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Technical Report 894

# Development of a Hypermedia Foreign Language Vocabulary Learning Environment

Merryanna L. Swartz

June 1990

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Technical Report 894

# Development of a Hypermedia Foreign Language Vocabulary Learning Environment

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Department of the Army

June 1990

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Army Project Number  
2Q162785A790

Human Performance Effectiveness  
and Simulation

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REPORT DOCUMENTATION PAGE				Form Approved OMB No. 0704-0188	
1a. REPORT SECURITY CLASSIFICATION Unclassified			1b. RESTRICTIVE MARKINGS ---		
2a. SECURITY CLASSIFICATION AUTHORITY ---			3. DISTRIBUTION / AVAILABILITY OF REPORT Approved for public release; distribution is unlimited.		
2b. DECLASSIFICATION / DOWNGRADING SCHEDULE ---					
4. PERFORMING ORGANIZATION REPORT NUMBER(S) ARI Technical Report 894			5. MONITORING ORGANIZATION REPORT NUMBER(S) ---		
6a. NAME OF PERFORMING ORGANIZATION U.S. Army Research Institute		6b. OFFICE SYMBOL (if applicable) PERI-I	7a. NAME OF MONITORING ORGANIZATION ---		
6c. ADDRESS (City, State, and ZIP Code) 5001 Eisenhower Avenue Alexandria, VA 22333-5600			7b. ADDRESS (City, State, and ZIP Code) ---		
8a. NAME OF FUNDING / SPONSORING ORGANIZATION U.S. Army Research Institute for the Behavioral and Social Sciences		8b. OFFICE SYMBOL (if applicable) PERI-I	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER ---		
8c. ADDRESS (City, State, and ZIP Code) 5001 Eisenhower Avenue Alexandria, VA 22333-5600			10. SOURCE OF FUNDING NUMBERS		
	PROGRAM ELEMENT NO.	PROJECT NO.	TASK NO.	WORK UNIT ACCESSION NO.	
	62785A	790	336	H1	
11. TITLE (Include Security Classification) Development of a Hypermedia Foreign Language Vocabulary Learning Environment					
12. PERSONAL AUTHOR(S) Swartz, Merryanna L.					
13a. TYPE OF REPORT Interim		13b. TIME COVERED FROM 88/02 TO 88/11		14. DATE OF REPORT (Year, Month, Day) 1990, June	15. PAGE COUNT 31
16. SUPPLEMENTARY NOTATION ---					
17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)		
FIELD	GROUP	SUB-GROUP	Hypertext Discourse processing		
			Foreign language learning		
			Lexical structure		
19. ABSTRACT (Continue on reverse if necessary and identify by block number) This report describes a theoretical framework for teaching military-specific foreign language vocabulary to Army soldiers. The theoretical framework relies on the psychological organization of lexical memory and the pedagogical principle of presenting new vocabulary in discourse contexts. Development of a prototype learning environment is described and a research plan to evaluate the system is proposed.					
20. DISTRIBUTION / AVAILABILITY OF ABSTRACT <input checked="" type="checkbox"/> UNCLASSIFIED/UNLIMITED <input type="checkbox"/> SAME AS RPT. <input type="checkbox"/> DTIC USERS			21. ABSTRACT SECURITY CLASSIFICATION Unclassified		
22a. NAME OF RESPONSIBLE INDIVIDUAL Joseph Psotka			22b. TELEPHONE (Include Area Code) (202) 274-5540	22c. OFFICE SYMBOL PERI-IC	

FOREWORD

The Technologies for Skill Acquisition and Retention Technical Area of the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) performs training systems research and development. One area of research is the development of foreign language training.

Training environments for teaching foreign languages to military intelligence soldiers need to be created for Army classrooms. Army trainers need to be informed of available tools and their application for skill acquisition and retention. This report documents a theoretical framework for developing training using hypertext software to improve retention of foreign language skills. The results of this effort may benefit language trainers in other Army installations and field units.

  
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Technical Director

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# DEVELOPMENT OF A HYPERMEDIA FOREIGN LANGUAGE VOCABULARY LEARNING ENVIRONMENT

## EXECUTIVE SUMMARY

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### Requirement:

The U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) conducts research on skill retention training for the Army. One area that we have been asked to investigate is in foreign language skill maintenance. This report discusses a preliminary effort to address this requirement.

### Procedure:

A theoretical framework used to guide development of a pedagogical approach for teaching foreign vocabulary was formulated from current cognitive science and language theories. Issues related to foreign language acquisition and organization of linguistic knowledge structures in memory were incorporated into the framework. HyperCard, a type of hypertext tool, was used for the development because of cost and portability to Army training systems, as well as its use for representing knowledge in semantic network models. Using hypertext, we created network structures for organizing the target vocabulary according to specified semantic relations. We began by developing an instructional knowledge base for the lexicon using a hypertext structure as a metaphor for a hierarchical organization for lexical memory. We used propositional networks to structure the discourse samples in which we presented the vocabulary to students. The learning development research used hypertext to do three things: (1) present multiple encodings for the lexicon (visual and phonetic), (2) present two levels of context (sentence and paragraph), and (3) present the semantic associations between words in a graphic representation.

### Findings:

This report represents a compilation of historical and state-of-the-art findings in cognitive and foreign language learning research for the purpose of developing an in-house research proposal, the objective of which is to enhance learning and performance by Army linguists.

### Utilization of Findings:

Once the learning environment has been evaluated using soldiers at Fort Huachuca, the software will be made available to their language trainers and to other Army installations that require language retention training.

DEVELOPMENT OF A HYPERMEDIA FOREIGN LANGUAGE VOCABULARY LEARNING ENVIRONMENT

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# DEVELOPMENT OF A HYPERMEDIA FOREIGN LANGUAGE VOCABULARY LEARNING ENVIRONMENT

## Introduction

### Background

Teaching foreign languages to students who can retain and use language skills to communicate has remained a compelling problem for language pedagogues. Recent work on second language acquisition from a cognitive psychology perspective has proposed that language learning be viewed as a complex cognitive skill (McLaughlin et. al. 1983) rather than as a separate mental faculty based on innate language structures in the mind (Chomsky, 1986; Flynn, 1987). Regarding foreign language learning as a cognitive process holds promise for researchers interested in developing more effective instructional strategies for foreign language learning. In this way we can use information processing paradigms to investigate linguistic properties, cognitive processes, and organization of the mental lexicon in foreign language learning.

Traditionally, foreign language research on vocabulary learning has focused on issues of how to teach the lexicon. Several approaches have been considered, teaching in context, teaching core vocabularies, and teaching keyword methods (Carter, 1987). Little work has been done by pedagogues on how to organize the vocabulary being taught, especially at more advanced levels of learning. The problem of acquiring more enriched lexicons in the target language by advanced students is well known by foreign language pedagogues, but the usual instructional approaches tend to use literary reading passages and dialogue content to drive vocabulary learning. However, some foreign language pedagogues have recognized the value of teaching vocabulary based on the semantic and categorical structure among concept groups (Cornu, 1979; Meara & Ingle, 1986; McCarthy, 1984). Cognitive scientists have long been interested in how knowledge structures of lexical items are acquired and stored in memory (Tulving & Donaldson, 1972; Anderson & Bower, 1974; Forster, 1976; Murdock, 1974). Their work has dealt with native language learning, however, a vastly different learning process than foreign language learning. Nevertheless, the cognitive processes for organizing and accessing the mental lexicon to retrieve information that are explained by these native language (L1) studies provides a theoretical framework that can be used for explaining how the foreign language (L2) lexicon is structured and accessed in communicative situations.

The acquisition of L2 vocabulary by intermediate and advanced language students extends beyond simple verbal associations in the new language to a known concept. At more advanced levels, the student needs more control over the L2 lexicon. The student must be able to understand and use the lexical items in a variety of communicative contexts. Different contexts elaborate upon various semantic and pragmatic meanings of a given lexical item. Vocabulary learning in contexts that teach these lexico-semantic relations in natural language samples has been shown to benefit advanced students (Meara & Ingle, 1986). Furthermore, foreign vocabulary taught in a semantically defined space which describes the associative relationships between lexical items has been shown to improve recall and retention of the vocabulary in advanced students (Carter, 1987). A semantic space for some grouping of words would include items that share the same meaning. For example, fruit, oranges, apples, cherries all belong in a space that shares the meaning of edible foods, in this case fruits. Thus we argue for the need to develop instructional approaches for L2 vocabulary learning that exploit the advantages of an associatively organized lexicon and use realistic language contexts for promoting retrieval and retention skills. Additionally, the instruction should draw upon a theoretical base derived from cognitive science and foreign language acquisition research.

One of the goals of foreign language teaching is to instill retention of the learned material in long term memory. We believe strategies that promote elaborative processing by the student best meet this requirement. Providing the student with multimodal instructional elaborations (Anderson & Reder, 1981) may be one way to encourage acquisition and retention of the material by the student. In order to implement these strategies in a computer-based delivery system, we argue that hypertext tools provide a rich environment for developing the instruction and promoting elaborative kinds of cognitive processing. For example, we could devise a hypertext vocabulary learning environment in which the student can get a direct translation, be sent to another instructional module for a designated word so that associated vocabulary for the target word can be studied and reviewed, get grammatical information about the target word, hear the word's pronunciation, and see the target word used in an exemplar sentence.

Using hypertext will also permit theoretical exploration of how knowledge is organized in memory. We can network structures for organizing the target vocabulary according to specified semantic relations. Such semantic networks for concept learning have been used to hypothesize about the organization of knowledge in memory and retrieval processes (Collins & Loftus, 1975). We can extend this work using network models to investigate similar

issues in L2 vocabulary learning. Thus we begin by developing an instructional knowledge base for the lexicon using a hypertext structure as a metaphor for a hierarchical organization for lexical memory.

Research has shown that contextual cues from organized networks of words (Bower, Clark, Lesgold, & Winzenz, 1969; Tulving & Dondalson, 1972) and from discourse (Swinney, 1979; Kintsch, 1988; Kaye, Sternberg, & Fonseca, 1987) have an effect on the learning of a word. We argue that a structured context for vocabulary learning imposed at presentation will act as a mediator to facilitate the acquisition of semantic relations between paradigmatic associates in the target lexicon. Paradigmatic associates are other words related to the target that can occupy the same position in an utterance (Deese, 1962). These associates are generally similar in form (nouns or verbs). Examples could be synonyms or even antonyms of the associated word. However, a structured context for the lexicon alone does not provide the learner with associations beyond the form classes (nouns, adjectives, verbs, etc.) that make up the lexical structure (Deese, 1962; Miller, Fellbaum, Kegl, & Miller, in press. Sentential and discourse contexts provide richer environments for presenting paradigmatic and syntagmatic relations that illustrate meanings of words in the context of a real language sample (Cornu, 1977; Swinney, 1979; Kintsch, 1988).

Thus we will strengthen our argument for teaching foreign vocabulary in a structured network by embedding the initial presentation of the words in discourse contexts. Cues from the structure of discourse contexts will present information to facilitate understanding the meaning of the target word as well as affect how the discourse is interpreted and used in communicative situations. Further, we can use context-based exercises to enrich vocabulary learning by elaborating on specific paradigmatic associates within some discourse sample. Therefore, how linguistic knowledge is organized in both the lexicon and discourse becomes a critical issue for our research. We will use an associative network as a model of lexical memory (Collins & Loftus, 1975) in our work with a propositional network model (Kintsch & van Dijk, 1978) for analyzing discourse structure. These models are defined below.

It is of empirical interest to assess whether contextual cues are used when reading narratives (a type of discourse) in L2 as they are in our native language. In relation to context cues from discourse, we might wonder how the L2 lexical structure interacts with the L2 discourse. How is the structure of the

lexicon mapped onto the structure of the discourse when it is being processed? Are known paradigmatic associates in addition to the target word accessible for recall as the sentence is processed?

### Objectives

The fundamental problem this research addresses is how best to teach foreign vocabulary to military intelligence linguists so that retention and use of the vocabulary is supported. The focus of this research is on the role of two types of context, organizational structure (weak) and discourse context (enriched) in promoting recall and retention in vocabulary learning. The kinds of questions addressed include: How do elaborative instructional contexts promote acquisition of vocabulary for foreign language learners? Does the presentation of a structured lexicon, when compared to random list learning, improve recall and retention of newly acquired vocabulary? How do combinations of both weak and enriched contexts support recall and language production tasks during language learning? The research proposed here attempts to address some aspects of these questions.

### Army Relevance

Several Army military occupational specialties (MOS) have a foreign language requirement. The Army is responsible for providing language training in 26 different languages. Soldiers coming to a training school often have good language skills but little background in a specific job assignment or the requisite specialized lexicon in the foreign language that accompanies the MOS. As a result, additional language acquisition in a particular foreign language as well as retention of acquired skills are required of the soldier. When Army trainers' linguistic expertise does not match that of the soldier, a training problem exists. Providing the Army with computer-based training systems in variety of language can help.

The research proposed in this report explores advanced technology methods and cognitive science theory as vehicles in the development of computer-based foreign language vocabulary training for the Army. We viewed this approach as necessary for providing soldiers with acquisition and retention skill training devices that will be used at the training schools and in the field for language skill maintenance.

The paper begins with a discussion of the theoretical framework guiding the instructional presentation in the design of an instructional environment for vocabulary learning. Next an

outline for the developmental progress of our language learning environment is presented. We close with a proposal for empirical research to validate some of our theoretical claims on which the instruction is based.

## Organizational Components in the Mental Lexicon for Foreign Language: Implications for Instruction

### Separate vs Shared Memory Systems

In order to improve instructional methods for foreign language, questions about the organization of the mental lexicon for a foreign language must be addressed. We use the term mental lexicon to refer to an individual's mental state of knowledge about words. Research on bilinguals has attempted to ascertain the degree to which separate or integrated memory systems are maintained for the languages. Several models of bilingual lexical memory have been explored within a semantic network framework. One view posits that bilinguals share a single semantic memory (conceptual knowledge) with two separate lexical networks in the memory system, one for each language (Kirsner, Smith, Lockhart, & King, 1984). The other view holds that separate semantic memory systems exist with associated lexical representations for each language. This separate language store hypothesis predicts slower lexical decision times as a result of category cueing in a separate presentation (Potter, So, Von Eckhardt, & Feldman, 1984; Schwanenflugel & Rey, 1987; Caramazza & Brones, 1980). On the other hand, the shared language store hypothesis predicts no time differences for lexical decision tasks. While each of these models has found support in the literature, the shared memory model also enjoys support from the theories of language learning and language acquisition (Richards, 1982; Bialystock, 1978) where processes to access world or conceptual knowledge are prerequisite to accessing the lexicon for language production activities. In view of this additional theoretical support, we assume the shared memory system hypothesis and use it in the development of the knowledge base for our instructional approach to vocabulary learning. This hypothesis leads us to look at issues of linguistic knowledge organization in order to understand how L2 knowledge structures develop when learning a language.

### Knowledge Organization

How knowledge is organized for instructional delivery is equally important as the content of the instruction. Studies in knowledge organization show that how knowledge is represented during instruction affects task performance (Elyon & Reif, 1984).

Therefore, the design and structure of the knowledge being taught plays a critical role in the teaching of any domain. In order to teach foreign language effectively, we must first decide how to represent this knowledge. In addition to linguistic theories of the structure of the mental lexicon, we look to cognitive science for other theories of knowledge representation. These theories for organizing knowledge vary in representational formats from schemas (Rumelhart, 1975; Thorndyke & Hayes-Roth, 1979) to semantic networks (Collins & Loftus, 1975) to production rules (Anderson, 1983) to story grammars (Rumelhart, 1975) to propositional networks (Anderson & Bower, 1974; Kintsch & van Dijk, 1978) and, recently, to connectionist networks (Rumelhart & McClelland, 1986). The variety of these formalisms reflects the specific needs of the many different kinds of knowledge (concepts, skills, events, etc.) to be represented. The nature of the information stored in these models is still subject to debate and we must ask which ones are best suited for representing language. Anderson's ACT\* theory (1983) which uses a network model, organizes the declarative knowledge into what he terms a "tangled" hierarchy given the many kinds of relations between concepts (words in a lexical network). This we find a useful description for the lexicon as we shall see below. On the other hand, story schemas seem to be appropriate for representing features in dialogue contexts.

#### Network Models for Organizing the Lexicon

Theories of semantic memory have been developed using network models that describe organizational structures for concepts connected by property links so that knowledge becomes associated within the network (Collins & Quillian, 1972; Collins & Loftus, 1975; Anderson & Bower, 1974). In the Collins and Loftus (1975) model, Loftus discusses an associative dictionary-network to explain semantic processing of lexical information. Recent work in organizing an electronic dictionary by Miller and his associates (in press) suggests that language models for the lexicon can be created using a hierarchically organized semantic network to present four basic relations between words: hyponymy (super-subordinate relations), meronymy (whole-part relations), synonymy (similarities), and antonymy (opposites). The semantic relations between words learned, based on Miller's organization for vocabulary as an instructional strategy, may encourage development of additional access routes to the lexicon for purpose of retrieval. Consider the following: if a structured network of words is learned with the super-subordinate relation, then presentation of a super ordinate item in the structure as a probe for recalling an associated subordinate item should serve as a retrieval cue for the word (i.e., Family--> Parents-> Children). The super-subordinate relation is not the only one that exists in lexical memory. We are also interested in

teaching synonyms and antonyms for several word form classes (nouns, adjectives, verbs) in our military vocabulary. Here is where our lexicon becomes 'tangled'. In organizing nouns with synonymy-antonymy relations, we find small clusters of words emerging. The organization of verbs poses a real challenge. Here, notions of entailment come into play (See Collier & Fellbaum, 1988) for making meaning associations. For example, a proposition 'A' entails proposition 'B' if and only if when A holds then B holds. Collier and Fellbaum use the following example:

John is walking (A)  
John is travelling (B)

Walking entails travelling since the act of walking is included in the act of traveling. One can use relations of entailment to organize verbs in the network structure. However, the simple example above illustrates how the relations between propositions may effect the choice of a word. We will return to this problem below when discussing representations for structuring discourse.

Currently, much effort is being devoted to organizing a lexical network for the target words to be taught. The network model we are developing is based on the Collins and Loftus framework (1975) with the incorporation of Miller's et al (in press) recent work using three of the four relations mentioned above (hyponymy, synonymy, antonymy) to structure the vocabulary. Twenty-three target words and approximately 150 associates are being organized in a network model for a military domain. However, Miller and his colleagues admit that certain semantic and pragmatic relations between words cannot be addressed in such a hierarchically organized system. Thus we term this context as 'weak'. Foreign language learners need a richer context during learning so that language production activities in the target language other than simple word learning are promoted. Exposing students to real language discourse samples will complement the weak context of an associatively organized lexicon structure. In order to understand how context effects from some discourse sample and the relations between its propositions affect the use and meaning of a particular word, we will need a formalism to analyze the structure of the discourse.

### Story Schemas for Organizing Discourse Structures

The structure of a particular discourse representation will define the features of the context, its topic, setting, roles, temporal relations, and events. These features are used to guide processing when learning new information. Because of the additional information these structures offer when used to

present new vocabulary, we term these contexts as 'enriched'. The use of more enriched contexts is important for building a more elaborate competency base for lexical knowledge in L2 that can in turn be used to understand and ultimately produce discourse in the foreign language.

Many types of knowledge representations have been used to describe the underlying structure of a discourse sample: schemas (Thorndyke & Hayes-Roth, 1979), scripts (Schank & Abelson, 1972), story grammars (Rumelhart, 1975), propositional networks (Kintsch & van Dijk, 1978), and associative networks (Rumelhart & McClelland, 1986; Kintsch, 1988). These different structures, when applied to discourse, can be referred to collectively as a representation of a 'story'. These story representations or schemas describe contextual information regarding topic or theme of a particular discourse sample. For advanced learners, the story schema for narrative discourse in L2 learning promises to be a powerful conveyor of semantic and pragmatic features in the target language since it provides access to world knowledge (concepts) that relates to situation specific meanings of various vocabulary items. This enriched information is not available from learning vocabulary using semantic network structures (Miller, et al in press) or keyword methods (Carter, 1987) alone. The story schema, organized according to any of the representational schemes presented above, can provide the student with a framework from which to consider expectations and make predictions about information that is presented in relation to the target vocabulary.

We selected a propositional network model as the best formal representation for analyzing our discourse samples for instructional purposes. We argue that a propositional network model is appropriate for investigating how the L2 lexicon is accessed during discourse processing for several reasons.

First, by using a propositional network structure to analyze the discourse, we will be able to define selectional constraints for lexical candidates within and between propositions based on several of the relations used by Miller, et al (in press) and Collier & Fellbaum, (1988). Propositional representations have a 'head' and one or more slots for 'arguments' (Kintsch, 1988). The slots specify the nature of the relation between the head and its argument(s). Consider the following example from Kintsch:

'Mary baked a sweet cake. Mary did not watch the cake and as a consequence it burned.' This text is represented by the following propositions:

1. BAKE [agent:MARY, object:SWEET[CAKE]]
2. CONSEQUENCE [condition:NOT[WATCH[agent:MARY, object:CAKE]  
effect:BURN[object:CAKE]]

Using this type of formalism we can come to understand the structure of a particular discourse and the relations among propositions that constrain the choices of lexical candidates as arguments to the head. In this manner, we hope to uncover the mapping process between discourse and lexicon structures as foreign language samples are processed by students.

Second, propositional structures have been used successfully for testing word knowledge in L2 cloze exercises (Deyes, 1894). These preliminary investigations using propositional networks may shed light on early mental model formation in L2. Johnson-Laird describes propositional network structures as simple first-order mental models for language (1983) and we might follow his views when investigating foreign language learning. However, considerable research must be undertaken before we can make claims about such model formation and this effort is currently beyond the scope of our present work. Nevertheless, we will begin by using a propositional framework as a formalism and rely on L1 research in discourse processing as a guide for our research in L2 vocabulary learning an organization.

Third, research in the comprehension of prose in L1 indicates that the topic of the discourse (story) is used to guide the memory search process (Kieras, 1981) in order to understand it. Using contextual information from the topic proposition in a discourse sample serves to aid processing of concepts, disambiguating words, and encoding of the information in the discourse. At advanced levels of L2 acquisition, we believe that this process also aids comprehension. In lexical decision tasks, the priming effect of a related associate is well known (Meyer & Schvaneveldt, 1971; Kintsch, 1988). Swinney (1979) has shown that, although discourse context serves as a type of prime to guide comprehension processes, the lexical access process retains some autonomy. Nevertheless, his data show that, the more semantic relations between elements in the sentence constrain the context, the quicker the decision process for selecting the appropriate lexical item when multiple meanings are possible for a word. However, Kintsch (1988) states that such context effects alone are not central to comprehension processes. He describes a model of discourse comprehension that is constructive, based on contextual cues that map onto an associative network structure for general world knowledge. This knowledge provides the context within which a person perceives

and then interprets discourse thus constructing situation specific meaning for a particular word. Despite this debate over the nature of context effects, these hypotheses lend support to our use of a propositional network structure for the discourse sample that interacts with an associative network for the lexicon as the theoretical framework for our learning environment.

Many of these representations share similar knowledge structures in the L1 and thus facilitate grasping the gist of what information is conveyed even if all of the foreign language input is not understood. Thus at times, the allocation of processing resources for a language learner can be focused on lower-level linguistic dimensions such as syntactic and morphologic features that are critical to gaining control over the L2 lexicon. Certainly the shared world knowledge for a given piece of discourse should help us in interpretation even when many of the details of the constituents are unknown, as is the case in processing L2 discourse. We might ask to what extent the context information of the shared world knowledge structure aids processing of new vocabulary in a L2 discourse. Future research will explore this question further using the proposed learning environment.

#### Encoding Processes and Retrieval Mechanisms in Vocabulary Learning

How the L2 lexicon is encoded will affect the access mechanisms as the mental lexicon is searched in recall tasks. The principle of encoding specificity has a role in how vocabulary is stored. This principle states that retrieval cues can provide access to information available about an event in the memory store if and only if it has been stored as part of the specific memory trace of the event. This principle was developed primarily in the context of cued recall experiments using paired-associate learning tasks. Nevertheless, we will be mindful of this principle in the set of vocabulary learning experiments presented at the end of this paper.

Studies in memory organization have indicated that word hierarchies can provide a powerful retrieval scheme in recall tasks (Tulving & Donaldson, 1972). In such experimental paradigms, the organization of a particular list of words to be memorized has been viewed as providing contextual information. Thus students will use the context structure of the list as they attempt to retrieve the words on subsequent recall tasks. However, these paradigms and experimental results are more indicative of episodic rather than semantic memory (Tulving & Donaldson, 1972). That is to say, anyone can memorize a list of items in an experimental episode. This kind of memorizing generally uses short term memory. In foreign language learning,

we want the student to encode and retain the words in semantic or long term memory. Nevertheless, the results of this work suggest that use of organized, structural context might be useful as an instructional approach when learning new words in a foreign language.

Effective encoding involves organizing the to-be-remembered material into higher-order 'chunks' or units of knowledge (Anderson, 1983). While researchers have debated whether organization comes at input or at retrieval, we will not address this issue further here. For our purpose, we assume as a pedagogical rationale that organization is accomplished at input through some instructional approach. Much work has been done investigating the nature of associative and categorical organization in memory and learning tasks (Bower, Clark, Lesgold & Winzenz, 1969; Meyer & Schvaneveldt, 1971; Tulving & Donaldson, 1972; Mandler, Pearlstone, & Koopmans, 1967). Foreign vocabulary, taught in a semantically defined space which describes the associative relationships between lexical items, has been shown to improve recall and retention of the vocabulary with advanced students (Carter, 1987). We argue, therefore, that imposing organizational structure at input as a mediator for foreign vocabulary with advanced learners will improve recall, retention, and use of the learned material. While the structure itself does provide some level of context with regard to the associative relations between words, it is unable to provide adequate information at higher semantic levels. Thus we term this context 'weak'. Another type of mediator, discourse context, will provide additional information about word meanings.

Different discourse contexts elaborate upon various semantic and pragmatic meanings of a given lexical item. Furthermore, vocabulary learning in contexts that teach these lexico-semantic relations in natural language samples has been shown to benefit advanced students (Meara & Ingle, 1986). Thus we will explore the use of two different levels of context beyond that of organizational structures as mediators: Sentential and Discourse. We term these two levels 'enriched' context. This is so because the structure of a sentence and even more so a paragraph provides rich lexico-semantic relations that teach more complete meanings of words and how they should be used in realistic language samples. Moreover, providing students with multiple examples of collocation should help improve language production skills.

Pedagogically, we know that by providing the student with multimodal encodings for the word (visual, semantic, phonetic) we are providing him/her with multiple access routes to a given word as these features are encoded, thus providing the learner with many possible retrieval schemes. Presenting the learner with a suite of elaborative exercises combining these kinds of encodings

encourages deeper levels of processing (Craik & Lockhart, 1972) which in turn reinforces control over the alternate retrieval schemes (Anderson, 1983; Anderson & Reder, 1981). The deeper the processing for a word, the better a student will be able to retrieve and use it appropriately. Yet, as students continue to master their new language competencies, they may continue to be unable to retrieve the appropriate word in communicative experiences (Carter, 1987). Thus we argue for the high utility of combining organizational and contextual structures for the lexicon and discourse samples during encoding for promoting efficient retrieval schemes through elaborative processing mechanisms. An instructional approach that exploits both organizational structure and discourse context as mediators during encoding is deemed appropriate for two reasons. First, since psychological theories of knowledge organization are based on a certain structural representation, why not exploit it instructionally at advanced levels of learning? The assumption is that, by teaching this structure overtly, we will help students acquire an enriched lexicon quicker and improve their ability to recall and use the vocabulary in comprehension and production tasks. Second, by analyzing a student's ability to use discourse context to facilitate comprehension of new vocabulary in a foreign language, we may come to understand the interaction of lexical structure with discourse structure when new words are acquired. Investigation into the combination of these two encoding contexts for promoting recall and retention processes may shed light on how to best teach L2 vocabulary so that the lexicon can be accessed later for productive language use.

### Proposed Research

Based on the theoretical framework discussed above, and the use of hypertext software for structuring knowledge, we are developing an instructional environment in which to test our hypotheses about how the structure of the mental lexicon develops when a foreign language is acquired. The evaluation of the learning environment will test what combination of elaborative pedagogical strategies are best for advanced vocabulary learning when skill retention is an instructional goal.

### Instructional System Development

Hypertext software allows the instructional designer to structure information that represents a set of relations between ideas and concepts in order to organize and retrieve the information in a coherent manner. Based on our evaluation of existing software and authoring environments, hypertext is deemed

the best available tool for organizing instructional knowledge structures. We used HyperCard, a type of hypertext tool, for our development because of cost and portability to Army training systems. This study will use the hypertext to do three things: (1) present multiple encodings for the lexicon (visual and phonetic), (2) present two levels of context (sentence and paragraph), and (3) present the semantic associations in a graphical representation. Three basic relations are presented: hyponymy, synonymy, and antonymy.

LEXNET-INSITU is the system under development in this research. We chose this name to signify the structured approach to presenting vocabulary based on network models of semantic memory (LEXNET) and for the situated presentation of lexical items in discourse contexts (INSITU). The 'story' used to select discourse samples for LEXNET-INSITU is one of terrorist attacks. This story line is useful for presenting military terminology since it exploits prototypical military roles, setting, and events. Thirty-three target vocabulary items from the training list of military vocabulary taught at the U.S. Army Intelligence Center and School at Fort Huachuca, Arizona, a military installation, were selected for use in the system. LEXNET-INSITU is made up of five instructional modules that exploit the advantages of hypertext for traversing rich knowledge structures to practice organizing and using the vocabulary items in various contexts.

Each module is designed to exploit and elaborate on specific cognitive skills to reflect our emphasis on elaborative processing as a pedagogical strategy. The sequence of instructional modules is designed to provide students with exercises that require more difficult kinds of elaborations. However, the initial presentation of the vocabulary in the first module provides very rich, multimodal elaborations for each word. This is because an important pedagogical principle exists for presenting language in context. We chose to uphold this principle in the design of our system and then proceed from simple to more complex elaborations in the subsequent lesson modules.

The first module presents vocabulary within the context of narrative texts (discourse) depicting recent terrorist attacks around the world. We used the construct of story schemas for our theoretical framework to represent features of the narrative texts. Each schema represents topic, setting, roles, and events information that are shared by the terrorist attack 'story'. Individual texts might have different values for each of these features. For example, in one narrative text the topic is about civilian killings in wartime. The setting is in Kurdistan at the

Irak-Iran border. Roles include Kurdish civilians, a Kurdish political party, the Irak army, and an American spy. The events included a terrorist attack and destruction of a village.

We propositionalized these discourse samples following Kintsch and van Dijk's model (1978). This was to allow us to codify the texts and see where the target words to be learned occurred within the propositional structure. Our rationale for this activity was to provide us with a means for understanding the structure for the individual propositions that make up a text and to discover if specific locations of words within a proposition were particularly troublesome for students. For example, would students have more difficulty learning words that served as predicates in the proposition or would words in argument slots provide the most difficulty? Additionally, propositional structures represent the concepts in some body of text and not the language specific elements (grammar, linguistic realization). Therefore, this formalism will transfer to future work translating the system into other foreign languages.

This module includes four different texts in French (See Figure 1). A pop-up menu is displayed when students click on a target word. The menu provides students with choices of various cogno-semantic elaborations for the word. These elaborations are believed to provide the student with multiple access routes to the vocabulary item stored in memory. The student can get a direct translation, be sent to the associative network structure for the designated word so associated of the target word can be studied and reviewed, get a grammar point presented about the target word, hear the word's pronunciation, and see an additional exemplar of collocation using the target word.

The second module presents the target lexicon in an organized, 'tangled' network structure based on the portion of our theoretical framework that describes how the mental lexicon is organized in memory. In particular, we adopt Miller's scheme for structuring words by incorporating two word classes (nouns and verbs) and three relations between constituents in the network: hyponymy, synonymy, and antonymy. All 33 target words are represented in this structure with related associates. The entire lexicon with all associates of the 33 target words is over 160 words total. However, the student only get presented with a small 'chunk' of the network (See Figure 2) at any one time. Pedagogically, we don't want to overwhelm the student with too many words to learn at a time.

The instructional goal of this lesson is to have students go through the network and memorize the words and the relations among their associates. This goal emphasizes acquisition of relations between words and is thus considered a simple

Le vingt-deux octobre dernier, l'ambassade américaine a été victime d'une attaque à la bombe. A la suite de la guerre de partisans, une vingtaine de soldats qui gardaient l'ambassade ont été tués au combat. Dix soldats ont été blessés à l'ennemi.

Dix personnes touchées, six étaient des officiers, et quatorze officiers.

écoutez

réseau

grammaire

traduction

phrase  
exemplaire

Figure 1. Vocabulary presented in a discourse model. Target vocabulary are in bold-face print. The menu offers students with a phonetic representation of the word (écoutez), a view of the word within the semantic network for the lexicon (réseau), a grammar note about the word (grammaire), the translation in English (traduction), and an additional instance of collocation in a sentence that differs in context from the paragraph (phrase exemplaire).

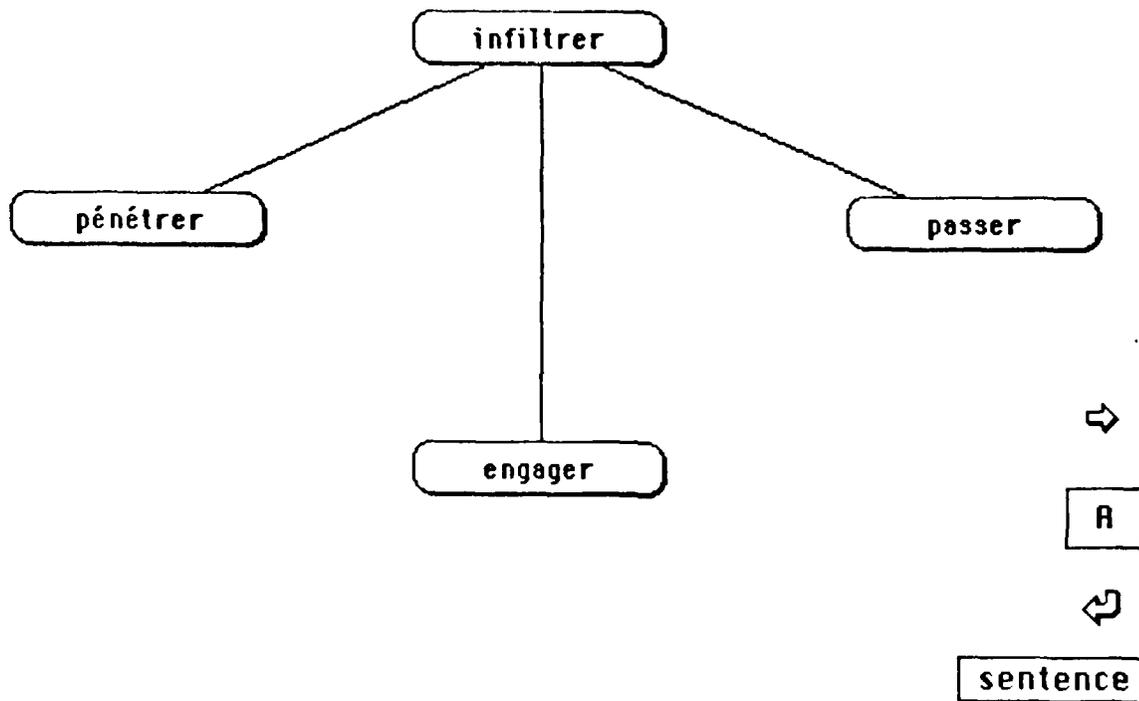


Figure 2: A portion of the associative return for verbs. A 'chunk' of the network showing the target word 'infiltrer' with three synonyms. This structure is what Miller calls a 'synset.' The "A" box takes the student to the antonym set for the target word.

elaboration. For example, if a student selects the word class 'noun' and relation 'type of', s/he will be presented with a target word (weapons) and several instances of types of weapons (automatic weapons, personal weapons, nuclear weapons). By clicking on a word or icon, students can have access to direct translations, pronunciations, and an illustrative sentence (collocation) for each word to promote redundant encoding.

The third module tests whether students have learned the relations among the lexical items they memorize in the organized network presented in the previous module. We use a semantic grouping strategy here to reinforce this instructional goal (See Figure 3). Because students must recall and represent a particular relationship between words, we view this lesson as requiring more elaborative processing by the student when compared to the previous module. Students select a particular relation and are presented with a mixed list of words they have already learned in modules one and two. They are to organize the words into network-like clusters according to 'how the words go together'. Each example has a correct grouping and an incorrect grouping. Translation and pronunciation cues are available for the words as support if needed. Students can make as many groupings as they choose given the list of words. Feedback is provided so that they may check their knowledge about relationships between the associates.

The fourth module assesses whether students can use the words appropriately in sentence contexts using a cloze procedure. This activity takes the student from the network structure, the weak context described earlier in this report, and introduces a first level of enriched context (sentences) for the words. Because this lesson introduces an enriched context and requires students to complete sentences using selected words, we view this as a more elaborative exercise than semantic grouping. This module presents the learner with a noun network and a verb network (See Figure 4).

The learner selects a candidate from each 'tree' and uses the item to fill in sentence templates that are shown on the bottom of the computer display. Students can make as many sentences as they wish by selecting different combinations of words from the trees and completing the templates. Feedback is provided so that they may check their knowledge about using words to create meaningful sentences. Although grammar teaching is not part of the instructional goals for this system, students must make correct subject-verb agreements. Students are provided with grammar 'help' if grammatical errors for this kind of agreement are made in this lesson.

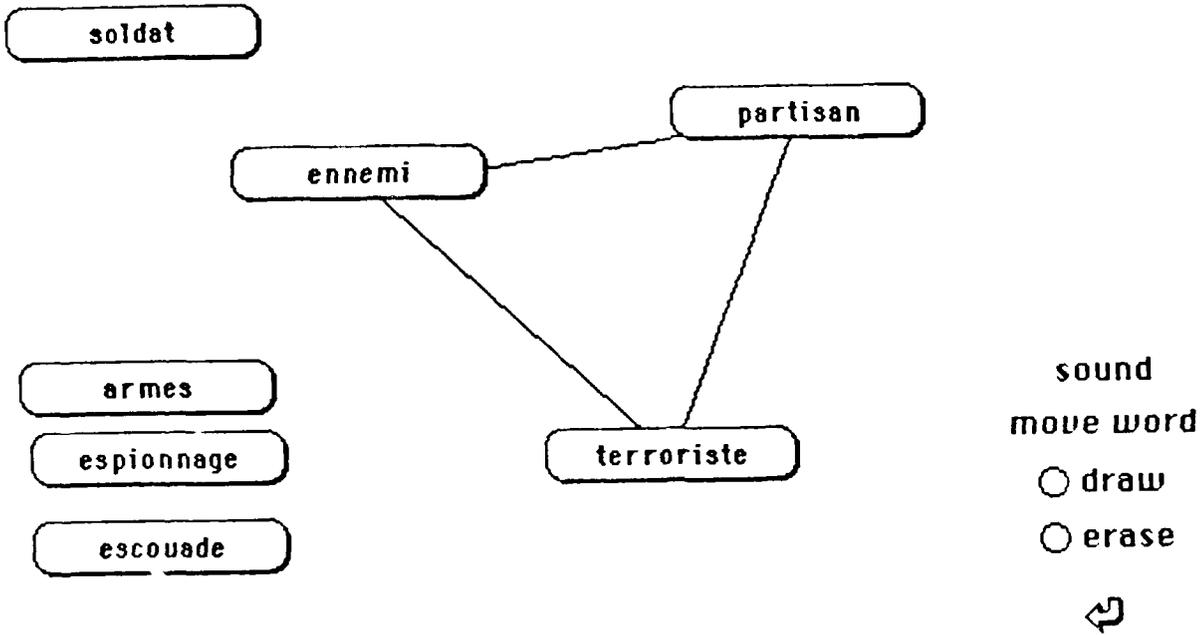
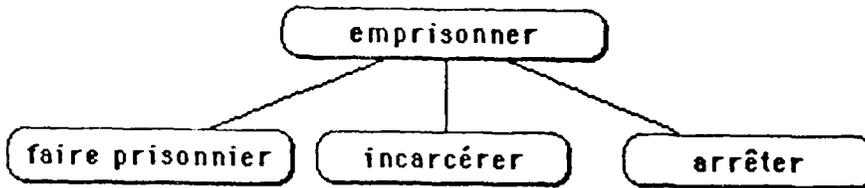
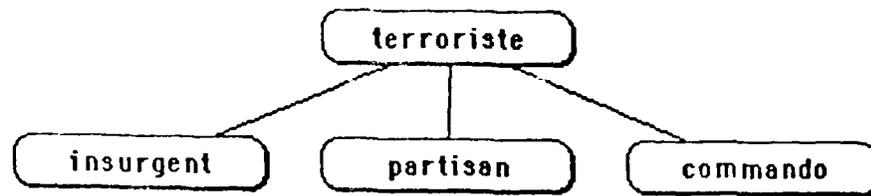


Figure 3. An exercise for reconstructing vocabulary networks. Students can use the buttons to manipulate the words and make linkages between words of a similar relation. The relation in this exercise is 'antonymy.'



L'aide grammatical  
Un lexique auxiliaire



Notre allié \_\_\_\_\_ (pc) quatre \_\_\_\_\_ de l'armée rouge.



Figure 4. Sentence cloze exercises. Students activate an active region on the bottom of the card and then create a sentence using a noun and verb selected from the networks provided. Grammatical and lexical aids are provided as "help." Feedback is provided so that students can evaluate their sentences.

The last module presents students with narrative texts of paragraph length similar in schema structure to the texts in the first module. This module has two modes: explore and test. Paragraphs, analyzed propositionally as described above, are available with carefully placed cloze items (Deyes, 1984) that can be used to test word understanding. The explore mode is designed to encourage broad use of the lexicon and its related associates in the paragraphs. Two paragraphs are available for exploration. A list of candidate words for each paragraph is provided with a menu that lets the students go to the network structure for the selected word (See Figure 5). By allowing the student to have access to the network structure for the lexicon as s/he attempts to complete the cloze items in the enriched context, we hope to promote better recall and retention for the lexicon as elaborated meanings of words are explored and used. Feedback on choices is provided so that students can check their understanding. Because students are now required to use the words appropriately at the paragraph level, and movement between the two levels of context is encouraged, we believe this activity requires the most elaborative processing from students. In the test mode, one paragraph is available with carefully placed cloze items as described above. The only difference between the explore and test mode is that once students complete the task, they are not allowed to change a response. Thus students are evaluated on their final performance in this exercise.

### Conclusions

This paper reports on the development of a hypertext computer system for teaching advanced foreign language vocabulary to military intelligence linguists in the Army. We described the theoretical framework for the learning environment and the development of the prototype system. Future work will address research to evaluate the system and the instructional approach we have described. Evaluating LEXNET-INSITU as a general hypertext-based learning environment is one goal. Another is the assessment of our pedagogical rationale of using a combination of structured network and discourse context as a presentation strategy for vocabulary learning.

## Téhéran et Bagdad s'accusent de violer le cessez-le-feu

Le ton entre l'Irak et l'Iran s'est fait de plus en plus menaçant depuis que la question des accords d'Alger fixant les frontières a été mise sur le tapis. Des \_\_\_\_\_ iraniens ont affirmé que les troupes irakiennes avaient \_\_\_\_\_ 700 soldats iraniens depuis le cessez-le-feu le 20 août et les avaient \_\_\_\_\_. Ces \_\_\_\_\_, après leur libération, ont \_\_\_\_\_ l'Iran sur des terroristes qui continuaient de faire les actes contre le peuple iranien. En plus, des Irakiens avaient envoyé un \_\_\_\_\_ parmi les villages du front pour disperser les gens. Alors, l'imam Khomeiny avait estimé que la \_\_\_\_\_ n'était pas finie et avait appelé les soldats iraniens à rester vigilants et à continuer à \_\_\_\_\_ contre les \_\_\_\_\_.

### Mots

détenir	captif
interner	renseigner
char	guerre
espion	révolter
force étrangère	



Figure 5. Paragraph cloze exercises. Students can move to any space in the paragraph and enter words from the list of candidates at the bottom of the card. In 'explore' mode, students can button on a candidate word and be sent to the network representation to find other associates that could be used to complete the paragraph. Feedback is provided so that students can evaluate how they did.

## References

- Anderson, J.R. & Bower, G. (1974). Human associative memory. Hillsdale, NJ: Lawrence Erlbaum Assoc.
- Anderson, J.R. & Reder, L.M. (1981). An elaborative processing explanation of depth of processing. In L.S. Cermack & F.I.M. Craik, Levels of processing. Hillsdale, NJ: Lawrence Erlbaum Assoc.
- Anderson, J.R. (1983). The architecture of cognition. Cambridge, MA: Harvard University Press.
- Bialystock, E. (1978). A theoretical model of second language learning. Language Learning, 28, 69-83.
- Bower, G., Clark, M.C., Lesgold, A.M., & Winzenz, D. (1969). Hierarchical retrieval schemes in recall of categorized word lists. Journal of Verbal Learning and Verbal Behavior, 8, 323-343.
- Caramazza, A. & Brones, I. (1980). Semantic classification by bilinguals. Canadian Journal of Psychology, 34, 77-81.
- Carter, R. (1987). Vocabulary and second/foreign language teaching, Language Teaching 2: 3-16.
- Chomsky, N. (1986). Rules and representations. New York, New York: Columbia University Press.
- Collins, A. & Quillian, M.R. (1972). How to make a language user. In E. Tulving, & W. Donaldson, Organization of memory. New York, NY: Academic Press.
- Collins, A. & Loftus, E.F. (1975). A spreading activation theory of semantic processing. Psychological Review, 82, 407-428.
- Collier, G.H. & Fellbaum, C. (1988). Exploring the verb lexicon with the sensus electronic thesaurus. CSL Report 30, Princeton University.
- Cornu, A-M. (1979). The first step in vocabulary teaching. Modern Language Journal, 63, 262-272.
- Craik, F.I.M., & Lockhart, R.S. (1972). Levels of processing: A framework for memory research. Journal of Verbal Learning and Verbal Behavior, 11, 671-684.
- Deese, J. (1962). Form class and determinants of association. Journal of Verbal Learning and Verbal Behavior, 1, 79-84.

- Deyes, T. (1984). Towards an authentic 'discourse cloze'. Applied Linguistics, 5, 128-137.
- Elyon, B-S & Reif, F. (1984). Effects of knowledge organization on task performance. Cognition and Instruction, 1, 5-44.
- Flynn, S. (1987). Contrast and construction in a parameter-setting model of L2 Acquisition. Language Learning, 37, 19-64.
- Forster, K.I. (1976). Accessing the mental lexicon, in R.J. Wales & E. Walker (Eds.), New Approaches to Language Mechanisms, Amsterdam, Netherlands: North-Holland Publishing Company.
- Johnson-Laird, P.N. (1983). Mental Models. Cambridge, MA: Harvard University Press.
- Kaye, D.B., Sternberg, R.J., & Fonesca, L. (1987). Verbal comprehension: The lexical decomposition strategy to define unfamiliar words. Intelligence, 11, 1-20.
- Kieras, D. (1981). Component processes in the comprehension of simple prose. Journal of Verbal Learning and Verbal Behavior, 20, 1-23.
- Kintsch, W. & van Dijk, T.A. (1978). Toward a model of text comprehension and production. Psychological Review, 85, 363-394.
- Kintsch, W. (1988). The role of knowledge in discourse comprehension: A construction-integration model. Psychological Review, 95, 163-182.
- Kirsner, K., Smith, R.S., Lockhart, R.S., & King, M.L. (1984). The bilingual lexicon: Language-specific units in an integrated network. Journal of Verbal Learning and Verbal Behavior, 8, 519-539.
- Mandler, G., Pearlstone, Z., & Koopmans, H.S. (1967). Effects of organization and semantic similarity on recall and recognition. Journal of Verbal Learning and Verbal Behavior, 8, 410-423.
- McCarthy, M.J. (1984). A new look at vocabulary in EFL. Applied Linguistics, 5, 12-21.
- McLaughlin, B., Rossman, T., & McLeod, B. (1983). Second language learning: An information processing perspective. Language Learning, 33, 135-158.
- Meara, P. & Ingle, S. (1986). The formal representation of words in and L2 speaker's lexicon. Second Language Research, 2, 160-171.

- Meyer, D.E. & Schvaneveldt, R.W. (1971). Facilitation in recognizing pairs of words: Evidence of a dependence between retrieval operations. Journal of Experimental Psychology, 90, 227-234.
- Miller, G.A., Fellbaum, C., Kegl, J., & Miller, K. (in press). WordNet: An Electronic Lexical Reference System Based of Theories of Lexical Memory. Revue Quebecoise de Linguistique.
- Murdock, B.B. (1974). Human memory: Theory and data. Hillsdale, NJ: Lawrence Erlbaum Assoc.
- Potter, M.C., So, K-F, Von Eckhardt, B., & Feldman, L.B. (1984). Lexical and conceptual representation in beginning and proficient bilinguals. Journal of Verbal Learning and Verbal Behavior, 23, 23-38.
- Richards, J.C. (1982). Second language learning. In R. Wardhaugh & D. Brown (Eds.) A Survey of Applied Linguistics. Ann Arbor, MI: University of Michigan Press.
- Rumelhart, D.E. (1975). Notes on a schema for stories. In D.G. Bobrow & A. Collins (Eds.) Representation and Understanding. New York, NY: Academic Press.
- Rumelhart, D.E. & McClelland, J. (1986). Parallel distributed processing. Los Altos, CA: Morgan-Kaufman Co.
- Schank, R. & Abelson, R. (1972). Scripts, plans, and goals. Hillsdale, NJ: Lawrence Erlbaum Assoc.
- Schwanenflugel, P.J. & Rey, M. (1987). Interlingual semantic facilitation: Evidence for a common representational system in a bilingual lexicon. Journal of Memory and Language, 25, 605-618
- Swinney, D.A. (1979). Lexical access during sentence comprehension: (Re)consideration of context effects. Journal of Verbal Learning and Verbal Behavior, 18, 645-659.
- Thorndyke, P.W. & Hayes-Roth, B. (1979). The use of schemata in the acquisition and transfer of knowledge. Cognitive Psychology, 11, 82-106.
- Tulving, E. & Donaldson, W. (1972). Organization of memory. New York, NY: Academic Press.