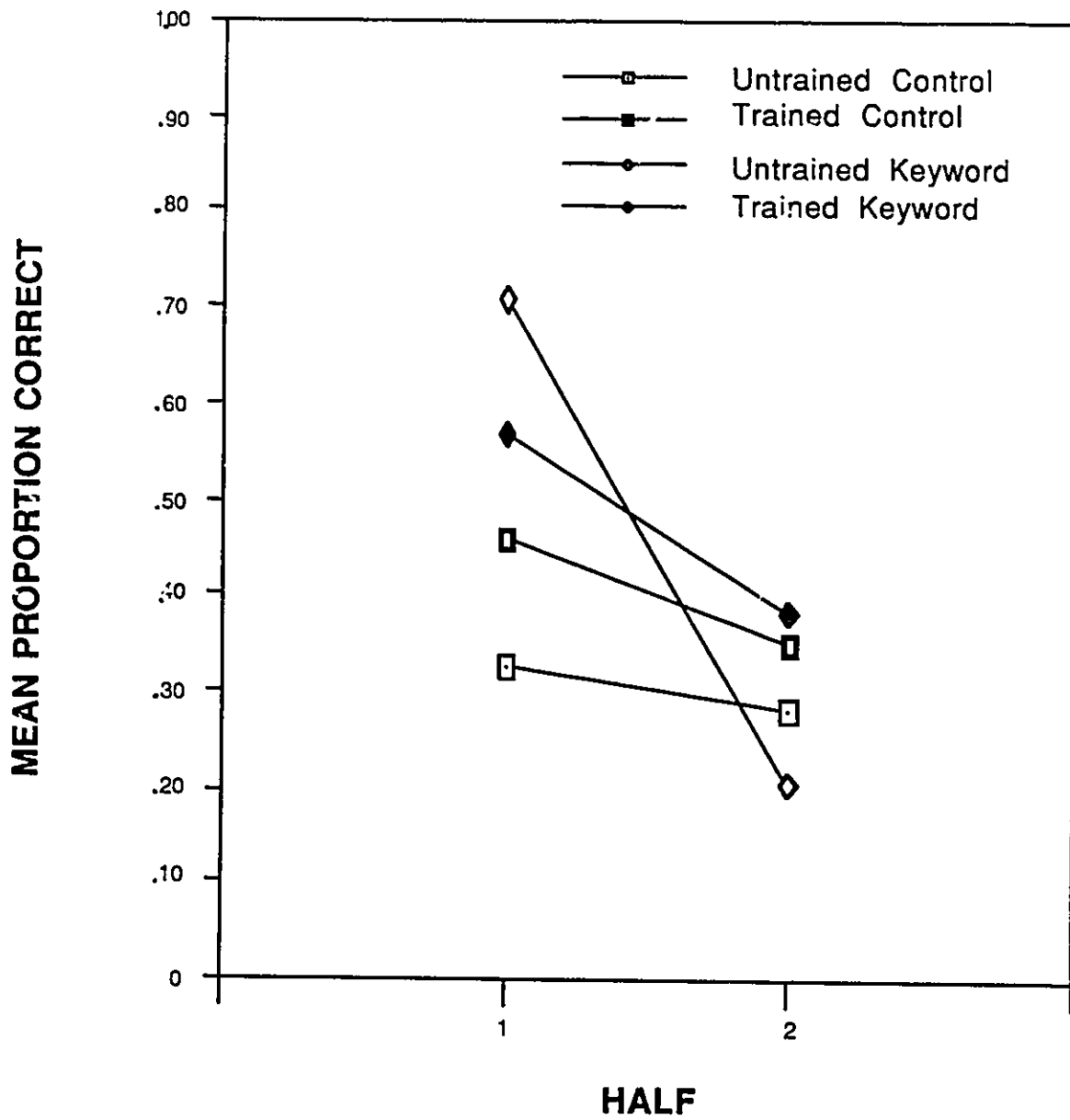


Figure 3.4 Effects of method and training on recall of pseudoword halves in Experiment 2

for second halves (i.e. untrained controls, trained controls, and trained keyword). The proportions of first and of second halves recalled by the untrained keyword group contrasts sharply with this pattern in that first halves were recalled far more frequently than were second halves. Compared with the other three groups, the untrained keyword group displayed the greatest proportion of first, and the smallest proportion of second halves.

These results were analyzed with statistical comparisons (i.e. tests of simple main effects) designed to answer the following questions. First, does training facilitate recall of first and/or second halves for controls? It might be expected that, if training facilitates recall of unfamiliar words overall, this training effect would be observed independently for recall of both first and second halves since trained subjects would be expected to have generated mediators for both halves of the unfamiliar word more often than would untrained controls. Second, does training affect recall of first and/or second halves for subjects provided with keywords to map the first halves of the pseudowords? The predictions would be different for first, as opposed to second halves. Training should not be as advantageous in recalling first halves, for which keywords are provided, as second halves, for mediators are not provided. Trained keyword subjects would presumably be better prepared to generate mediators for second halves, for which keywords are not provided, than would untrained keyword subjects, resulting in superior recall of second halves by trained subjects, while training would not be as advantageous for recalling the first halves, for which keywords are equally available to all subjects. And third, does providing a keyword for first halves facilitate recall of first halves and of second halves in trained subjects? The answers to this question are more difficult to anticipate, as the advantage of provided keywords (their instant availability at the time of study) might be compensated for by the potential advantage of self-generated keywords (their idiosyncratic meaningfulness and possibly the more thorough processing of the unfamiliar word necessary to produce them), and might have a differential effect on recall of the two halves.

The final question suggested by the results of recall of halves is related to the second question, that is, does training reduce the extreme discrepancy between recall of first halves and of second halves by both keyword groups observed in the previous experiment. In Experiment 1, recall of first halves by keyword subjects was extremely

high while that of second halves was extremely low compared with the relatively equivalent proportions of recall of the two halves by controls. If training increases recall of second halves, then the large difference in recall of the two halves should be smaller in the trained groups than in untrained keyword subjects and should more closely approximate that of controls.

The answers to the first, two-part, question were sought in comparisons between recall of first halves and of second halves by trained versus untrained controls. Interestingly, a training effect expected for both halves was observed only for first, $F(1,76)=5.09$, $MSe=.098$, $p<.027$, but not second halves, $F(1,76)=1.53$, $MSe=.091$, $p<.22$; that is, trained controls recalled more first, but not more second halves than did untrained controls. A possible reason for this pattern of effects might be a greater proportion, or a better quality, of generated mediators for first, but not second halves by trained as opposed to untrained subjects. The proportions of self-reported mediator use for first and second halves were later examined in order to confirm the proportion, although not the quality, of mediators used by subjects in each control condition.

In order to answer the second question, the proportions of first halves and of second halves recalled by the two keyword groups were compared separately. The hypothesis that the provision of keywords would prove an equalizing measure, resulting in similar proportions of recall by trained and untrained subjects, was not supported, as untrained keyword subjects exhibited superior recall of first halves relative to trained keyword subjects, $F(1,76)=5.71$, $MSe=.098$, $p<.019$. This result might be due to trained keyword subjects expending more effort than their untrained counterparts to find either second-half mediators, or mediators which either spanned the entire pseudoword or were superior to the provided keyword, leaving the former subjects less able to integrate the provided keyword into a unitary memory trace along with the other elements of the interactive association. Answering the remainder of the second question entailed comparing the proportions of second halves recalled by trained versus untrained keyword subjects. The expectation that trained keyword subjects would recall more second halves than would untrained keyword subjects was confirmed, $F(1,76)=10.35$, $MSe=.015$, $p<.002$. Training did appear to positively affect the recall of second halves, presumably because trained subjects were better able to

generate and/or associate second-half mediators than were their untrained counterparts.

The third question, whether providing a keyword facilitates recall of first halves (or even second halves) when subjects have been trained to generate their own mediators, is an unqualified no for second halves, although the answer for first halves is less clear-cut. Trained keyword subjects recalled more first halves, although this difference did not quite reach the .05 level of significance, than did trained controls, $F(1,76)=3.77$, $MSe=.098$, $p<.056$. The difference between the two groups on recall of second halves was almost nonexistent, $F(1,76)=.029$, $MSe=.091$, $p<.589$. The advantage, if a nonsignificant one, of having a keyword provided was evident solely for the half for which it was provided. Apparently the time and/or effort saved by not having to generate mediators for both halves was not sufficient to allow trained keyword subjects to better integrate the second halves.

The expectation that the discrepancy between recall of the two halves by trained subjects would be reduced relative to that by untrained keyword subjects was supported. Although each group recalled more first than second halves overall, the magnitude of the difference between recall of first and second halves was greatest for untrained keyword subjects, $F(1,76)=502.65$, $MSe=.015$, $p<.0001$, and smallest for untrained controls, $F(1,76)=4.19$, $MSe=.015$, $p<.044$ (the pattern observed in the previous experiment), while that for the other two groups fell in between these two extremes. Training, therefore, did not eliminate the discrepancy between recall of first and second halves by either the keyword or control groups, but did serve to reduce the size of the difference of both trained groups relative to that of the untrained keyword group. It is important to note that the decrease in the discrepancy between recall of first and second halves was effected at the cost of reduced recall of first halves by the trained keyword group, as well as by the enhanced recall of first halves by this group relative to the untrained keyword group. There seems to be a trade-off for this group between their higher recall of second and their lower recall of first halves, the possible reasons for which have already been discussed in the context of the answer to the second question. The effect of training on controls is somewhat less dramatic than on keyword subjects, but is nevertheless significant, in that training results in an overall increase in recall of first halves by trained control subjects

relative to that of untrained controls, without a corresponding significant increase in recall of second halves by controls.

Four major conclusions can be drawn from the pattern of results observed for pseudowords, letters, and halves. First, even the brief training provided to the trained subjects enhanced recall of unfamiliar words and letters comprising these words, particularly after practice studying and recalling the experimental stimuli. In order to effectively use the keyword method, even for forward recall, several steps must be successfully carried out: a) formation of or attention to a perceptually-similar natural language mediator, b) association of the mediator to the translation of an unfamiliar word by creating an interactive image or verbal association, c) retrieval of the image or verbal association, and d) identification of the relevant portion of the image or sentence (the translation for forward, or the keyword for backward recall). For backward recall, the method is even more complex, as attention must be paid to the orthographic similarities and differences between the mediator(s) and the unfamiliar word, and mediators mapping the entire unfamiliar word must be associated with each other and with the translation. It would not be surprising if the successful application of this mnemonic technique, even by university students, necessitates more than the simple instructions usually provided in the context of standard empirical tests of mnemonic strategy instructions. The need for training, rather than instructions, becomes even greater when subjects are required to supply their own natural language mediators for the entire unfamiliar word. The ability to generate mediators, to link them with each other and with the translation, and to reintegrate the unfamiliar word from the retrieved mediators could be expected to be greater after explanation, practice, and feedback, than without such training. In addition, training may serve, not only to build skills in using a mnemonic technique, but also to engender confidence that the technique will be helpful, without which subjects may abandon a mnemonic technique before recognizing its positive effects. The keyword method is sufficiently complex, even for forward recall, that its benefits are not always obvious on initial recall trials. In this experiment, training may have served to build confidence as well as skill in the using the keyword method.

The lack of a significant interaction between training and method (keyword vs. nonkeyword) suggests that the effect of training on the recall of unfamiliar words is

not differentially affected by either the provision of a keyword for the first halves of the pseudowords or by the self-generation of mediators for the entire unfamiliar word. Even in the 10 sec. study period allotted per item set, and in three learning-test trials, trained controls were able to attain proportions of pseudoword recall equivalent to that of trained keyword subjects. For university students, brief training seems sufficient to effect improvements in backward recall, even without provided keywords.

The second conclusion pertains to the efficacy of providing keywords to trained individuals. The provision of a mediator for the first half of the unfamiliar word did facilitate somewhat the recall of the keyword-mapped portion of the unfamiliar word relative no-keyword conditions when subjects were trained to create their own mediators. This finding suggests that generating mediators may be more effortful than associating externally-assigned mediators to a translation, and partially contradicts the proposal that the effort needed to associate provided mediators with each other and with translations may be greater than, or equivalent to, the effort required to both create idiosyncratic mediators and link them to the translation. Regardless of the degree of mental effort needed to generate one's own mediators entirely, the fact that all provided mediators in this experiment exactly mapped the first half of the pseudoword may have given keyword subjects an advantage over controls. When a mediator is generated that is not an exact orthographic match for the mapped portion of the unfamiliar word, the learner has the additional task of remembering the differences between the two letter strings in order to reconstruct the unfamiliar word from the keyword. Keyword subjects in this experiment were spared that task, while it is likely that many of the keywords generated by controls were not orthographically identical to the mapped portion.

It would be imprudent, however, to extrapolate from these results and propose that trained subjects would benefit from having provided mediators for an entire unfamiliar word, for two reasons. First, if provided keywords must map an entire unfamiliar word, it is unlikely that they could be as orthographically identical to the unfamiliar word as were the first-half keywords in this experiment. Therefore, keyword-provided subjects would not enjoy the same advantage with regard to

orthographic similarity between keyword and pseudoword as did subjects in this experiment. Second, provided keywords are generally chosen on the basis of their perceptual similarity with the unfamiliar word, rather than on the basis of semantic similarity with each other and/or the translation (e.g. *pie-saw-hay*). The relative difficulty of associating two or more externally-provided mediators with a translation may be greater than that of associating just one externally-provided mediator with a self-generated mediator and a translation, and may be greater than generating and associating one's own mediators together with a translation. The return in terms of recall performance by students, therefore, may not be great enough to warrant the investment needed by educators to provide mediators to map entire unfamiliar words.

The third conclusion drawn is related to the second: provision of first-half keywords does *not* facilitate recall of second halves when subjects are trained in mediator generation. It was expected that providing a keyword for the first half of the pseudoword might allow keyword-provided trained subjects to generate mediators for the remaining half of the pseudoword more quickly than would trained controls. Although recall of first halves was facilitated by the provided keyword, recall of second halves by these two groups was equivalent. Either trained keyword subjects did not take advantage of initial edge, or they were unable to make effective use of their second-half mediators due to the difficulty of associating them to provided keywords and the translations. These two possibilities will be further examined in the context of the results of the interview data.

The fourth and final conclusion is that the provision of first-half keywords is less effective in enhancing recall of first halves when subjects have been trained to generate their own mediators than when they have not been trained. This finding is not difficult to interpret. Trained subjects have been instructed, as well as trained, to generate one or more mediators for the second half of the pseudoword. They have also been taught that sometimes a single mediator can be a better choice than two unrelated mediators. It would not be surprising if trained keyword subjects declined to use the provided keyword in favor of their own, and/or divided their effort between a) associating the provided keyword with the translation and b) generating

and associating their own mediator(s), with or without the provided keyword, with the translation and each other. Either of these activities would result in reduced recall of first halves by trained keyword subjects.

Relationship Between MLAT and Recall Scores

It was hypothesized that the ability measured by the MLAT would be positively correlated with recall scores, but exactly how individual treatments might affect this correlation was not predicted. The possible role of individual differences in learning unfamiliar words and their meanings, and the way in which this role might be influenced by method of study and by training was explored by examining the relationships between MLAT scores and recall scores for subjects in each of the four experimental conditions with two separate types of analyses. In the first set of analyses, correlation coefficients were calculated, using a one-tailed test of significance, between the MLAT scores and the mean recall scores for whole pseudowords, total correct letters, first halves, and second halves of pseudowords averaged over three trials in each experimental condition. MLAT scores were compared with recall scores averaged over three trials because the average scores were considered to be more representative of subjects' performance overall than were scores for individual trials. Averaging scores across trials resulted in a more stable measure of each subject's performance by reducing the variance inherent in scores measured at each trial. The second set of analyses were carried out in order to determine whether the pattern of relationships between MLAT and recall scores were significantly different between groups. For that purpose, a tests of heterogeneity of slopes of regression lines were performed for selected pairs of conditions on each of the four recall measures, using the GLM program in the SAS statistical software package (1985). The following comparisons of slopes were performed: a) untrained versus trained controls, b) untrained controls versus untrained keyword subjects, c) untrained versus trained keyword subjects, and d) trained controls versus trained keyword subjects. The correlations between the MLAT scores and recall scores within each experimental

condition are illustrated in Table 3.4. The F ratios ($df = 1,76$) for each of these comparisons is reported in Table 3.5.¹²

Table 3.4 Correlations of MLAT score with recall of whole pseudowords, correct letters, and first and second halves of pseudowords under four conditions of strategy method and training.

Condition	Whole Pseudoword	Letters	First Half	Second Half
Control				
Untrained (N=20)	.31	.24	.23	.35
Trained (N=20)	.34	.33	.25	.30
Keyword				
Untrained (N=20)	.42	.50*	.59*	.41
Trained (N=20)	.08	.10	.03	.07

* = $p < .0125$

The correlational analysis revealed positive relationships between MLAT scores and each of the dependent measures for all groups, supporting the expectation that aptitude measured by the MLAT subtest is related to, and probably facilitates performance. This relationship reached statistical significance, however, only for subjects in the untrained keyword group. The smallest correlation coefficients were observed in the trained keyword group. These results suggest that training keyword generation and use may benefit low-aptitude subjects more than high-aptitude subjects, thereby reducing the advantage enjoyed by high-aptitude subjects over their low-aptitude counterparts in the untrained conditions when a keyword is provided for part of the unfamiliar word.

¹²In order to control the experimentwise alpha level, the .05 alpha level was divided by the four comparisons to yield an alpha level of .0125. The error term (residual mean square) for each dependent variable is reported in the last row of the table.

Table 3.5 F ratios for tests of heterogeneity of slopes for four comparisons between experimental groups for recall of whole pseudowords, correct letters, and first and second halves of pseudowords.

Conditions Compared	Whole Pseudoword	Letters	First Half	Second Half
Untrained Keyword vs. Trained Control	0.016	0.018	0.000	0.058
Untrained Control vs. Untrained Keyword	0.237	0.815	2.315	0.055
Trained Control vs. Trained Keyword	1.406	0.975	0.710	1.039
Untrained Keyword vs. Trained Keyword	2.387	3.471	7.025*	2.286
ERROR TERM	.0274	.0274	.0295	.0286

* = $p < .0125$

The pattern of correlations between MLAT scores and recall scores observed between trained and untrained subjects in the keyword conditions was not observed for subjects in the control conditions, however, as the correlations for trained controls were similar to those of untrained controls. If the effect of training were to reduce or eliminate the natural advantage held by high-MLAT scorers, then this effect should be seen in both control and keyword groups. The fact that it is not suggests that providing a keyword may additively serve to enhance the leveling effect of training on inherent ability.

The dispersion of MLAT scores relative to recall scores of pseudowords, letters, first halves, and second halves by subjects in each group are represented in Figures 3.5, 3.6, 3.7, and 3.8 respectively. Tests of heterogeneity of slopes indicate that the only significant difference between the groups compared is that between the slopes

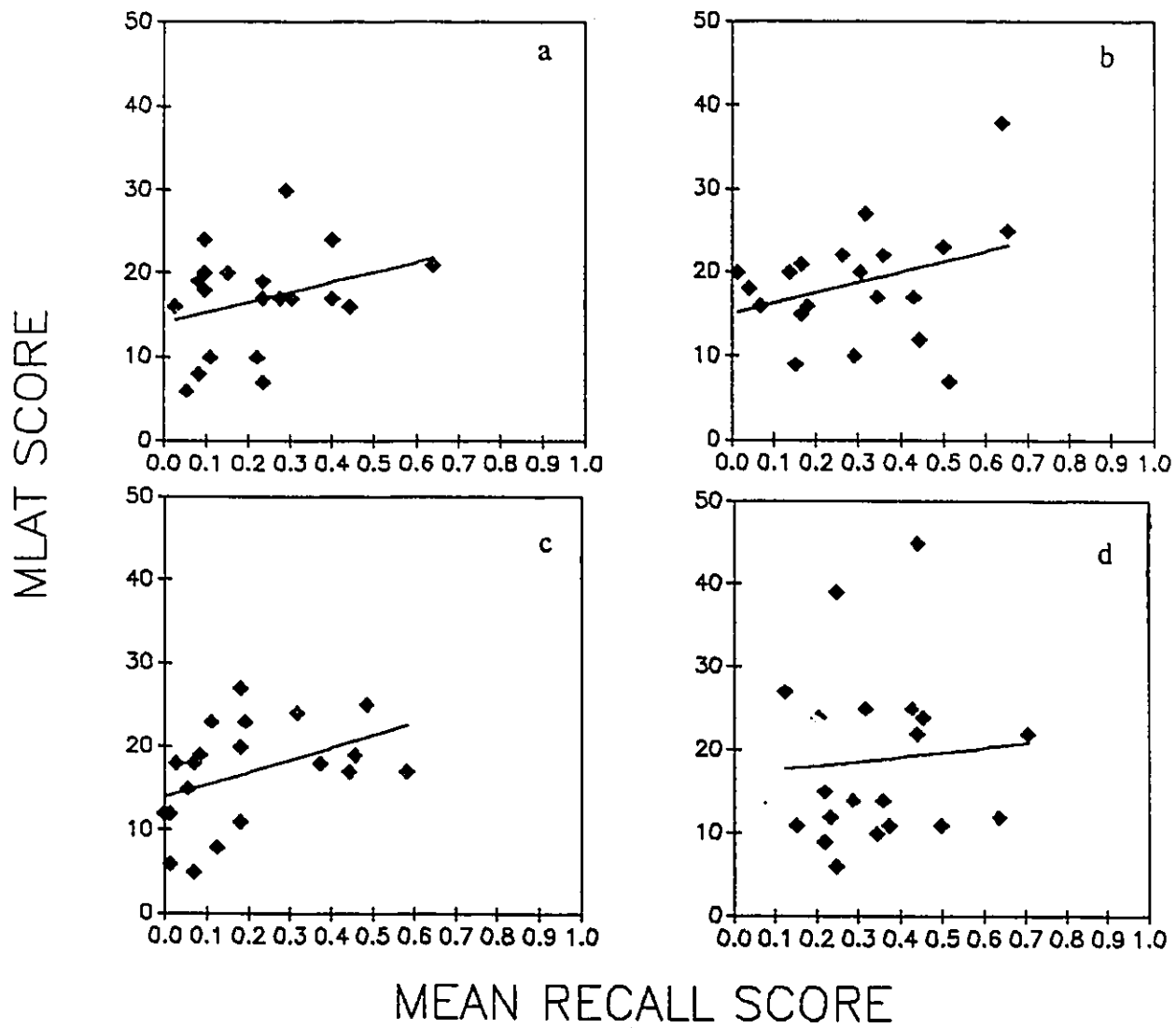


Figure 3.5 Scatterplot showing the relationship between scores on Part III of the MLAT and recall of whole pseudowords for the (a) untrained control, (b) trained control, (c) untrained keyword, and (d) trained keyword conditions.

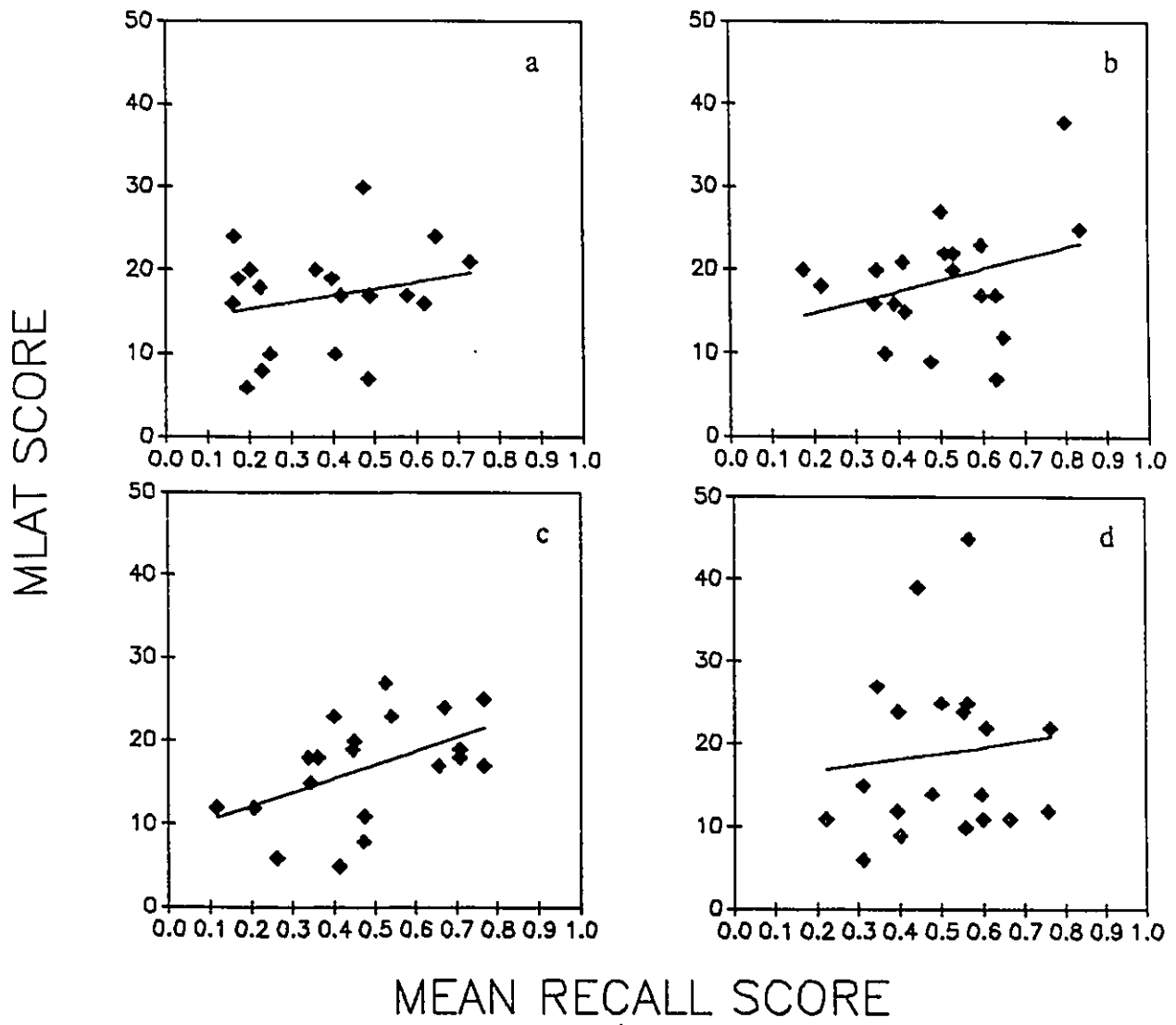


Figure 3.6 Scatterplot showing the relationship between scores on Part III of the MLAT and recall of pseudoword letters for the (a) untrained control, (b) trained control, (c) untrained keyword, and (d) trained keyword conditions.

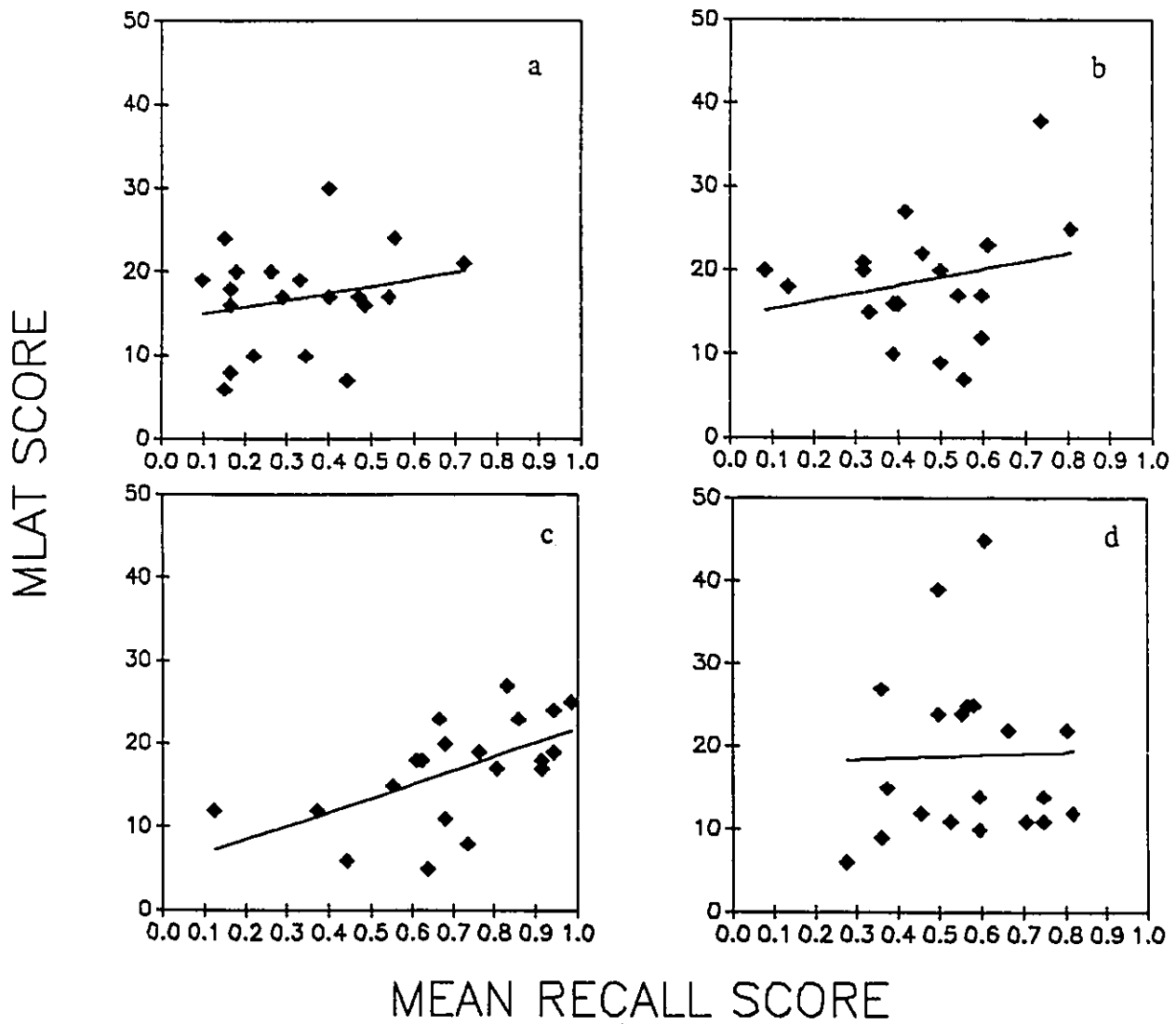


Figure 3.7 Scatterplot showing the relationship between scores on Part III of the MLAT and recall of pseudoword first halves for the (a) untrained control, (b) trained control, (c) untrained keyword, and (d) trained keyword conditions.

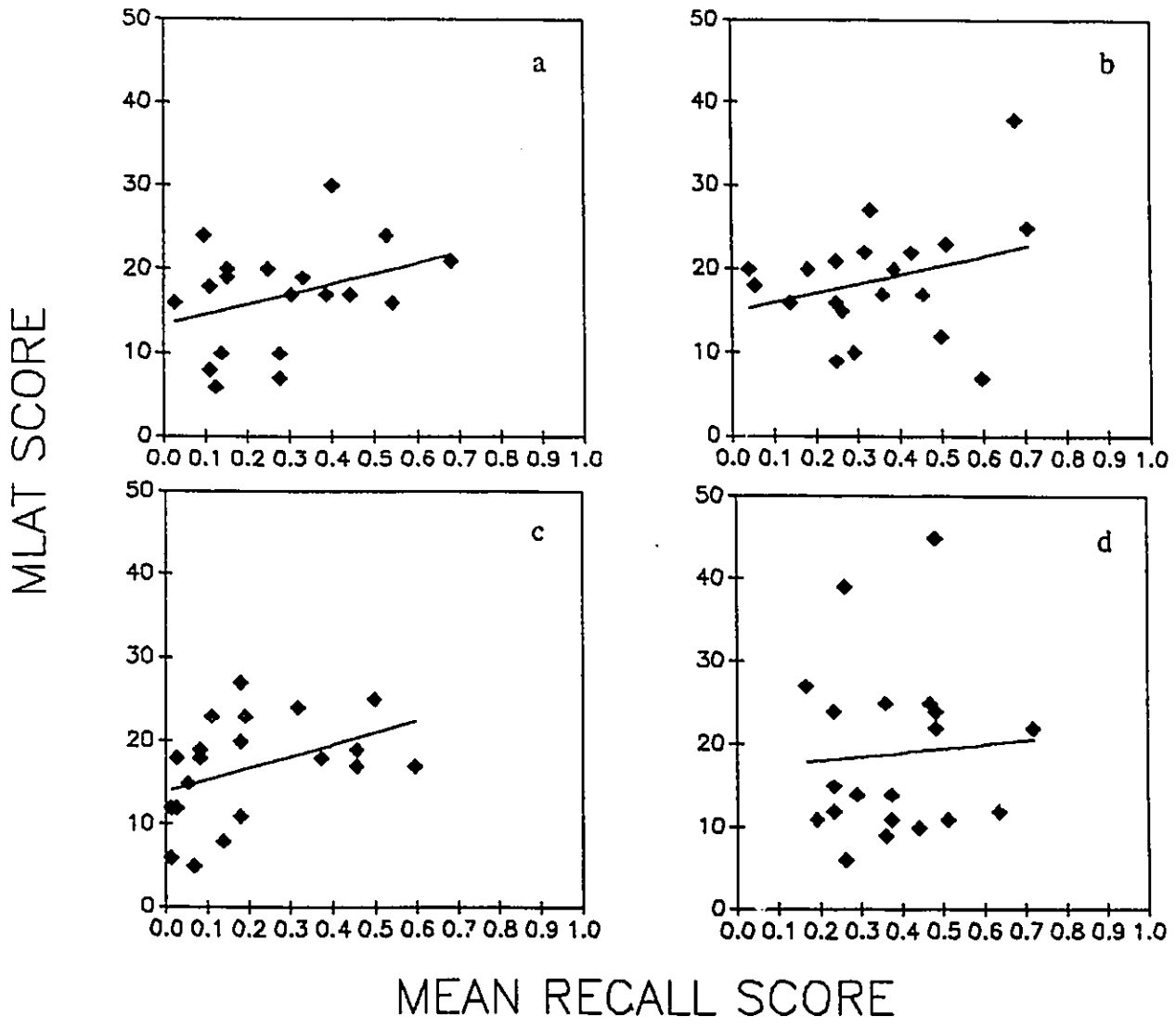


Figure 3.8 Scatterplot showing the relationship between scores on Part III of the MLAT and recall of pseudoword second halves for the (a) untrained control, (b) trained control, (c) untrained keyword, and (d) trained keyword conditions.

of trained and untrained keyword subjects for recall of the first half of the unfamiliar word. The MLAT is therefore a stronger predictor of recall of the first half for untrained keyword subjects than for trained keyword subjects.

The results of the correlational analysis and of the test of heterogeneity of slopes indicate that individual differences in the ability to find meaningful words in non-words is positively related to recall performance in this backward recall task, but that this relationship is significantly greater only for recall of first halves of unfamiliar items by untrained keyword subjects than by trained keyword subjects.

Considered together, the results of these tests partially support the hypothesis that training is more effective for individuals possessing a low aptitude for performing the acoustic decoding of unfamiliar words, as evidenced by the smaller positive relationship between aptitude (MLAT score) and recall performance for trained keyword subjects than for untrained keyword subjects. The comparisons between trained and untrained controls would seem to qualify that statement, however, as correlations for these groups were equivalent to each other. While all correlations were positive, indicating that acoustic decoding aptitude is an asset in performing the backward recall task, the lowest positive correlations between MLAT scores and recall on all of the dependent measures were observed in the trained keyword group. This group would be expected to have the lowest correlation between MLAT and recall, since the provision of a keyword makes it unnecessary to enlist one's own abilities to generate mediators, and training mediator generation might help subjects with lower aptitude in this area to improve their skill in mediator-generation, and subsequently improve their recall scores. However, it is puzzling that a similar effect of training was not observed in the trained control group. One possible explanation for the similarity of correlations between the two control, but not between the two keyword groups, might be that natural ability is related to spontaneous keyword method use, therefore training may have had an enhancing effect on keyword method use for both high- and low-aptitude subjects equally, resulting in similar correlations with the untrained control group. For keyword groups, an overall enhancing effect of training may have been further strengthened by the provision of a partial-word mediator, allowing low-MLAT scorers to improve their performance to levels approaching or equally those of high-MLAT scorers.

Most puzzling of all is the fact that the highest positive correlation between MLAT and recall scores was that of the untrained keyword group for recall of the first half of the pseudoword. The provision of a keyword for this portion of the pseudoword theoretically should serve to reduce the effect of natural ability in decoding unfamiliar words, because this ability should not be required of standard keyword subjects for the study of the keyword-mapped portion of the unfamiliar word. The comparison between slopes confirms this curious relationship. The only significant comparison between slopes was found for the relationship between MLAT and recall of first halves between untrained and trained keyword subjects. It would seem more probable that a significant difference should be found between these groups in the recall of second, rather than first, halves, since the second halves would require self-mediation. It is possible that natural aptitude, and hence experience in using mediator-based strategies spontaneously, assists untrained keyword subjects to more effectively implement the instructed keyword method than do their low-aptitude counterparts, while the additive effects of training plus provision of a keyword may benefit the low-aptitude subjects more than those with greater aptitude in the trained keyword condition. These results highlight the potential value of training this mnemonic technique in order to reduce the disparity in learning between low- and high-ability students.

Descriptive Analyses of the Post-Experimental Interview Data

The post-experimental interviews were examined with procedures similar to those in Experiment 1. That is, method of encoding first and last halves were assessed separately, as was the method, if any, of linking mediators with translations. The responses were coded initially in detail, then a more global coding was applied and the conditional probabilities of recalling halves and whole pseudowords was calculated based on the reported rates of strategy use.

Initial Coding of Interview Data. The initial coding of subjects' reported strategy use was conducted similarly to that in Experiment 1, with the following exceptions. The category of encoding the second half of the pseudoword by the incorporation of the orthographic form of the pseudoword into an interactive image was omitted, since there were no instructions to do so in this experiment. The distinction between primarily visual as opposed to primarily verbal association of the mediator(s) and translation was also omitted for two reasons. First, as was noted in the preceding chapter, many subjects find it difficult to differentiate between these types of elaboration, and second, the element of imagery association was de-emphasized in the mnemonic instructions given to trained controls and trained and untrained keyword subjects in this study for reasons previously explained. In this experiment it was considered more important whether or not the elements had been meaningfully associated than whether they had been associated by imagery, verbal associations, or a combination of the two. As before, responses which were not obtained were excluded from the data sets.¹³ Descriptions of the scoring criteria and categories of mediators and associations used in the coding of the interviews is found in Appendix C. The results of the initial coding of strategies reportedly used by subjects in the four experimental conditions are shown in Table 3.6.

As in Experiment 1, subjects in the two keyword groups reported a high proportion of provided keywords to study the first part of the pseudoword (untrained keyword = .87 and trained keyword = .72), and trained keyword subjects reported using slightly more self generated keywords (.09) than did untrained keyword subjects (.02). Both untrained and trained keyword subjects also reported using, in addition to the provided keyword, a self-generated keyword for the first half (.07 and .10 respectively). Trained controls reported using a self-generated keyword for considerably more first halves (.80) than did untrained controls (.45), confirming the effectiveness of the training.

¹³A total of 3 responses (.001%), all from the untrained keyword condition, were classified as "no response obtained".

Table 3.6 Mean proportions of reported strategies used to study the experimental stimuli.

First Half of Pseudoword				
Condition	Provided Keyword	Self-Generated Keywords	Two	Other
Control				
Untrained	---	.45	---	.55
Trained	---	.80	---	.20
Keyword				
Untrained	.87	.02	.07	.04
Trained	.72	.09	.10	.09

Second Half of Pseudoword		
Condition	Self-Generated Keyword	Other
Control		
Untrained	.40	.60
Trained	.74	.26
Keyword		
Untrained	.34	.66
Trained	.66	.34

Associative Link (Keyword + Translation)		
Condition	Meaningful	None
Control		
Untrained	.44	.56
Trained	.79	.21
Keyword		
Untrained	.93	.07
Trained	.89	.11

The effect of training was also evident in the proportions of second halves reportedly studied with a mediator by trained and untrained subjects. The proportions of second halves reportedly studied with a self-generated mediator was higher both for trained controls relative to untrained controls (.74 vs .40) and for trained keyword subjects compared to untrained keyword subjects (.66 vs .34). These results suggest that, although trained keyword subjects have a potential advantage in the availability of provided keywords, which might be expected to enable them more reliably to generate mediators for the second halves, they do not take advantage of this, and in fact report generating fewer mediators (.66) for second halves than do trained controls (.74). Interestingly, the former nevertheless manage to recall slightly more second halves than do the latter, possibly indicating a higher probability of recall of second halves given the generation of mediators for them.

Training also appeared to promote the meaningful association of mediators and translations for controls. Trained controls reportedly associated at least one mediator with the translation for .79 of item sets, compared with .40 for untrained controls. Not surprisingly, training was not a significant factor in the proportions of items associated by keyword subjects, since all keyword subjects are instructed to associate the provided keyword interactively with the translation.

Subsequent Coding of Interview Data. As in the previous experiment, the initial strategy categories were combined to form seven categories of method of encoding the first and second half of each pseudoword and of associating one or more mediators with the pseudoword translation. The results of this count of strategy use by condition is reported in Table 3.7. The most salient results of this descriptive analysis were the elevated use of the complete keyword strategy (KKL, mediator(s) mapping the entire pseudoword combined with a meaningful association between mediator(s) and translation) reported by trained controls relative to untrained controls (.65 vs .29) and by trained keyword subjects relative to untrained keyword subjects (.65 vs .34). Untrained keyword subjects reported similar proportions of items studied with a mediator mapping only the first half of the pseudoword, and associated meaningfully with the translation (.59). As in Experiment 1, untrained controls

reported the highest use of a totally non-keyword strategy (.49 of items). To summarize, the primary effect of training on reported strategy use was to increase the use of a complete keyword method for both controls and keyword subjects.

Table 3.7 Mean proportions of reported strategies used by each experimental group to study the experimental stimuli in Experiment 2.

Condition	Strategy Type						
	KKL	KOL	OKL	KKO	KOO	OKO	OOO
Control							
Untrained	.29	.09	.06	.05	.02	.00	.49
Trained	.65	.09	.03	.04	.01	.03	.15
Keyword							
Untrained	.34	.59	.00	.00	.04	.00	.03
Trained	.65	.24	.00	.01	.02	.00	.08

A Comparison of Reported Primary Strategy Use with Reported Strategy Use for Individual Items. The rate of control subjects who reported their primary study strategy as a keyword-like strategy was compared with that of those who reported a nonkeyword strategy. Eighty percent of controls reported that they had used primarily a keyword-like strategy, while the remaining 20 percent reported that they had relied on a nonkeyword strategy. Of the 80% of controls who reported using a keyword strategy more than any other, actual use of a keyword strategy as reported for individual items ranged from .17 to .53 of items (mean = .33 of items). As in the first experiment, controls tended to overestimate their reliance on a keyword method, even while identifying it as their primary strategy. Compared with the first experiment, fewer controls who reported relying mainly on a nonkeyword strategy reported use of a keyword strategy (between .04 to .21 of items, with a mean of .15 of items). Lower

overall reports of keyword strategy use was reported by all controls in this experiment than in Experiment 1, possibly because, with only three learning trials as opposed to four, they may have had less opportunity to switch to a mediator-based method after having assessed and discarded a less effective nonmediator-based technique.

Conditional Probabilities of Recalling Halves and Pseudowords Given the Strategy Reportedly Used to Study Items. The probability of successful recall of pseudowords and their halves were conditionalized on reported strategy use as in Experiment 1. The conditional probabilities and the frequencies from which they are calculated are reported in Table 3.8.

The conditional probabilities of recalling pseudowords and halves were generally lower in this study than in the previous study. The lower conditional probabilities were probably due to the fact that, although the stimulus list consisted of 24 items, as opposed to 30 in the first study, subjects had one fewer study-test trial in the present study than in the previous experiment. The relative effectiveness of various strategies, however, were similar to those observed in Experiment 1. Recall of entire pseudowords was most likely when subjects reported having used mediators associated to the translation to map the entire pseudoword (KKL = .66, KOL = .27, partial KW = .36, and OOO = .36). The KKL strategy and KOL (standard keyword) strategy were equivalent for probability of recall of first halves (.82 and .82 respectively), and both were associated with higher probabilities of recall than were either the partial KW (.56) or the nonkeyword (OOO) strategy (.44).

As in Experiment 1, the probability of recalling the second half was greatest when the KKL strategy had been used to study the item (.71) than when any other strategy had been used (KOL, partial KW, and OOO = .31, .47, and .40 respectively). No striking differences in conditional probabilities were observed between groups.

Table 3.8 Frequency of reported strategy use and probability of recall of first and second halves and whole pseudowords conditionalized on type of strategy reported.

Condition	Frequency				Conditional Probability				
	KKL	KOL	KW	OOO	KKL	KOL	KW	OOO	
First Half									
			Partial				Partial		
Untrained Control	97	27	34	93	.69	.64	.53	.40	
Trained Control	237	33	24	38	.75	.75	.52	.51	
Untrained Keyword	152	248	12	9	.94	.88	.63	.60	
Trained Keyword	274	90	10	20	.88	.77	.71	.51	
Total	760	398	80	160	Mean	<u>.82</u>	<u>.82</u>	<u>.56</u>	<u>.44</u>
Second Half									
			Partial				Partial		
Untrained Control	90	16	35	92	.64	.38	.55	.39	
Trained Control	207	21	24	38	.66	.44	.52	.51	
Untrained Keyword	118	68	2	3	.73	.24	.11	.20	
Trained Keyword	243	46	6	12	.78	.39	.43	.31	
Total	658	151	67	145	Mean	<u>.71</u>	<u>.31</u>	<u>.47</u>	<u>.40</u>
Whole Pseudoword									
			Partial				Partial		
Untrained Control	75	0	24	81	.54	.00	.38	.35	
Trained Control	191	21	19	35	.60	.48	.41	.47	
Untrained Keyword	116	66	2	3	.72	.23	.11	.20	
Trained Keyword	230	46	6	11	.74	.39	.43	.28	
Total	612	133	51	130	Mean	<u>.66</u>	<u>.27</u>	<u>.36</u>	<u>.36</u>
Frequency of strategy use									
Untrained Control	140	42	64	234					
Trained Control	316	44	46	74					
Untrained Keyword	161	282	19	15					
Trained Keyword	310	117	14	39					
Total	927	485	143	362					

General Discussion

The current research study answers some questions, suggests possible answers to other, and raises still more questions to be answered. The three main goals of the present experiment will be discussed in turn, in light of the obtained results their possible significance.

The first goal of this study was to examine the effects of training the generation and association of natural language mediators on the recall of unfamiliar words. That training can facilitate backward recall was supported by the superior recall performance by trained relative to untrained subjects for pseudowords, letters, and total halves of pseudowords, if not on the first, then at least on subsequent test trials. Furthermore, this effect was observed whether or not subjects had been provided with a keyword for the first half of the unfamiliar word. These results have practical implications for pedagogical applications of the keyword method for teaching both foreign and unfamiliar native-language words. The results of the present study, conducted with university students, cannot automatically be applied to younger and/or less cognitively able learners, however, previous studies have successfully trained elementary school age children to use a variety of learning strategies, and there is no compelling reason to think that children could not be trained to generate their own mediators as were subjects in this experiment. If students could be trained to apply the keyword method to the various tasks for which it has been proven effective, a powerful learning tool would be available to these students throughout their educational careers. Furthermore, this tool would be even more valuable if these same students were able to generate their own mediators independently for entire unfamiliar words, rather than have to depend on teacher-provided mediators.

While the apparent success of the training procedure for backward recall is encouraging for advocates of the keyword method, three cautionary notes must be added to these results. First, because the possible effectiveness of simple instructions to generate and associate mediators to map the entire pseudoword was doubtful based on evidence from the first experiment, the present experiment did not control for these effects. Therefore, the results of this study cannot unequivocally support the

contention that training is absolutely necessary to effect enhanced backward recall. Evidence that training is necessary, and that simple instructions are not sufficient in this regard, would be possible only if recall performance of trained groups were compared to that of both untrained control and keyword groups instructed to generate and associate mediators for the entire pseudoword, as well as to the untrained, uninstructed control and keyword groups used in the present study.

A second caution pertains to the cost-effectiveness of training subjects in mediator generation and use. The present study utilized a one-on-one training procedure with university students, which required approximately 20 minutes per training session. The apparent effectiveness of this training may not generalize to classroom training, and/or to younger or less intellectually-able learners, situations and individuals for which training might be most valuable. If the element of individualized feedback on performance during practice is in fact an essential component of the training procedure, then the logistics of responding to learner's successes and errors in generating and associating mediators must be taken into account if the provision of training is to be feasible in a classroom setting.¹⁴ However, this reservation regarding the feasibility of training may become less serious as interactive computer assisted learning software becomes more and more sophisticated. Already, software exists which can evaluate and correct the quality and style of prose, so it is conceivable that a trainee's responses to prompts to generate and associate mediators may be similarly evaluated and provided with feedback by means of classroom microcomputers.

The third reservation is related to the principles on which the keyword method is based. The keyword method was designed to facilitate the learning of word forms which resemble familiar, native-language words. The results of this study were obtained using, as unfamiliar stimuli, relatively short (6-letter) pseudowords whose orthographic structure was relatively familiar to English-speakers. Less successful results might be obtained if the stimulus list were made up of unfamiliar words with

¹⁴This study did not specifically test the efficacy of individual components of the training procedure, therefore the value of personalized feedback was not tested. Further studies which compare various training components, and combinations of components, are needed in order to determine the relative contribution of such procedures as explanation, examples, practice, and personalized feedback before ways to provide all of these to classrooms of children should be sought.

orthographic structures consisting of letter strings or characters rarely, if ever, encountered in the subjects' native language.¹⁵ Lengthier unfamiliar words might require more (or longer) mediators, which might complicate the processes of linking the keywords to each other and to the translation, retrieving them in serial order, and reconstructing the unfamiliar word. Nevertheless, if a student could learn a significant proportion of required foreign language vocabulary using this method, the fact that the student could not learn all of the vocabulary in this way would not diminish the contribution of the method.

The second goal of this study was to provide information regarding the relative benefits of providing keywords for the first portion of the pseudoword, given training or lack of training in generating and using mediators. The results of this study indicate that providing a keyword does not have any effect in the recall of entire pseudowords, but does facilitate recall of the keyword-mapped portion of the pseudoword. This finding has implications for the feasibility of using the keyword method for a variety of learning materials in a classroom setting. The less effort required on the part of teaching professionals to generate mediators for to-be-learned material, the more attractive the method may be to those in a position to decide if and how the technique should be included in the school curriculum. The time previously required to generate mediators for students could be invested in training students to apply the keyword method autonomously in a variety of learning situations. These results must be tested with learners of different ages and intellectual capacities, however, before they can be generalized to groups other than university students.

The third major goal of this study was to examine the contribution of individual differences in language-learning aptitude to backward recall, given two methods of study (keyword and control) and training or non-training in mediator generation and

¹⁵It should be noted that creative solutions to the problem of character dissimilarity can overcome this potential obstacle to using the keyword method. Even Chinese characters have been successfully taught using keywords, the referents for which bear a physical similarity to the Chinese character (Hing-Kay Ho, 1984). For example, a Chinese symbol which resembles a flower in a pot, and which means "book" was combined by asking students to think of a book about how to take care of plants.

association. The significantly high positive correlations between MLAT scores and recall scores in the untrained keyword group suggest that individuals who use the keyword method for backward recall, and possess a higher aptitude for processing the acoustic properties of unfamiliar words, have an inherent advantage over those with a correspondingly lower aptitude. The combined effects of training and of the provision of keywords on these variables may be to compensate for lower aptitude by providing individuals with the metacognitive knowledge and skill-building practice to successfully implement the complete keyword method for backward recall. The absence of significant differences between MLAT-recall correlations of trained and of untrained controls may indicate that the benefits of training for lower-aptitude individuals cannot be as fully exploited by those responsible for generating mediators for an entire pseudoword within the restriction of three study-test trials. Alternatively, it may indicate that both high- and low-aptitude subjects benefit equally, resulting in similar correlations to those of untrained control subjects.

It must be remembered that the subtest used in this experiment is only one of five comprising the entire MLAT. Future investigations might use the entire MLAT, or at least parts III, Spelling Clues and V, Paired Associates (reputed to measure rote memory for paired associates, probably due to the use of mnemonic strategies) (Gajar, 1987), to provide a fuller assessment of individual's aptitude for, and probable spontaneous use of mediator-based mnemonic strategies. Individual differences in other areas might also be measured and related to recall performance. For example, imagery ability might be examined as a predictor of subjects reporting the use of imaginal or verbal association of mediators and translations, and with recall performance, in order to determine if individual differences in this ability should be considered when encouraging the use of imaginal encoding.

Finally, it should be noted that, over and above facilitating immediate recall of unfamiliar words on the trained task, both with and without a provided mediator, training the generation and use of mediators may have other benefits not tested in this study, such as maintenance and transfer of the method over time and over tasks. This experiment tested only recall performance during a single experimental session, but did not test longer-term recall after a period of days, weeks, or even months, as

have some previous studies on the effectiveness of a variety of memory strategies. In general, studies in which students were trained to use strategies not only performed better during the initial learning session than did untrained students, but also maintained and/or transferred these strategies (Negin, 1978; O'Sullivan & Pressley, 1984; Pressley, Borkowski, & O'Sullivan, 1984; Pressley, Snyder, & Cariglia-Bull, 1989; Snowman, 1987). Justification for providing training would exist even if training had only a transitory effect on learning unfamiliar words, that is, if training helped students to retain unfamiliar words long enough for integration to be reinforced by actual use. If it were to become evident that training also promotes maintenance and transfer of the keyword method, the time and effort to train students would be even more highly justified.

CHAPTER 4

Summary and Conclusions

The primary purpose of the present research was to investigate means of applying the mnemonic keyword method to the association of an unfamiliar word with its translation with the goal of recalling the unfamiliar word when cued with its meaning. Two experiments were conducted. In both experiments, university students proficient in English studied a list of pseudowords, each paired with an assigned English "translation", over several study-test trials. Following the study of the stimulus list according to the experimental instructions, subjects were to recall the unfamiliar words when cued with their corresponding translations. At the conclusion of the final experimental trial, subjects were interviewed and asked to describe their method of studying each item set individually.

The first experiment was designed primarily to test a modification of the standard mnemonic keyword method, in which an additional step was included in the study phase of the method. A subordinate goal was to determine whether the failure of keyword instructions to enhance recall of unfamiliar words observed in previous experiments (Pressley, Levin, Hall, Miller, & Berry, 1980; Pressley, Levin, Nakamura, Hope, Bispo, & Toye, 1980; Pressley & Levin, 1981) might be due to a failure on the part of keyword subjects to recall the keywords. A second subsidiary goal was to obtain information about the strategies employed spontaneously by free-strategy control subjects, as well as to corroborate the use of instructed strategies by keyword strategy groups. The experiment varied mnemonic instructions (free-strategy, standard mnemonic keyword, and keyword + orthographic image) between groups. The free strategy group was presented with pseudowords and translations only, whereas both keyword groups were additionally presented with a keyword mapping the first half of each pseudoword. The single difference between the standard keyword and the

keyword + orthographic image instructions was that in the latter, subjects were instructed to include an image of the orthographic form of the pseudoword in their interactive image of the keyword and translation. This additional step was intended to aid recall of the unmapped portion of the pseudoword. Following a brief practice session, four study-test trials were presented. At each recall test, subjects were provided with a list of translations which served as retrieval cues. For each translation, free strategy controls were asked to recall the pseudoword only, whereas both keyword groups were asked to recall the keyword also. Dependent measures examined were a) recall of entire pseudowords, b) letters in their correct serial position, and c) first and second halves of pseudowords, and d) (for keyword groups only) keywords. Recall of pseudowords and of letters did not differ significantly among the three groups. It was concluded that the inherent difficulty in using the keyword method for recalling unfamiliar word may be that the method, as traditionally instructed, may not promote the formation of a unitary memory trace which contains both relational and item-specific information sufficient to reintegrate the entire unfamiliar word. The modified keyword instructions did not enhance pseudoword recall, although whether due to an intrinsic inadequacy of the method or to the failure of subjects to follow these instructions was unclear. The absence of an effect of method instructions by both keyword groups could not be attributed to a failure to recall keywords, as keyword recall reached equivalently high proportions on early trials. Furthermore, recall of first halves, for which keywords were provided, was superior for both keyword groups relative to controls, a result which is consistent both with keyword recall as well as with previous keyword studies in which recall of unfamiliar words (backward recall) was the dependent measure (Pressley, Levin, Hall, Miller, & Berry, 1980; Pressley, Levin, Nakamura, Hope, Bispo, & Toye, 1980; Pressley & Levin, 1981). Self-reports of strategy use and of probabilities of successful recall conditionalized on strategy revealed the following: a) many free-strategy controls spontaneously used mediators to study pseudoword-translation pairs, b) recall of halves was positively related to the reported use of a mediator to study that half, and c) recall of entire pseudowords was related to the reported use and association to the translation of mediators to map the entire pseudoword. These results were interpreted as evidence that, although the standard mnemonic keyword method does

provide learners with the item-specific and relational information necessary to recall either the familiar translation and/or the keyword-mapped portion of the unfamiliar word only, it is not sufficient to promote recall of the unmapped portion of the unfamiliar word. It was hypothesized that the extension of the method to provide item-specific information related to the entire unfamiliar word might result if keywords to map the entire unfamiliar word were linked with the translation in a single interactive association, either imaginal or verbal. A means of promoting the use of this extension to the keyword method as an aid to backward recall was examined in the second experiment.

The primary goal of the second experiment was to examine the effects of a brief session of training designed to facilitate the generation of keywords mapping the entire unfamiliar word and their association together with the translation. As in Experiment 1, an ancillary goal was to examine self-reported strategy use and likelihood of successful recall based on strategy used for each item set. A question posed in this experiment which was absent in the previous one was whether or not existing language aptitude plays a role in successful keyword strategy use. Four experimental groups were compared on the same dependent measures as in the previous experiment (with the exception of keyword recall) over three study-test trials. All subjects were tested for aptitude in finding familiar words in non-words. Subsequently, half of all subjects were subjected to a brief training session consisting of a) information about the applications, effectiveness, and method of implementation of the keyword method, b) practice generating and associating keywords with translations, and c) individualized feedback. The remaining subjects received an exposure to the training stimuli without training. Half of all trained and of all untrained subjects were either given a keyword for the first half of the pseudoword (keyword group) or were not (control group), yielding four experimental conditions: untrained control, trained control, untrained keyword, and trained keyword. The untrained control and untrained keyword groups were analogous to the free-strategy control and the standard keyword groups respectively of the previous experiment. The trained groups were instructed to either generate mediators for the entire pseudoword and associate them with the translation, either verbally or imaginally, (trained control group) or to use the provided keyword and associate it to a self-generated mediator for the second half and with the

translation (trained keyword group). Training was found to enhance recall of pseudowords overall, and more so on each successive trial. Recall of letters and of halves were facilitated by training, but only by the second and third trials respectively. The provision of a first-half keyword interacted with training by facilitating recall of first halves, even for trained subjects. Training also enhanced recall of second halves for keyword subjects relative to untrained keyword subjects, but not relative to the controls. It was concluded that training students of this age and ability was effective in extending the use of the keyword method to supply item-specific information sufficient to facilitate recall of unfamiliar words when cued with their meanings. Furthermore, training was as effective as was training plus the provision of a mediator mapping a portion of the unfamiliar word for recall of unfamiliar words, although recall of the keyword-mapped portion was greater when a keyword was combined with training.

Individual differences were found to be positively related to recall in all strategy conditions, but significantly so for untrained keyword subjects only. Training did not have a significant effect on the relationship between aptitude and recall for controls. However, training *and* provision of a keyword reduced this positive correlation relative to provision of a keyword without training, particularly for recall of first halves. These results were interpreted as evidence that successful use of the keyword method in the absence of training may be greater for individuals with aptitude (and probably experience) in the use of mediator-based strategies. Training and the provision of a keyword may combine to compensate those individuals with less aptitude and experience, allowing them to compete with those with higher-aptitude. The data did not support the hypothesis that training may be more beneficial for high-aptitude than for low-aptitude individuals. Interview data confirmed that the frequency of using a "complete" keyword strategy is increased following training, whether or not a keyword is provided, and the recall probabilities conditionalized on strategy use paralleled those in the first experiment.

Several practical implications of the present research, which could be developed in the context of research in the application of the keyword method for backward recall, were discussed. The effect of training university students, for a brief period on an individual basis, was found to enhance their recall of unfamiliar words, with or

without provided keywords. This experiment is the first in which a keyword method effect has been found for entire unfamiliar words in the backward recall task. Although encouraging, several things must be considered when planning future studies on the benefits of training on backward recall using the keyword method.

First, it was noted that it was not a goal of the second experiment to determine unequivocally that training was superior to simple instruction for facilitating mediator generation and association, nor to identify the individual components of training which may be essential if training is superior to instruction. Therefore, this experiment did not control for the possible effects of simply instructing subjects to either generate and associate mediators and the translation for the entire pseudoword (control group) or to generate a further keyword for the second half and additionally link it to the provided keyword and translation (keyword group), nor did it manipulate individual components of training. The effects of training, must therefore, be interpreted more cautiously than they might have been had training been found to enhance backward recall relative to simple instructions as well as to no-training/no-instructions, and/or had training components been tested individually or in various combinations. In the interests of finding the most economical method of extending the keyword method to backward recall, the comparison of subjects receiving simple instructions should be made to both trained and instructed, as well as to untrained, uninstructed subjects, both with and without provided keywords. If simply instructing subjects to generate and use mediators to map entire unfamiliar words is as effective as is training, then the former (and more economical) method of teaching the method should be chosen over the latter. If training is more effective than is instruction, then the relative merits of various components of training (e.g., the provision of specific strategy information, examples, individualized feedback, human versus computerized interaction during training, etc.) should be examined and tested systematically so as to design the most effective, yet efficient, method of training this type of skill.

Second, it was cautioned that it may not be feasible to conduct individualized training in a classroom setting, particularly with younger children who may need longer training consisting or more practice and feedback. Individualized feedback has been provided in a classroom setting in previous studies, demonstrating that is

possible to do so (e.g., Borkowski, Levers, & Gruenenfelder, 1976; Elliott-Faust et al., 1986; O'Sullivan & Pressley, 1984; Snowman, 1987), and it was noted that the rapid advancement in sophistication if computer software could conceivably solve the problem of the allocation of teachers' time for training students. Whether or not it is practical and cost-effective (i.e., are the costs of teacher's time and effort to train students outweighed by the improvements in speed and quality of students' future acquisition of knowledge) could be decided after consideration of the relative time and effort required by educators to either provide such training or teach the integration of new vocabulary by other means such as rote practice, or by generating teacher-provided keywords for entire unfamiliar words.

Third, it was noted that the less similar the unfamiliar vocabulary to native-language words, the more difficult it might be to apply the keyword method for backward recall. However, this line of research can nevertheless be pursued whenever the unfamiliar vocabulary bears some resemblance to that of the native language.

Finally, the role of individual differences in language learning should be considered when deciding if and how to implement training in memory strategy use in the classroom. Training in certain strategies, particularly ones which are strongly based on a particular cognitive modality (such as imagery-based strategies), may be more or less beneficial depending on the inherent aptitudes of the learner. Determining in advance whether an individual is already using the strategy, and whether the individual has cognitive strengths and/or weaknesses which may enhance or inhibit the usefulness of training may be possible as a result of more strategy research which controls for these variables. Training with personalized feedback may be best reserved for those who both need and can benefit from it. The use of "intelligent tutors" could be programmed to take these variables into account, and whether teacher-provided or computer-assisted, the types of skills trained (e.g., verbal or imaginal association) could be tailored to the individual's cognitive preferences and strengths.

APPENDIX A: Instructions

EXPERIMENT 1

Introductory instructions given to all participants for learning pseudowords and translations, following which individualized instructions were presented to participants in the three experimental conditions.

INSTRUCTIONS TO ALL PARTICIPANTS

During this session you will be presented with a list of 30 pseudowords. These pseudowords are artificial words constructed so as to conform to the orthographic structure of English, so they should not appear particularly strange to you. You may wonder why we are not using real words. 1) First, we wanted to have some control over various aspects of the words such as length and shape; and 2) secondly, we wanted these words to be as close as possible as those found in a natural language, and yet be sure that they would be equally unfamiliar to all of the participants.

From this point on, however, you may think of these pseudowords as foreign words, since they serve the same purpose as foreign words in this learning task. Each of these words will be presented with an English word that you can think of as its English translation or meaning.

Each item will be presented on the video screen before you for an interval of 10 seconds. Immediately following the presentation of the 30 items I will give you a list of the 30 English translations and I will ask you to recall in writing the foreign words associated with each of these English translations. The translations on the response sheet will be in a different order from the order in which they were presented on the screen.

This procedure will be repeated 4 times. You will study the entire list of foreign words with their translations four times, in a random order each time, and after each presentation of the list you will be asked to recall the foreign words when given a list of the translations, again in a different random order each time.

(PROCEED TO APPROPRIATE STRATEGY INSTRUCTIONS FOR EXPERIMENTAL CONDITION: free-strategy control, standard mnemonic keyword, or keyword + orthographic image.)

EXPERIMENT 1

Instructions given to participants in the free strategy control condition.

FREE STRATEGY CONTROL INSTRUCTIONS

(SHOW FIRST EXAMPLE)

Here is the way in which each item will be presented: on the left is the foreign word and on the right its associated meaning. For this first example, the foreign word is wrifep and its meaning is salad.

You may use whatever method you like to learn this vocabulary. We know that learning a new word and its meaning is not an easy task. You may find that you remember some parts of the foreign word, but may be unsure of other parts. We are interested in the progress you make on each trial in recalling the foreign word. Therefore, on the recall test sheets there are spaces for each letter of the foreign word. For each foreign word, please print in these spaces, in lower-case letters, as many letters as you recall, even if you are not absolutely certain that they are correct, either in identity or position within the foreign word. If you do not recall a letter or letters at all, just leave those spaces blank.

In order for you to become familiar with the task, I will present two more examples. These will be followed by a practice recall test of the three examples. I will provide you with a list of the three English translations, and I will ask you to try to print each word's associated foreign word, or at least as much of the foreign word as you think you can recall.

(PRESENT PRACTICE ITEMS AND PRACTICE RECALL TEST)

Do you have any questions concerning the procedure?

If you are ready, I will now present the list. Do your best to memorize the list.

(PRESENT LIST #1)

Here is the list of English translations that you studied. Try to print, in lower-case letters, as many of the keywords and foreign words as you think you can remember. You have five minutes.

(PRESENT RECALL TEST #1)

The list will be presented again, in a new random order. Please continue to do your best to learn the foreign words and their translations.

(REPEAT PRESENTATION AND RECALL TEST THREE MORE TIMES)

(QUESTIONNAIRE)

(DEBRIEFING)

EXPERIMENT 1

Instructions given to participants in the standard mnemonic keyword condition.

STANDARD MNEMONIC KEYWORD INSTRUCTIONS

(SHOW FIRST EXAMPLE)

Here is the way in which each item will be presented: on the left is the foreign word and on the right its associated meaning. Below the foreign word will be another English word. The first portion of this English word resembles the first portion of the foreign word. This English word is called the "keyword". For this first example, the foreign word is wrifep, its keyword is wristwatch and its meaning is salad.

In order to learn these foreign words, please use the following method.

Create a mental image of a scene or a situation containing the objects referred to by the foreign word and the keyword (that is, the translation and the keyword). For this item you might imagine a wristwatch in a bowl of salad.

I will now explain the use of this method during recall. During the recall test I will give you a list of the English translations that you have studied and, for each of these English translations, I will ask you to recall its keyword and its associated foreign word. This is how the keyword will help you:

- 1) The English translation will help you to recall the mental image that you created.
- 2) This image should also contain the object designated by the keyword which will permit you to recall the keyword.
- 3) The first portion of the keyword will always resemble the first portion of the foreign word. This will help you to recall at least that portion of the foreign word and get a good start on recalling the whole word. The principle of this method is to permit you to go from the English translation to the image, from the image to the keyword, and from the keyword to the foreign word that resembles it. I will ask you to use this method throughout the session.

We know that learning a new word and its meaning is not an easy task. You may find that you remember some parts of the foreign word, but may be unsure of other parts. We are interested in the progress you make on each trial in recalling the foreign word. Therefore, on the recall test sheets there are spaces for each letter of the foreign word. For each foreign word, please print in these spaces, in lower-case letters, as many letters as you recall, even if you are not absolutely certain that

they are correct, either in identity or position within the foreign word. If you do not recall a letter or letters at all, just leave those spaces blank.

In order for you to become familiar with the task, I will present two more examples. These will be followed by a practice recall test of the three examples. I will provide you with a list of the three English translations, and I will ask you to try to print each word's keyword and associated foreign word, or at least as much of the foreign word as you think you can recall.

(PRESENT PRACTICE ITEMS AND PRACTICE RECALL TEST)

Do you have any questions concerning the procedure?

If you are ready, I will now present the list. Do your best to memorize the list.

(PRESENT LIST #1)

Here is the list of English translations that you studied. Try to print, in lowercase letters, as many of the keywords and foreign words as you think you can remember. You have five minutes.

(PRESENT RECALL TEST #1)

The list will now be presented again, in a new random order. Please continue to study the words by creating an interactive image containing objects representing both the keyword and the translation, and try hard to remember the rest of the foreign word.

(REPEAT PRESENTATION AND RECALL TEST THREE MORE TIMES)

(QUESTIONNAIRE)

(DEBRIEFING)

EXPERIMENT 1

Instructions given to participants in the keyword + orthographic image condition.

KEYWORD + ORTHOGRAPHIC IMAGE INSTRUCTIONS

(SHOW FIRST EXAMPLE)

Here is the way in which each item will be presented: on the left is the foreign word and on the right its associated meaning. Below the foreign word will be another English word. The first portion of this English word resembles the first portion of the foreign word. This English word is called the "keyword". For this first example, the foreign word is wrifep, its keyword is wristwatch and its meaning is salad.

In order to learn these foreign words, please use the following method.

1) First, create a mental image of a scene or a situation containing the objects referred to by the foreign word and the keyword (that is, the translation and the keyword). For this item you might imagine a wristwatch in a bowl of salad.

2) Once you have established this image, try to imagine the foreign word itself, printed in lower-case letters, on or at least near the object which represents the translation of the foreign word. You may be able to incorporate this word into the image, for example as the brand-name on an object, or as some other type of label which might appear on the object. Otherwise, just try to picture the foreign word as clearly as possible on or near the translation object and notice the word's overall shape as well as the appearance of the individual letters. For example, for this item, you might imagine the word "wrifep" printed on the bowl of salad with the wristwatch in it.

I will now explain the use of this method during recall. During the recall test I will give you a list of the English translations that you have studied and, for each of these English translations, I will ask you to recall its keyword and its associated foreign word. This is how the keyword will help you:

1) The English translation will help you to recall the mental image that you created.

2) This image should also contain the object designated by the keyword which will permit you to recall the keyword.

3) Your image should also contain, on or near the translation object, the spelling of the foreign word itself. In addition, remember that the first few letters of the keyword will always resemble the first portion of the foreign word. This will help you to recall at least that portion of the foreign word and get a good start on recalling the whole word in case the image of the foreign word itself is unclear. The principle

of this method is to permit you to go from the English translation to the image, from the image to the keyword and to the foreign word that resembles it. I will ask you to use this method throughout the session.

We know that learning a new word and its meaning is not an easy task. You may find that you remember some parts of the foreign word, but may be unsure of other parts. We are interested in the progress you make on each trial in recalling the foreign word. Therefore, on the recall test sheets there are spaces for each letter of the foreign word. For each foreign word, please print in these spaces, in lower-case letters, as many letters as you recall, even if you are not absolutely certain that they are correct, either in identity or position within the foreign word. If you do not recall a letter or letters at all, just leave those spaces blank.

In order for you to become familiar with the task, I will present two more examples. These will be followed by a practice recall test of the three examples. I will provide you with a list of the three English translations, and I will ask you to try to print each word's keyword and associated foreign word, or at least as much of the foreign word as you think you can recall.

(PRESENT PRACTICE ITEMS AND PRACTICE RECALL TEST)

Do you have any questions concerning the procedure?

If you are ready, I will now present the list. Do your best to memorize the list.

(PRESENT LIST #1)

Here is the list of English translations that you studied. Try to print, in lower-case letters, as many of the keywords and foreign words as you think you can remember. You have five minutes.

(PRESENT RECALL TEST #1)

The list will now be presented again, in a new random order. Please continue to study the words by creating an interactive image containing objects representing both the keyword and the translation, and then imagine the foreign word itself spelled out in the image.

(REPEAT PRESENTATION AND RECALL TEST THREE MORE TIMES)

(QUESTIONNAIRE)

(DEBRIEFING)

EXPERIMENT 2

MLAT subtest administration and introductory instructions given to all participants.

ADMINISTRATION OF MLAT SUBTEST TO ALL PARTICIPANTS

The task that you will perform later in this session involves learning unfamiliar words. However, before you begin the task, I would first like to administer a brief test that is sometimes associated with language-learning skills. The test takes approximately five minutes to complete. The scores are entirely confidential as are all individual results in this study.

(INSTRUCTIONS FOR THE MLAT SPELLING CUES SUBTEST, PRESENTED BY AUDIO TAPE.)

Part 3 - Spelling Clues.

You will need your test booklet now. When the signal is given, not yet, you will open your test booklet to page 2 and study the directions and sample problems for Part 3, Spelling Clues. As soon as you understand what to do, you will begin working on the test and continue until you are told to stop. You will mark your answers on the answer sheet. Do not write anything on the test booklet. You should work rapidly on this test. If you cannot answer an item in a short time, you may skip it and try the next one. You will have 5 minutes to work. Now wait for the signal to start Part 3, page 2 of your test booklet. Ready? Go.

(5 MINUTES OF SILENCE)

Stop. Stop work on Part 3, close your booklets, and wait for further instructions.

INSTRUCTIONS TO ALL PARTICIPANTS

This session will be divided into two phases: 1) a practice phase, and 2) a learning phase. The practice phase will precede the learning phase, but I will first tell you about the learning phase so that you will understand why the practice phase may be useful. During the learning phase of this session you will be presented with a list of pseudowords. These pseudowords are artificial words constructed so as to conform to the orthographic structure of English, so they should not appear particularly strange to you. You may wonder why we are not using real words. 1) First, we wanted to have some control over various aspects of the words such as

length and shape; and 2) secondly, we wanted these words to be as close as possible as those found in a natural language, and yet be sure that they would be equally unfamiliar to all of the participants.

From this point on, however, you may think of these pseudowords as foreign words, since they serve the same purpose as foreign words in this learning task. Each of these words will be presented with an English word that you can think of as its English translation or meaning.

During the learning phase of this experiment, these items will be presented on the video screen before you for a period of 10 seconds each. Immediately following the presentation of the entire list, I will provide you with a list of the translations and I will ask you to recall in writing the foreign words associated with each of these English translations. There will be three presentations of the same set of words, and each presentation will be followed by a recall test.

The practice phase is designed to expose you to the type of items and the rate of presentation, that you will encounter during the learning phase. The items presented during the learning phase will be different, but somewhat similar to those presented during the practice phase.

**(PROCEED TO APPROPRIATE INSTRUCTIONS FOR TRAINING CONDITION:
untrained or trained.)**

EXPERIMENT 2

Experimental instructions presented to all participants in the untrained conditions.

INSTRUCTIONS TO UNTRAINED PARTICIPANTS

This session will be divided into two phases: first, a practice or pre-exposure phase, followed by a learning phase. The practice phase is designed to expose you to both the type of items and the rate of presentation, that you will encounter during the learning phase. The items presented during the learning phase will be different, but similar to those presented during the learning phase. The words that you will learn are pseudowords. These pseudowords are artificial words constructed so as to conform to the orthographic structure of English, so they should not appear particularly strange to you. You may wonder why we are not using real words. 1) First, we wanted to have some control over various aspects of the words such as length and shape; and 2) secondly, we wanted these words to be as close as possible as those found in a natural language, and yet be sure that they would be equally unfamiliar to all of the participants.

From this point on, however, you may think of these pseudowords as foreign words, since they serve the same purpose as foreign words in this learning task. Each of these words will be presented with an English word that you can think of as its English translation or meaning.

(PRESENT PRE-EXPOSURE PHASE)

PRE-EXPOSURE PHASE

Part 1

Because we are using pseudowords in place of foreign words in this experiment, we want you to become familiar with the type of material you will study in the learning phase of the session. This pre-exposure phase of the experiment is designed to allow you to become accustomed to both the type of items you will be studying, and to the pace at which these items will be presented. You will not be asked to recall any of these items.

All of the foreign words you will be asked to learn are six letters long, and each will be paired with an English translation or meaning. During this pre-exposure phase, however, you will first be presented with twelve 3-letter items (trigrams), in order to become familiar with the types of letter strings which compose the 6-letter words.

(PRESENT TRIGRAMS)

Part 2

Next you will be presented with six 6-letter words made up of the twelve trigrams which you just saw.

(PRESENT 6-LETTER WORDS)

Part 3

Now you will be presented with the same six words, but this time each one will be paired with an English translation. This is the method of presentation that you will encounter during the learning phase of the experiment.

(PRESENT 6-LETTER WORDS + TRANSLATIONS)

This concludes the pre-exposure phase of the session. Do you have any questions so far? If not, we can proceed to the learning phase.

**(PROCEED TO INSTRUCTIONS FOR APPROPRIATE METHOD CONDITIONS:
untrained control or untrained keyword.)**

EXPERIMENT 2

Experimental instructions presented to participants in the untrained control condition.

INSTRUCTIONS TO UNTRAINED CONTROL PARTICIPANTS

You will now be presented with a list of 24 new foreign words. These items will be presented on the video screen before you for a period of 10 seconds each. Immediately following the presentation of the entire list, I will provide you with a list of the translations and I will ask you to recall in writing the foreign words associated with each of these English translations. There will be three presentations of the same set of items, and each presentation will be followed by a recall test.

Each item will be presented in the same format as the examples you have already seen: The foreign word is on the left of the screen and its associated meaning or translation is on the right.

You may use whatever method you like to learn this vocabulary. We know that learning a new word and its meaning is not an easy task. You may find that you remember some parts of the foreign word, but may be unsure of other parts. We are interested in the progress you make on each trial in recalling the foreign word. Therefore, on the recall test sheets there are spaces for each letter of the foreign word. For each foreign word, please print in these spaces as many letters as you recall, even if you are not absolutely certain that they are correct, either in identity or position within the foreign word. If you do not recall a letter or letters at all, just leave those spaces blank.

Do you have any questions concerning the procedure?

If you are ready, I will now present the list. Do your best to memorize the list.

(PRESENT LIST #1)

Here is the list of English translations that you studied. Try to print as many of the foreign words as you think you can remember. You have five minutes.

(PRESENT RECALL TEST #1)

The list will now be presented again, but in a new random order. Please continue to do your best to learn this vocabulary.

(REPEAT PRESENTATION AND RECALL TEST TWO MORE TIMES)

(QUESTIONNAIRE)

(DEBRIEFING)

EXPERIMENT 2

Experimental instructions presented to participants in the untrained keyword condition.

INSTRUCTIONS TO UNTRAINED KEYWORD PARTICIPANTS

You will now be presented with a list of 24 new foreign words. These items will be presented on the video screen before you for a period of 10 seconds each. Immediately following the presentation of the entire list, I will provide you with a list of the translations and I will ask you to recall in writing the foreign words associated with each of these English translations. There will be three presentations of the same set of items, and each presentation will be followed by a recall test.

Each item will be presented in the same format as the examples you have already seen: The foreign word is on the left of the screen and its associated meaning or translation is on the right. In addition, below the foreign word is another English word. The first three letters of this English keyword are identical to the first three letters of the foreign word. We call this English word a "keyword".

In order to learn this vocabulary, please use the following method: Associate the object referred to by the keyword with that referred to by the translation of the foreign word either by creating a mental image, a verbal association, or a combination of both.

I will now explain the use of this method during recall. During the recall test I will give you a list of the English translations that you have studied and, for each of these English translations, I will ask you to recall its keyword and its associated foreign word. This is how the keyword will help you:

- 1) The English translation will help you to recall the mental image or verbal association that you created.
- 2) This association should also include the object designated by the keyword which will permit you to recall the keyword.
- 3) The first portion of the keyword will always resemble the first portion of the foreign word. This will help you to recall at least that portion of the foreign word and get a good start on recalling the whole word. The principle of this method is to permit you to go from the English translation to the imaginal or verbal association, from this association to the keyword, and from the keyword to the foreign word that resembles it. Remember that, although your recall of the keyword will help you to recall the first part of the whole word, you will still have to try hard to recall the rest of the foreign word. I will ask you to use this method throughout the session.

We know that learning a new word is not an easy task. You may find that you remember some parts of the foreign word, but may be unsure of other parts. We are interested in the progress you make on each trial in recalling the foreign word. Therefore, on the recall test sheets there are spaces for each letter of the foreign word. For each foreign word, please print in these spaces as many letters as you recall, even if you are not absolutely certain that they are correct, either in identity or position within the foreign word. If you do not recall a letter or letters at all, just leave those spaces blank.

Do you have any questions concerning the procedure?

If you are ready, I will now present the list. Do your best to memorize the list.

(PRESENT LIST #1)

Here is the list of English translations that you studied. Try to print as many of the foreign words as you think you can remember. You have five minutes.

(PRESENT RECALL TEST #1)

The list will now be presented again, in a new random order. Please continue to study the words by associating the objects to represent the keyword and translation and try hard to remember the rest of the foreign word.

(REPEAT PRESENTATION AND RECALL TEST TWO MORE TIMES)

(QUESTIONNAIRE)

(DEBRIEFING)

EXPERIMENT 2

Experimental instructions presented to all participants in the trained conditions.

INSTRUCTIONS TO TRAINED PARTICIPANTS

This session will be divided into two phases: first, a practice or pre-exposure phase, followed by a learning phase. The practice phase is designed to expose you to both the type of items and the rate of presentation that you will encounter during the learning phase. As well, it will provide you with an opportunity to learn a technique that will help you to memorize items during the learning phase. I will tell you more about this technique shortly. The items presented during the learning phase will be different, but similar to those presented during the learning phase. The words that you will learn are pseudowords. These pseudowords are artificial words constructed so as to conform to the orthographic structure of English, so they should not appear particularly strange to you. You may wonder why we are not using real words. 1) First, we wanted to have some control over various aspects of the words such as length and shape; and 2) secondly, we wanted these words to be as close as possible as those found in a natural language, and yet be sure that they would be equally unfamiliar to all of the participants.

From this point on, however, you may think of these pseudowords as foreign words, since they serve the same purpose as foreign words in this learning task. Each of these words will be presented with an English word that you can think of as its English translation or meaning.

(PRESENT TRAINING PHASE)

TRAINING PHASE

Part 1

During this training phase you will learn about a method of studying unfamiliar words and their meanings which should be helpful to you. I will explain the method step-by-step and you will have opportunities to practice it and to get feedback on your progress.

The method I will describe is called "the mnemonic keyword method", a form of natural language mediation, in which you try to find one or more familiar words in your own language which is similar in either sound or spelling to the foreign word, then associate these mediators to the translation of the foreign word. This association can be made by forming a mental image of a scene or situation in which an object

representing the keyword mediator and one representing the translation interact in some way, or by a sentence or phrase describing this sort of interaction, or by a combination of both. The familiar words (sometimes referred to as "keywords") then serve as mediators or links between the translation and the foreign word so that when you are given the translation at the time of recall, you can remember the mediator which was associated with the translation, and this mediator or keyword, because it is similar in sound or spelling to the foreign word, can help you recall the foreign word.

There are several ways in which a mediator or keyword can be generated from a foreign word:

- 1) some letters of the foreign word suggest a string of words (e.g. the string "tgif" might be encoded as the expression "thank goodness it's Friday");
- 2) some letters of the foreign word might be identical to those in a familiar word (e.g. "cur" and "curtain");
- 3) some letters of the foreign word might be similar, but not identical to those in a familiar word, in which case you would have to try to remember how the two letter strings differ if you want to be able to spell the foreign word, and;
- 4) a portion of the foreign word might sound like a portion of a familiar word, but be spelled differently (e.g. "cur" and "kerchief") in which case you must remember that the words only sound alike, and remember how to spell the foreign word.

You will now see 11 more 3-letter strings, or trigrams for 10 seconds each. After 10 seconds the screen will go blank. I would like you to practice generating keyword mediators aloud for these trigrams. You should try to generate as many mediators as you can for each word, as this practice will help you later on. I will note down your mediators and give you some feedback on them.

(DISPLAY REMAINING TRIGRAMS)

Part 2

You have seen how 3-letter segments of words can suggest mediators, now these same 12 segments will be combined into six 6-letter words and I would like you to again practice generating mediators for them. You may find that using the same mediators as before will still be useful, or you may find that, once combined, these segments will suggest other mediators, perhaps mediators which look or sound like the entire foreign word. One potential problem with using two or more keywords for one foreign word is that you must find a way to link them so that the segments of the foreign word are kept in correct order. For example, you might want to use "curtain" and "physician" for "curphy", but unless you are careful, you could end up with "phycur". Again, please tell me any mediators that you think of, and I will give you feedback on them.

(DISPLAY REMAINING 6-LETTER WORDS)

Phase 3

Because this type of technique is most often used in order to link a foreign word with its translation, you will now see the same 6-letter words, this time presented with an English translation. You may find that considering the translation may help to suggest mediators which can naturally be associated with the translation. For example, "curphy-slave" might suggest Eddie Murphy because he is a well-known Black actor, and slaves in the American South were also black, or it might suggest "curfew" because you could imagine a slave having a curfew. On the other hand, if "curphy" meant "lamp" you might want to picture a "curvy" lamp, or your father sitting under a lamp at night waiting for you to come home in time for your "curfew".

Sometimes the foreign word may be very close in spelling to a familiar word which is difficult to associate with the translation. In a case like this, you might have to work harder in order to form an association between the keyword and the translation, possibly by creating a mental image of a scene or a situation in which the two interact in some way. Other times you may find a mediator which is closely related to the translation, but is not very close in spelling to the foreign word, in which case you must work hard to remember how the spelling of the foreign word differs from that of the keyword. However the mediators are chosen, however, the purpose of having them is to associate them with the translation so that, given the translation, you can recall both the mediators and the actual spelling of the foreign word, so you must always notice any similarities and differences between them so that you can recall the spelling of the foreign word.

You will now see the same 6-letter words, this time with an English translation. Try to form an association between the translation and any mediators you wish to use for each foreign word. In order to get practice in doing this flexibly, each word will also be shown with a second translation, and I would like you to try to form a new association with the alternate translation, either with the same mediators or with any other ones which seem useful. Tell me your mediators and how you would associate them with the translations, and I will provide feedback.

(DISPLAY 6-LETTER WORDS + TRANSLATIONS)

**(PROCEED TO INSTRUCTIONS FOR APPROPRIATE METHOD CONDITIONS:
trained control or trained keyword.)**

EXPERIMENT 2

Experimental instructions presented to participants in the trained control condition.

INSTRUCTIONS TO TRAINED CONTROL PARTICIPANTS

You will now be presented with a list of 24 new foreign words. These items will be presented on the video screen before you for a period of 10 seconds each. Immediately following the presentation of the entire list, I will provide you with a list of the translations and I will ask you to recall in writing the foreign words associated with each of these English translations. There will be three presentations of the same set of items, and each presentation will be followed by a recall test.

Each item will be presented in the same format as the examples you have already seen: The foreign word is on the left of the screen and its associated meaning or translation is on the right.

In order to learn this vocabulary, please use the techniques you have just practiced: For each foreign word, try to generate one or more mediators and associate them with the translation, either by creating a mental image, a verbal association, or a combination of both. At the same time, try to note the way in which the foreign word may differ from the spelling of the mediators so that you will be able to recall the spelling of the foreign word. We know that learning a new word and its meaning is not an easy task. You may find that you remember some parts of the foreign word, but may be unsure of other parts. We are interested in the progress you make on each trial in recalling the foreign word. Therefore, on the recall test sheets there are spaces for each letter of the foreign word. For each foreign word, please print in these spaces as many letters as you recall, even if you are not absolutely certain that they are correct, either in identity or position within the foreign word. If you do not recall a letter or letters at all, just leave those spaces blank.

Do you have any questions concerning the procedure?

If you are ready, I will now present the list. Do your best to memorize the list.

(PRESENT LIST #1)

Here is the list of English translations that you studied. Try to print as many of the foreign words as you think you can remember. You have five minutes.

(PRESENT RECALL TEST #1)

The list will now be presented again in a new random order. Please continue study the words by associating objects representing one or more mediators together with an object to represent the translation.

(REPEAT PRESENTATION AND RECALL TEST TWO MORE TIMES)

(QUESTIONNAIRE)

(DEBRIEFING)

EXPERIMENT 2

Experimental instructions presented to participants in the trained keyword condition.

INSTRUCTIONS TO TRAINED KEYWORD PARTICIPANTS

You will now be presented with a list of 24 new foreign words. These items will be presented on the video screen before you for a period of 10 seconds each. Immediately following the presentation of the entire list, I will provide you with a list of the translations and I will ask you to recall in writing the foreign words associated with each of these English translations. There will be three presentations of the same set of items, and each presentation will be followed by a recall test.

Each item will be presented in the same format as the examples you have already seen: The foreign word is on the left of the screen and its associated meaning or translation is on the right. In addition, below the foreign word is another English word. The first three letters of this English keyword are identical to the first three letters of the foreign word, so by using this keyword you will have a head start in finding mediators for the foreign word, although you will still have to find your own mediator or mediators for the remainder of each foreign word.

In order to learn this vocabulary, please use the techniques you have just practiced: For each foreign word, use the keyword provided and also try to generate one or more mediators for the remainder of the foreign word, and associate both the provided and self-generated keywords with the translation, either by creating a mental image, a verbal association, or a combination of both. At the same time, try to note the way in which the foreign word may differ from the spelling of the mediators so that you will be able to recall the spelling of the foreign word. We know that learning a new word and its meaning is not an easy task. You may find that you remember some parts of the foreign word, but may be unsure of other parts. We are interested in the progress you make on each trial in recalling the foreign word. Therefore, on the recall test sheets there are spaces for each letter of the foreign word. For each foreign word, please print in these spaces as many letters as you recall, even if you are not absolutely certain that they are correct, either in identity or position within the foreign word. If you do not recall a letter or letters at all, just leave those spaces blank.

Do you have any questions concerning the procedure?

If you are ready, I will now present the list. Do your best to memorize the list.

(PRESENT LIST #1)

Here is the list of English translations that you studied. Try to print as many of the foreign words as you think you can remember. You have five minutes.

(PRESENT RECALL TEST #1)

The list will be now be presented again in a new random order. Please continue to study the words by associating an object to represent the keyword and any other mediators for the rest of the foreign word together with an object to represent the translation.

(REPEAT PRESENTATION AND RECALL TEST TWO MORE TIMES)

(QUESTIONNAIRE)

(DEBRIEFING)

EXPERIMENT 2

Form used by experimenter to record self-generated mediators and associations during training phase (trained subjects only).

TRAINING PHASE RESPONSES

jai	_____
zie	_____
ava	_____
zep	_____
rus	_____
arb	_____
ush	_____
aph	_____
kio	_____
dby	_____
jaizie	_____
avazep	_____
rusarb	_____
ushaph	_____
kiodby	_____
jaizie	1. (golf) _____
	2. (moon) _____
avazep	1. (garden) _____
	2. (jewel) _____
rusarb	1. (oven) _____
	2. (billboard) _____
ushaph	1. (skillet) _____
	2. (butter) _____
kiodby	1. (shoe) _____
	2. (tricycle) _____

APPENDIX B: Experimental Stimuli

List of pseudowords and their summed position-sensitive log bigram and single-letter frequency values.

Pseudoword	Summed position-sensitive log frequency	
	bigram frequency	single-letter frequency
ambawn	7.293	18.913
avazep	6.710	18.273
bilvna	8.363	20.771
curphy	10.150	21.660
drudoy	10.258	21.541
embtur	8.324	20.108
elewos	8.226	21.195
fenork	12.010	21.340
flevro	8.853	19.649
glauky	8.392	20.770
goamto	9.301	21.732
jaizie	8.436	20.064
jelpda	8.395	19.675
kaylze	7.154	18.875
kiodby	7.066	19.132
lunvio	8.742	19.663
musdau	10.363	19.786
ocepca	6.840	20.362
optsul	9.129	19.987
phocir	10.684	21.794
quifut	9.051	18.602
rhjata	10.026	20.701
rusarb	10.958	20.044
skubew	8.602	19.667
swesny	7.940	21.210
telsia	11.321	21.433
twiorm	10.624	20.280
ushaph	7.739	19.004
vesmip	10.326	19.953
whefra	8.601	19.609
Range:	6.710-12.010	18.273-21.794

EXPERIMENT 1

List of experimental stimuli.

<u>Pseudoword</u>	<u>Translation</u>	<u>Keyword</u>
ambawn	tree	ambulance
avazep	garden	avalanche
bilvna	microscope	billboard
curphy	slave	curtain
drudoy	basement	drum
embtur	queen	embroidery
elewos	toast	elephant
fenork	acrobat	fence
flevro	bottle	flea
glauky	hotel	glacier
goamto	umbrella	goalie
jaizie	golf	jail
jelpda	letter	jelly
kaylze	newspaper	kayak
kiodby	shoe	kiosk
lunvio	ticket	lunchbox
musdau	potato	museum
ocepca	flag	ocean
optsul	mud	optician
phocir	nun	photograph
quifut	piano	quilt
rhiata	swamp	rhino
rusarb	oven	rust
skubew	apple	skunk
swesny	wigwam	sweater
telsia	harp	television
twiorm	pencil	twins
ushaph	skillet	usher
vesmip	fox	vest
whefra	table	wheat

Items used as examples

swazro	poster	swan
wrifep	salad	wristwatch
twefny	butter	tweezers

EXPERIMENT 2

List of experimental stimuli.

<u>Pseudoword</u>	<u>Translation</u>	<u>Keyword</u>
ambawn	tree	ambulance
bilvna	microscope	billboard
drudoy	basement	drum
embtur	queen	embroidery
elewos	toast	elephant
fenork	acrobat	fence
flevro	bottle	flea
glauky	hotel	glacier
goamto	umbrella	goalie
jelpda	letter	jelly
kaylze	newspaper	kayak
lunvio	ticket	lunchbox
musdau	potato	museum
ocepca	flag	ocean
optsul	mud	optician
phocir	nun	photograph
quifut	piano	quilt
rhiata	swamp	rhino
skubew	apple	skunk
swesny	wigwam	sweater
telsia	harp	television
twiorm	pencil	twins
vesmip	fox	vest
whefra	table	wheat

**APPENDIX C: Strategy-Use Interviews:
Interview Questions and Coding Criteria**

EXPERIMENT 1

Introduction to the post-experimental strategy-use interview given to participants in the control condition.

CONTROL CONDITION INTERVIEW

I would like to ask you some questions about how you attempted to remember the foreign words and their translations.

First of all, in general, did you have any particular method or strategy more often than any other in order to link the foreign word with its translation and to recall the foreign word itself?

Now I would like to go through the list of foreign words, in alphabetical order. I will read the foreign word and its translation and I would like you to tell me what you did to form associations between these items at the time you studied them, regardless of whether you were later able to recall them.

I would like you to give me this information in a specific way. For each word I would like you to answer two questions:

1) First, was there anything about the foreign word itself that helped you to remember it? That is, what made the foreign word distinctive and helped you to some or all of it?

2) Second, how did you try to link the foreign word with its translation?

Do you have any final comments about the words, your reaction to them, or the strategies you used to memorize them?

EXPERIMENT 1

Introduction to the post-experimental strategy-use interview given to participants in the standard mnemonic keyword condition.

STANDARD MNEMONIC KEYWORD CONDITION INTERVIEW

I would now like to go through the list of foreign words in alphabetical order and ask you to tell me if you were able to form an interactive image containing both the keyword and translation for each foreign word. If you did use the keyword method as I just described it, you may just reply "yes". If not, perhaps you could describe to me what you did do to try to remember the meaning and spelling of the foreign word. For example, did you form an image of the translation without the keyword or without the translation? Or did you use some other method entirely to remember the word and its meaning, such as a sentence or your own keyword?

EXPERIMENT 1

Introduction to the post-experimental strategy-use interview given to participants in the keyword + orthographic image condition.

KEYWORD + ORTHOGRAPHIC IMAGE CONDITION INTERVIEW

I would now like to go through the list of foreign words in alphabetical order and ask you to tell me if you were able to form an interactive image containing both the keyword and translation and the foreign word itself for each foreign word. If you did use the keyword method as I just described it, you may just reply "yes". If not, perhaps you could describe to me what you did do to try to remember the meaning and spelling of the foreign word. For example, did you form an image of the translation without the keyword or without the translation or were you unable to visualize the foreign word printed in the image? Or did you use some other method entirely to remember the word and its meaning, such as a sentence or your own keyword?

EXPERIMENT 1

Decision criteria for coding interview responses.

FIRST HALF

O = non-keyword strategy

- e.g.:
- no strategy specified
 - rote rehearsal
 - spelling the pseudoword
 - substitution of the pseudoword for the translation in a sentence
 - use of a proper name for which the subject has no concrete referent

P = provided keyword

S = self-generated keyword used which has at least one letter in common with first syllable

- e.g.:
- any word(s) or proper names for which the subject knows the meaning or has a referent

X = no response obtained

- e.g.:
- an item was overlooked by the interviewer or the response was not recorded on the audio tape

SECOND HALF

O = non-keyword strategy

S = self-generated keyword

W = orthographic form of the pseudoword (or at least second half) imaged in interactive image with translation and keyword

X = no response obtained (see first half)

LINK BETWEEN THE KEYWORD MEDIATOR(S) AND THE TRANSLATION

O = non-semantic link

- e.g.: -- no strategy specified
 -- rote rehearsal of keyword(s) and translation
 -- an acoustic or orthographic link (e.g.: sweater and wigwam both have a "w" in them)

I = at least one mediator linked with translation in an interactive image

V = at least one mediator linked with translation in a sentence or other verbal association

- e.g.: -- optsul /optician/ (mud): The OPTICIAN was SULLEN when he fell in the mud.
 -- embtur (queen): EMPEROR-Queen (semantic similarity between keyword and translation)

GLOBAL CATEGORIES

First and second halves:

O = non-keyword encoding strategies (includes O and W)

K = keyword encoding strategies (includes P, S, and T)

Link between keyword mediator(s) and translation:

O = no semantic link present (includes O)

L = semantic link present (includes I and V)

EXPERIMENT 2

Introduction to the post-experimental strategy-use interview given to participants in the untrained control condition.

UNTRAINED CONTROL CONDITION INTERVIEW

I would like to ask you some questions about how you attempted to remember the foreign words and their translations.

First of all, in general, did you have any particular method or strategy more often than any other in order to link the foreign word with its translation and to recall the foreign word itself?

Now I would like to go through the list of foreign words, in alphabetical order. I will read the foreign word and its translation and I would like you to tell me what you did to form associations between these items at the time you studied them, regardless of whether you were later able to recall them.

I would like you to give me this information in a specific way.
For each word I would like you to answer two questions:

- 1) First, was there anything about the foreign word itself that helped you to remember it? That is, what made the foreign word distinctive and helped you to some or all of it?
- 2) Second, how did you try to link the foreign word with its translation?

Do you have any final comments about the words, your reaction to them, or the strategies you used to memorize them?

EXPERIMENT 2

Introduction to the post-experimental strategy-use interview given to participants in the untrained keyword condition.

UNTRAINED KEYWORD CONDITION INTERVIEW

I would like to ask you some questions about how you attempted to remember the foreign words and their translations.

Now I would like to go through the list of foreign words, in alphabetical order. I will read the foreign word and its translation and I would like you to tell me what you did to form associations between these items at the time you studied them, regardless of whether you were later able to recall them.

I would like you to give me this information in a specific way. For each word I would like you to answer two questions:

- 1) First, was there anything about the foreign word itself that helped you to remember it? That is, what made the foreign word distinctive and helped you to some or all of it?
- 2) Second, how did you try to link the foreign word with its translation?

Do you have any final comments about the words, your reaction to them, or the strategies you used to memorize them?

EXPERIMENT 2

Introduction to the post-experimental strategy-use interview given to participants in the untrained keyword condition.

UNTRAINED KEYWORD CONDITION INTERVIEW

I would like to ask you some questions about how you attempted to remember the foreign words and their translations.

Now I would like to go through the list of foreign words, in alphabetical order. I will read the foreign word and its translation and I would like you to tell me what you did to form associations between these items at the time you studied them, regardless of whether you were later able to recall them.

I would like you to give me this information in a specific way.
For each word I would like you to answer two questions:

- 1) First, were you able to form an interactive image or verbal association which included the keyword and the translation? Could you describe this association?
- 2) In addition, could you explain how you attempted to remember the second half of the word?

Do you have any final comments about the words, your reaction to them, or the strategies you used to memorize them?

EXPERIMENT 2

Introduction to the post-experimental strategy-use interview given to participants in the trained keyword condition.

TRAINED KEYWORD CONDITION INTERVIEW

I would like to ask you some questions about how you attempted to remember the foreign words and their translations.

Now I would like to go through the list of foreign words, in alphabetical order. I will read the foreign word and its translation and I would like you to tell me what you did to form associations between these items at the time you studied them, regardless of whether you were later able to recall them.

I would like you to give me this information in a specific way. For each word I would like you to answer two questions:

- 1) First, were you able to form an interactive image or verbal association which included the keyword which was provided, the translation, and possibly other mediators which you yourself generated? Could you describe this association?
- 2) If you did not generate a mediator for the second half of the word, how did you attempt to memorize it?

Do you have any final comments about the words, your reaction to them, or the strategies you used to memorize them?

EXPERIMENT 2

Decision criteria for coding interview responses.

FIRST HALF

O = non-keyword strategy

- e.g.:
- no strategy specified
 - rote rehearsal
 - spelling the pseudoword
 - substitution of the pseudoword for the translation in a sentence
 - use of a proper name for which the subject has no concrete referent

P = provided keyword

S = self-generated keyword used which has at least one letter in common with first syllable

- e.g.:
- any word(s) or proper names for which the subject knows the meaning or has a referent

X = no response obtained

- e.g.:
- an item was overlooked by the interviewer or the response was not recorded on the audio tape

SECOND HALF

O = non-keyword strategy

S = self-generated keyword

X = no response obtained

LINK BETWEEN THE KEYWORD MEDIATOR(S) AND THE TRANSLATION

O = non-semantic link

- e.g.:
- no strategy specified
 - rote rehearsal of keyword(s) and translation an acoustic or orthographic link (e.g.: SWEATER and SWESNY both have "w" in them)

L = at least one mediator linked with translation in an interactive image, sentence, phrase, or other type of word association

EXPERIMENTS 1 AND 2

Consent form signed by subjects prior to the post-experimental interview.

FORM OF CONSENT

I, _____, have agreed to participate in an experiment on memory processes, conducted at the Cognitive Psychology Laboratory, and to have the verbal description of what I did to memorize the presented words taped on a cassette. It is my understanding that a) this information will remain strictly confidential, b) this information will be used only for the expressed purpose of this research project (that is, to examine participants' subjective impressions of what they do when they try to memorize information) and for no other purposes, and c) every cassette that contains participants' verbal descriptions of what I did to memorize the presented material will be erased after these descriptions have been coded for statistical analyses.

Signature: _____

APPENDIX D: Computer Programs to Analyze Data

EXPERIMENTS 1 AND 2

The following programs, written in GW-BASIC, were written by David Wieland to analyze, letter by letter, the responses of each subject on every trial. The following steps were carried out in order to run these programs:

1) Each subject's responses were entered into a standard BASIC data file (RESPONSE.DAT) in the format shown in the example below:

```
"1","01","2","B2","emb...","1"
"1","01","2","B2","*....a","0"
"1","01","2","B2","jaizae","1"
"1","01","3","C1","curphy","1"
"1","01","3","C1","mis...","0"
"1","01","3","C1",".awn...","0"
```

Where the following, in order on the data line represents:

```
"1"           = experimental condition
"01"          = subject number
"2" and "3"   = trial
"B2" and "C1" = response sheet number
"emb..."    = subject's response for that item
               (... represents blank letter spaces)
"1" and "0"   = successful (1) or unsuccessful (0)
               recall of the keyword
```

The above information was typed into a file from the individual subjects' response sheets.

The "foreign word" (pseudoword) lists with correct responses were also entered as individual files for each response answer sheet (e.g. FORWORDS.B2, FORWORDS.C1) against which subjects' answers were compared.

The following is an example of a FORWORDS. file. In Experiment 1, there were two such files (for a total of 30 words) for each subject per trial.

The output file consists of a copy of the original input file fields plus the new categorization fields. These are:

The first 6 fields without quotation marks are the exact match between the letters in the subject's response and the correct response from the master response sheet.

The next 12 fields refer to matches between the subject's response and a comparison with two sets of categories of letters which were not used in the final analyses of the responses.

The next 6 fields represented letters which belonged to the correct pseudoword, but which were not in their correct position.

The last field indicated if a trigram appeared in the subject's response which belonged in the correct word, but was shifted from its correct position.¹⁶

The analysis of **Experiment 2** was similar to that of **Experiment 1** with the following exceptions:

- 1) the input file (RESPONSE.DAT) did not include keyword scores, and
- 2) the word list sheets were different, each consisting of 24 pseudowords.

A series of short programs (not included) used the analyzed data in the RESPONSE.CAT file to generate reports listing the recall, by subject and by trial, of whole pseudowords, first and second halves of pseudowords, and total correct letters.

¹⁶Shifted trigrams were not analyzed in this research due to the infrequency of their occurrence.

EXPERIMENT 1

Computer program for analyzing subjects' responses.

```

10 'ANALYZE.ASC -- Analyze "foreign" word responses (ASCII version)
20 'Author: David Wieland
30 'Date: 14/Jan/87
40 '
50 CLS
60 LPRINT TIMES
70 PRINT "Preparing to analyze file 'RESPONSE.DAT'"
80 DEFINT A-Z
100 ON ERROR GOTO 1150
130 OPEN "RESPONSE.DAT" FOR INPUT AS #1
140 OPEN "RESPONSE.cat" FOR OUTPUT AS #2
180 OPTION BASE 1
190 DIM BS$(7)
200 BS$(1)="aszx" :BS$(2)="eoc" :BS$(3)="rvv" :BS$(4)="nmu"
210 BS$(5)="dhkb" :BS$(6)="tilf" :BS$(7)="gjpqy"
220 DIM SX$(7)
230 SX$(1)="aehiouwy" : SX$(2)="bfpv" : SX$(3)="cgjkqszx" : SX$(4)="dt" :
SX$(5)="l" : SX$(6)="m" : SX$(7)="r"
240 DIM EXAC(6), BOUM(6), BADP(6), SNDX(6)
250 DIM TRIS(4)
280 SHT$ = " " : SBJ$ = " "
290 LINE INPUT #1, REC$
300 WHILE NOT EOF(1)
310 INPUT #1, COND$, SUBJ$, TRIAL$, SHEET$, RESP$, KWSCORE$
340 PRINT SUBJ$,TRIAL$,SHEET$
350 IF SHEET$ + SUBJ$ <> SHT$ + SBJ$ THEN GOSUB 900
380 INPUT #3, LN, FW$
400 FW2$ = FW$
410 SHIFTED = 0
420 IF RESP$ = "....." THEN GOSUB 560 : GOTO 480
430 IF RESP$ = FW$ THEN GOSUB 630 : GOTO 480
440 GOSUB 710
450 GOSUB 1250
480 WRITE#2,COND$,SUBJ$,TRIAL$,SHEET$,RESP$,KWSCORE$,EXAC(1),
EXAC(2),EXAC(3),EXAC(4),EXAC(5),EXAC(6),BOUM(1),BOUM(2),BOUM(3),
BOUM(4),BOUM(5),BOUM(6),SNDX(1),SNDX(2),SNDX(3),SNDX(4),SNDX(5),
SNDX(6),BADP(1),BADP(2),BADP(3),BADP(4),BADP(5),BADP(6),SHIFTED
490 WEND
500 CLOSE
510 END
560 FOR P = 1 TO 6
570 EXAC(P)=0: BOUM(P)=0: SNDX(P)=0: BADP(P)=0
580 NEXT P
600 RETURN
630 FOR P = 1 TO 6
640 EXAC(P)=1: BOUM(P)=0: SNDX(P)=0: BADP(P)=0
650 NEXT P

```

```

670 RETURN
710 FOR P = 1 TO 6
720 RLETR$ = MID$(RESP$,P,1) : FLETR$ = MID$(FW$,P,1)
730 IF RLETR$ = FLETR$ THEN GOSUB 1220
740 NEXT
760 FOR P = 1 TO 6
770 EXAC(P) = 0 : BOUM(P) = 0 : BADP(P) = 0 : SNOX(P) = 0
780 RLETR$ = MID$(RESP$,P,1) : FLETR$ = MID$(FW$,P,1)
790 IF RLETR$ = "." THEN GOTO 860
800 IF RLETR$ = FLETR$ THEN EXAC(P)=1 : BOUM(P)=0 : BADP(P)=0 : SNOX(P)=0 : GO
TO 860
810 IF RLETR$ <> FLETR$ THEN GOSUB 970 : GOSUB 1060
820 IF BMATCH = 0 THEN BOUM(P) = 0 ELSE BOUM(P) = 1
830 IF SMATCH = 0 THEN SNOX(P) = 0 ELSE SNOX(P) = 1
840 IF INSTR(FW2$,RLETR$) <> 0 THEN BADP(P) = 1 : GOSUB 1220
860 NEXT P
870 RETURN
900 FW$ = "FORWORDS." + SHEET$
910 CLOSE #3
920 OPEN FW$ FOR INPUT AS #3
930 SHT$ = SHEET$ : SBJ$ = SUBJ$
940 RETURN
970 BGROUP = 0
980 FOR G = 1 TO 7
990 IF INSTR(BS$(G),RLETR$) > 0 THEN BGROUP=G : G=7
1000 NEXT G
1020 BMATCH = INSTR(BS$(BGROUP),FLETR$)
1030 RETURN
1060 SGROUP = 0
1070 FOR G = 1 TO 7
1080 IF INSTR(SX$(G),RLETR$) > 0 THEN SGROUP=G : G=7
1090 NEXT G
1110 SMATCH = INSTR(SX$(SGROUP),FLETR$)
1120 RETURN
1150 IF ERR = 53 THEN PRINT "Non-existent file" ELSE PRINT "Error #"; ERR
1160 IF ERL = 920 THEN PRINT " " FW$ ELSE PRINT " at line"; ERL
1170 WRITE #2, "ERROR",COND$, SUBJ$, TRIAL$, SHEET$, RESP$, FW$, FW2$, RLETR$, F
LETR$,P
1171 LPRINT "ERROR",COND$, SUBJ$, TRIAL$, SHEET$, RESP$, FW$, FW2$, RLETR$, F
LETR$,P
1180 LPRINT TIMES
1190 GOTO 300
1220 FW2$ = LEFT$(FW2$,INSTR(FW2$,RLETR$)-1) + MID$(FW2$,INSTR(FW2$,RLETR$)+1)
1230 RETURN
1250 FOR TCNT = 1 TO 4
1260 TRIS(TCNT) = MID$(RESP$,TCNT,3)
1270 IF INSTR(TRIS(TCNT),".") THEN GOTO 1300
1280 POSN = INSTR(FW$,TRIS(TCNT))
1290 IF (POSN <> 0 AND POSN <> TCNT) THEN SHIFTED = POSN : TCNT = 4
1300 NEXT TCNT
1310 RETURN

```

EXPERIMENT 2

Computer program for analyzing subjects' responses.

```

10 'ANALYZE2.ASC -- Analyze "foreign" word responses (ASCII version)
20 'Author: David Wieland
30 'Date: 14/Jan/87
40 '
50 CLS
60 LPRINT TIMES
70 PRINT "Preparing to analyze file 'RESPONSE.DAT'"
80 DEFINT A-Z
100 ON ERROR GOTO 1150
130 OPEN "RESPONSE.DAT" FOR INPUT AS #1
140 OPEN "RESPONSE.cat" FOR OUTPUT AS #2
180 OPTION BASE 1
190 DIM BS$(7)
200 BS$(1)="aszx" : BS$(2)="eoc" : BS$(3)="rvw" : BS$(4)="nmu"
210 BS$(5)="dhkb" : BS$(6)="tilf" : BS$(7)="gjqpy"
220 DIM SX$(7)
230 SX$(1)="aeihouwy" : SX$(2)="bfpv" : SX$(3)="cgjkqszx" : SX$(4)="dt" : SX$(5)="l" : SX$(6)="m"
   : SX$(7)="r"
240 DIM EXAC(6), BOUM(6), BADP(6), SNOX(6)
250 DIM TRIS(4)
280 SHT$ = " " : SBJS = " "
290 LINE INPUT #1, RECS
300 WHILE NOT EOF(1)
310 INPUT #1, CONDS$, SUBJS$, TRIAL$, SHEETS$, RESP$
340 PRINT SUBJS$, TRIAL$, SHEETS$
350 IF SHEETS$ + SUBJS$ <> SHT$ + SBJS$ THEN GOSUB 900
380 INPUT #3, LN, FL$
400 FW2$ = FL$
410 SHIFTED = 0
420 IF RESP$ = "....." THEN GOSUB 560 : GOTO 480
430 IF RESP$ = FL$ THEN GOSUB 630 : GOTO 480
440 GOSUB 710
450 GOSUB 1250
480 WRITE #2, CONDS$, SUBJS$, TRIAL$, SHEETS$, RESP$, EXAC(1), EXAC(2), EXAC(3), EXAC(4), EXAC(5), EXAC(6), BOUM(1),
BOUM(2), BOUM(3), BOUM(4), BOUM(5), BOUM(6), SNOX(1), SNOX(2), SNOX(3), SNOX(4), SNOX(5), SNOX(6), BADP(1), BADP(2),
BADP(3), BADP(4), BADP(5), BADP(6), SHIFTED
490 WEND
500 CLOSE
510 END
560 FOR P = 1 TO 6
570 EXAC(P)=0: BOUM(P)=0: SNOX(P)=0: BADP(P)=0
580 NEXT P
600 RETURN
630 FOR P = 1 TO 6
640 EXAC(P)=1: BOUM(P)=0: SNOX(P)=0: BADP(P)=0
650 NEXT P
670 RETURN
710 FOR P = 1 TO 6

```

```

720 RLETR$ = MID$(RESP$,P,1) : FLETR$ = MID$(FW$,P,1)
730 IF RLETR$ = FLETR$ THEN GOSUB 1220
740 NEXT
760 FOR P = 1 TO 6
770 EXAC(P) = 0 : BOUM(P) = 0 : BADP(P) = 0 : SNOX(P) = 0
780 RLETR$ = MID$(RESP$,P,1) : FLETR$ = MID$(FW$,P,1)
790 IF RLETR$ = "." THEN GOTO 860
800 IF RLETR$ = FLETR$ THEN EXAC(P)=1 : BOUM(P)=0 : BADP(P)=0 : SNOX(P)=0 : GOTO 860
810 IF RLETR$ <> FLETR$ THEN GOSUB 970 : GOSUB 1060
820 IF SMATCH = 0 THEN BOUM(P) = 0 ELSE BOUM(P) = 1
830 IF SMATCH = 0 THEN SNOX(P) = 0 ELSE SNOX(P) = 1
840 IF INSTR(FW2$,RLETR$) <> 0 THEN BADP(P) = 1 : GOSUB 1220
860 NEXT P
870 RETURN
900 FW$ = "FORWORDS." + SHEET$
910 CLOSE #3
920 OPEN FW$ FOR INPUT AS #3
930 SHT$ = SHEET$ : SBJ$ = SUBJ$
940 RETURN
970 BGROUP = 0
980 FOR G = 1 TO 7
990 IF INSTR(BS$(G),RLETR$) > 0 THEN BGROUP=G : G=7
1000 NEXT G
1020 BMATCH = INSTR(BS$(BGROUP),FLETR$)
1030 RETURN
1060 SGROUP = 0
1070 FOR G = 1 TO 7
1080 IF INSTR(SX$(G),RLETR$) > 0 THEN SGROUP=G : G=7
1090 NEXT G
1110 SMATCH = INSTR(SX$(SGROUP),FLETR$)
1120 RETURN
1150 IF ERR = 53 THEN PRINT "Non-existent file" ELSE PRINT "Error #"; ERR
1160 IF ERL = 920 THEN PRINT " " FW$ ELSE PRINT " at line"; ERL
1170 WRITE #2, "ERROR",COMD$, SUBJ$, TRIAL$, SHEET$, RESP$, FW$, FW2$, RLETR$, FLETR$,P
1171 LPRINT "ERROR",COMD$, SUBJ$, TRIAL$, SHEET$, RESP$, FW$, FW2$, RLETR$, FLETR$,P
1180 LPRINT TIMES
1190 GOTO 300
1220 FW2$ = LEFT$(FW2$,INSTR(FW2$,RLETR$)-1) + MID$(FW2$,INSTR(FW2$,RLETR$)+1)
1230 RETURN
1250 FOR TCNT = 1 TO 4
1260 TRIS(TCNT) = MID$(RESP$,TCNT,3)
1270 IF INSTR(TRIS(TCNT),".") THEN GOTO 1300
1280 POSN = INSTR(FW$,TRIS(TCNT))
1290 IF (POSN <> 0 AND POSN <> TCNT) THEN SHIFTED = POSN : TCNT = 4
1300 NEXT TCNT
1310 RETURN

```

APPENDIX E: Summary of ANOVAs, Tests of Simple Effects, and t Tests

EXPERIMENT 1

Results of the analysis of variance performed on recall of pseudowords with one between-subjects variable (mnemonic instructions) and one within-subjects variable (trial).

<u>Effect</u>	<u>F value</u>	<u>df</u>	<u>MSe</u>	<u>Probability of Significance</u>
Mnemonic instructions	0.86	2,57	.117	.429
Trial	284.02	2,84	.014	.0001
T X M	0.91	3,84	.014	.439

EXPERIMENT 1

Results of the analysis of variance performed on recall of letters with one between-subjects variable (mnemonic instructions), and one within-subjects variable (trial).

<u>Effect</u>	<u>F value</u>	<u>df</u>	<u>MSe</u>	<u>Probability of Significance</u>
Mnemonic instructions	2.22	2,57	.103	.117
Trial	438.90	2,92	.008	.0001
T X M	1.88	3,92	.008	.134

EXPERIMENT 1

Results of the analysis of variance performed on recall of halves with one between-subjects variable (mnemonic instructions), and two within-subjects variables (trial and half).

<u>Effect</u>	<u>F value</u>	<u>df</u>	<u>MSe</u>	<u>Probability of Significance</u>
Mnemonic instructions	6.65	2,57	.172	.003
Half	435.08	1,57	.034	.0001
H X M	78.27	2,57	.034	.0001
Trial	473.64	2,97	.015	.0001
T X M	1.12	3,97	.015	.346
H X T	24.37	1,84	.011	.0001
H X T X M	6.39	3,84	.011	.001

EXPERIMENT 1

Results of tests of simple interaction effects on the Halves x Trials x Mnemonic instructions interaction for recall of halves.

<u>Variable</u> <u>Held Constant</u>	<u>Effect</u>	<u>F value</u>	<u>df</u>	<u>MSe</u>	<u>Probability</u> <u>of Significance</u>
Control	H X T	0.42	1,84	.011	.599
Standard KW	H X T	21.79	1,84	.011	.0001
KW + O.I.	H X T	14.94	1,84	.011	.0001
Trial 1	H X M	37.94	2,57	.017	.0001
Trial 2	H X M	97.36	2,57	.012	.0001
Trial 3	H X M	36.94	2,57	.020	.0001
Trial 4	H X M	15.49	2,57	.017	.0001
1st Half	T X M	6.00	3,91	.012	.001
2nd Half	T X M	1.18	3,90	.014	.324

EXPERIMENT 1

Results of tests of simple simple main effects on recall of halves.

<u>Variables</u>					
<u>Held Constant</u>	<u>Effect</u>	<u>F value</u>	<u>df</u>	<u>MSe</u>	<u>Probability of Significance</u>
1st half at T1	M	27.58	2,57	.037	.0001
1st half at T2	M	50.05	2,57	.030	.0001
1st half at T3	M	32.21	2,57	.028	.0001
1st half at T4	M	14.67	2,57	.025	.0001
Standard KW at T1	H	144.54	1,57	.017	.0001
Standard KW at T2	H	385.80	1,57	.012	.0001
Standard KW at T3	H	116.05	1,57	.020	.0001
Standard KW at T4	H	55.55	1,57	.017	.0001
KW + O.I. at T1	H	106.19	1,57	.017	.0001
KW + O.I. at T2	H	352.91	1,57	.012	.0001
KW + O.I. at T3	H	151.83	1,57	.020	.0001
KW + O.I. at T4	H	80.71	1,57	.017	.0001

EXPERIMENT 1

Results of the analysis of variance performed on recall of keywords with one between-subjects variable (mnemonic instructions, two keyword conditions only) and one within-subjects variable (trial).

<u>Effect</u>	<u>F value</u>	<u>df</u>	<u>MSe</u>	<u>Probability of Significance</u>
Mnemonic instructions	1.58	2,38	.043	.216
Trial	164.62	2,57	.009	.0001
T X M	2.50	2,57	.009	.105

EXPERIMENT 1

Results of t tests performed on main effects and interaction effects involving trials.

<u>Comparisons</u>	<u>Trials</u>	<u>Mean</u>	<u>S.E.M.</u>	<u>t value</u>	<u>Prob. of Sig.</u>	<u>df</u>
Pseudowords (m.e.)	1 - 2	.16	.017	- 9.25	.0000	59
	2 - 3	.23	.016	-14.33	.0000	59
	3 - 4	.20	.013	-15.63	.0000	59
Letters (m.e.)	1 - 2	.25	.017	-14.83	.0000	59
	2 - 3	.19	.009	-20.00	.0000	59
	3 - 4	.13	.010	-12.97	.0000	59
Keywords (m.e.)	1 - 2	.31	.023	-13.66	.0000	39
	2 - 3	.10	.016	- 6.24	.0000	39
	3 - 4	.03	.007	- 3.72	.0006	39
Pseudowords at Controls	1 - 2	.20	.036	- 5.58	.0000	19
	2 - 3	.21	.027	- 7.69	.0000	19
	3 - 4	.18	.027	- 6.70	.0000	19
Pseudowords at Standard keyword	1 - 2	.15	.030	- 4.93	.0000	19
	2 - 3	.28	.029	- 9.43	.0000	19
	3 - 4	.22	.025	- 8.54	.0000	19
Pseudowords at Keyword + o.i.	1 - 2	.13	.021	- 6.15	.0000	19
	2 - 3	.22	.028	- 7.88	.0000	19
	3 - 4	.22	.014	-15.96	.0000	19
First Halves at Controls	1 - 2	.26	.035	- 7.39	.0000	19
	2 - 3	.20	.024	- 8.50	.0000	19
	3 - 4	.17	.023	- 7.35	.0000	19
First Halves at Standard keyword	1 - 2	.34	.037	- 9.06	.0000	19
	2 - 3	.08	.019	- 4.01	.0008	19
	3 - 4	.03	.012	- 2.76	.0126	19
First Halves at Keyword + o.i.	1 - 2	.36	.036	-10.09	.0000	19
	2 - 3	.12	.022	- 5.47	.0000	19
	3 - 4	.03	.012	- 2.70	.0141	19

EXPERIMENT 2

Results of the analysis of variance performed on MLAT scores with two between-subjects variables (method and training).

<u>Effect</u>	<u>F value</u>	<u>df</u>	<u>MSe</u>	<u>Probability of Significance</u>
Method	0.00	1,76	57.31	.953
Training	1.40	1,76	57.31	.241
M X Tra	0.00	1,76	57.31	.977

EXPERIMENT 2

Results of the analysis of variance performed on recall of pseudowords with two between-subjects variables (method and training) and one within-subjects variable (trial).

<u>Effect</u>	<u>F value</u>	<u>df</u>	<u>MSe</u>	<u>Probability of Significance</u>
Method	0.09	1,76	.087	.765
Training	8.74	1,76	.087	.004
M X Tra	0.98	1,76	.087	.325
Trial	221.62	1,97	.017	.0001
T X M	0.13	1,97	.017	.781
T X Tra	6.12	1,97	.017	.009
T X M X Tra	0.14	1,97	.017	.772

EXPERIMENT 2

Results of tests of simple main effects on the Trial x Training interaction on recall of pseudowords.

<u>Variable</u>					<u>Probability</u>
<u>Held Constant</u>	<u>Effect</u>	<u>F value</u>	<u>df</u>	<u>MSe</u>	<u>of Significance</u>
Untrained	T	77.05	1,97	.017	.0001
Trained	T	150.69	1,97	.017	.0001
Trial 1	Tra	7.20	1,76	.004	.009
Trial 2	Tra	6.09	1,76	.042	.016
Trial 3	Tra	9.11	1,76	.075	.004

EXPERIMENT 2

Results of the analysis of variance performed on recall of letters with two between-subjects variables (method and training) and one within-subjects variable (trial).

<u>Effect</u>	<u>F value</u>	<u>df</u>	<u>MSe</u>	<u>Probability of Significance</u>
Method	1.70	1,76	.088	.196
Training	3.16	1,76	.088	.079
M X Tra	1.53	1,76	.088	.221
Trial	764.62	2,128	.006	.0001
T X M	0.07	2,128	.006	.899
T X Tra	7.46	2,128	.006	.002
T X M X Tra	1.11	2,128	.006	.324

EXPERIMENT 2

Results of tests of simple main effects on the Training x Trials interaction for recall of letters.

<u>Variable</u>					<u>Probability</u>
<u>Held Constant</u>	<u>Effect</u>	<u>F value</u>	<u>df</u>	<u>MSe</u>	<u>of Significance</u>
Untrained	T	310.55	2,128	.006	.0001
Trained	T	461.53	2,128	.006	.0001
Trial 1	Tra	0.38	1,76	.017	.539
Trial 2	Tra	2.65	1,76	.042	.108
Trial 3	Tra	6.12	1,76	.041	.016

EXPERIMENT 2

Results of the analysis of variance performed on halves with two between-subjects variables (method and training) and two within-subjects variable (trial and half).

<u>Effect</u>	<u>F value</u>	<u>df</u>	<u>MSe</u>	<u>Probability of Significance</u>
Method	8.29	1,76	.174	.005
Training	2.43	1,76	.174	.123
M X Tra	1.06	1,76	.174	.306
Half	354.29	1,76	.015	.0001
H X M	144.02	1,76	.015	.0001
H X Tra	31.85	1,76	.015	.0001
H X M X Tra	70.10	1,76	.015	.0001
Trial	587.31	2,115	.015	.0001
T X M	0.34	2,115	.015	.650
T X Tra	11.57	2,115	.015	.0001
T X M X Tra	0.25	2,115	.015	.716
H X T	3.91	1,106	.013	.037
H X T X M	0.84	1,106	.013	.397
H X T X Tra	0.03	1,106	.013	.919
H X T X M X Tra	0.49	1,106	.013	.546

EXPERIMENT 2

Results of tests of simple main effects on the Halves x Trials and Trials x Training interactions for recall of halves.

<u>Variable</u>					<u>Probability</u>
<u>Held Constant</u>	<u>Effect</u>	<u>F value</u>	<u>df</u>	<u>MSe</u>	<u>of Significance</u>
1st half	T	396.82	2,124	.012	.0001
2nd half	T	250.84	1,120	.016	.0001
Trial 1	H	85.43	1,76	.015	.0001
Trial 2	H	208.21	1,76	.012	.0001
Trial 3	H	113.32	1,76	.014	.0001
Untrained	T	217.16	2,115	.015	.0001
Trained	T	381.72	2,115	.015	.0001
Trial 1	Tra	0.16	1,76	.028	.693
Trial 2	Tru	2.47	1,76	.078	.120
Trial 3	Tra	5.78	1,76	.098	.019

EXPERIMENT 2

Results of tests of simple interaction effects on the Halves x Method x Training interaction.

<u>Variable</u>	<u>Effect</u>	<u>F value</u>	<u>df</u>	<u>MSe</u>	<u>Probability of Significance</u>
<u>Held Constant</u>					
Control	H X Tra	3.72	1,76	.015	.057
Keyword	H X Tra	98.23	1,76	.015	.0001
Untrained	H X M	207.54	1,76	.015	.0001
Trained	H X M	6.58	1,76	.015	.012
1st half	M X Tra	10.79	1,76	.098	.002
2nd half	M X Tra	1.96	1,76	.091	.166

EXPERIMENT 2

Results of tests of simple simple main effects on recall of halves.

<u>Variables</u> <u>Held Constant</u>	<u>Effect</u>	<u>F value</u>	<u>df</u>	<u>MSe</u>	<u>Probability</u> <u>of Significance</u>
Untrained, 1st half	M	43.38	1,76	.098	.0001
Trained, 1st half	M	3.77	1,76	.098	.056
Untrained, 2nd half	M	2.07	1,76	.091	.155
Trained, 2nd half	M	0.29	1,76	.091	.589
Control, 1st half	Tra	5.09	1,76	.098	.027
Control, 2nd half	Tra	1.53	1,76	.091	.220
Keyword, 1st half	Tra	5.71	1,76	.098	.019
Keyword, 2nd half	Tra	10.35	1,76	.091	.002
Untrained control	H	4.19	1,76	.015	.044
Trained control	H	22.80	1,76	.015	.0001
Untrained keyword	H	502.65	1,76	.015	.0001
Trained keyword	H	70.62	1,76	.015	.0001

EXPERIMENT 2

Results of t tests performed on interaction effects involving trials.

<u>Comparisons</u>	<u>Trials</u>	<u>Mean</u>	<u>S.E.M.</u>	<u>t value</u>	<u>Prob. of Sig.</u>	<u>df</u>
Pseudowords at untrained	1 - 2	.17	.026	- 6.58	.0000	39
	2 - 3	.19	.021	- 9.16	.0000	39
Pseudowords at trained	1 - 2	.24	.025	- 9.80	.0000	39
	2 - 3	.26	.019	-13.62	.0000	39
Letters at untrained	1 - 2	.24	.017	-14.68	.0000	39
	2 - 3	.19	.011	-16.39	.0000	39
Letters at trained	1 - 2	.30	.019	-15.47	.0000	39
	2 - 3	.22	.015	-15.03	.0000	39
Halves at untrained	1 - 2	.22	.018	-12.34	.0000	39
	2 - 3	.18	.014	-13.03	.0000	39
Halves at trained	1 - 2	.30	.019	-16.04	.0000	39
	2 - 3	.23	.015	-15.71	.0000	39
First halves (m.e.)	1 - 2	.29	.018	-16.84	.0000	79
	2 - 3	.18	.014	-13.26	.0000	79
Second halves (m.e.)	1 - 2	.22	.018	-12.35	.0000	79
	2 - 3	.23	.015	-15.89	.0000	79

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CURRICULUM VITAE

LINDA DeROY WIELAND

Date of birth: February 15, 1948

Citizenship: Canadian

EDUCATION:

- 1983-89 University of Ottawa, Ontario
Programme: Doctorate in Psychology
- 1979-83 University of Ottawa, Ottawa, Ontario
B.A. Honours in Psychology
- 1966-69 Oregon State University, Corvallis, Oregon
Programme: B.A., Major: Elementary Education
Minor: French

PROFESSIONAL EXPERIENCE:**Practicum**

- 1988-89 The Rehabilitation Centre, Student Practicum
School of Psychology, University of Ottawa

Teaching

- 1987-88 Introduction to Developmental Psychology (3 terms)
1988-89 Developmental Psychology: Childhood (2 terms)

Teaching Assistant

- 1983-86 Research Methods I (4 terms)
Cognition (1 term)

Research

- 1985 Research Assistant (2 terms)
Cognitive Psychology Laboratory
University of Ottawa
Director: Dr. Alain Desrochers
- 1981-82 Research Assistant
Parent Aid Programme, Renfrew County Family and Children's
Services
Research Supervisor: Carl Lakaski, MSW, Perley Hospital,
Ottawa, Ontario

ACADEMIC AWARDS AND SCHOLARSHIPS:

- | | | |
|---------|---|----------------------|
| 1983-87 | NSERC Postgraduate Scholarship | University of Ottawa |
| 1983-86 | Supplementary Research
Scholarship | University of Ottawa |
| 1983 | Roger Stretch Award of Excellence | University of Ottawa |
| 1983 | Gold Medal from the School
of Psychology | University of Ottawa |
| 1982-83 | APUO Award | University of Ottawa |

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