DOCUMENT RESUME

ED 101 569 FL 006 465

AUTHOR	Baker, Lorain Nancy
TITLE	The Lexicon: Some Psycholinguistic Evidence. Working Papers in Phonetics 26.
INSTITUTION	California Univ., Los Angeles. Dept. of Linguistics.
PUB DATE	Jul 74
NOTE	138p.
AVAILABLE FROM	University Microfilms, P.O. Box 1764, Ann Arbor, Michigan 48106
EDRS PRICE	MF-$0.76 HC Not Available from EDRS. PLUS POSTAGE
DESCRIPTORS	*Cognitive Processes; Lexicology; Linguistic Theory; Models; *Phonology; *Psycholinguistics; *Speech; *Vocabulary

ABSTRACT

The aim of this work is to provide a first-approximation model of the lexicon as stored and used in speech production and perception. Both the form of the stored item and the form of the storage network is of concern. Five lexical models--the Transformational model, the Wickelgren model, the Fromkin (speech error) model, the MacKay (speech error) model, and the Brown and McNeill ('tip of the tongue') model-- are discussed. The data on which these models are based is summarized, and various hypotheses on which the models depend are tested. The issue of the ordering of phonological segments in the stored representation of words is considered in Chapter 3. The issue of the interrelations of lexical items and the form of the storage network is considered in Chapter 4. Chapter 5 deals with the possibility of a hierarchical representation of the phonological structure of lexical items. Chapter 6 deals with the representation of the lexical item with regard to semantic features. (Author/KM)

The Lexicon: Some Psycholinguistic Evidence

Lorian Nancy Baker

Working Papers in Phonetics 26

July 1974

University of California, Los Angeles

2/3

Table of Contents

Acknowledgments

I am grateful to Victoria Fromkin, not only for her criticism and suggestions for this work, but also for her concern and guidance throughout my career as a graduate student. I would also like to acknowledge the guidance and support given to me by Peter Ladefoged and the patient explanations of statistics provided by Breyne Moskowitz. Finally, I am thankful for the encouragement and moral support provided by my friends Rosa Needleman, Helen Martucci, Mickey Krieger and especially Marshall Buck.

This work was supported in part by grants from the Canada Council and the U.S. National Institutes of Health (NS 9780).

Abstract

The aim of this work is to provide a first-approximation model of the lexicon as stored and used in speech production and perception. Both the form of the stored item and the form of the storage network is of concern. Performance data from a wide range of sources is considered.

Five lexical models -- the Transformational model, the Wickelgren model, the Fromkin (speech error) model, and MacKay (speech error) model, and the Brown and McNeill ('tip of the tongue') model -- are discussed. The data upon which these models are based is summarized and various of the hypotheses upon which the models depend are tested.

The issue of the ordering of phonological segments in the stored representation of words is considered in Chapter 3. Here, word association evidence and experimental evidence are cited. This evidence indicates that an unordered model of storage (such as that of Wickelgren) is inadequate.

The issue of the interrelations of lexical items and the form of the storage network is considered in Chapter 4. Experimental evidence (involving a continuous, controlled word association test) is provided which indicates that the lexical network consists of a number of sub-groupings of lexical items as has been suggested in the Fromkin model. The features by which lexical items are grouped are apparently not those enumerated by Brown and McNeill as being prominent in generic recall.

Chapter 5 deals with the possibility of a hierarchical representation of the phonological structure of lexical items. Experimental evidence is presented which appears to support MacKay's hierarchical model, but an alternative explanation for this evidence is provided.

Chapter 6 deals with the representation of the lexical item with regard to semantic features. The questions of a semantic feature hierarchy and of semantic sub-sets in the lexical network are considered. Word Association evidence, aphasia evidence, and evidence from experimentation is analyzed.

Chapter 1

Introduction

The lexicon is the speaker's store of words or formatives. Models of both linguistic performance and linguistic competence must then include a lexicon. Those who distinguish between these two aspects of language and language behavior define "competence" as the innate knowledge that a speaker has about his language. A performance model attempts to represent *how* that knowledge is organized in the speaker's brain, and how a speaker uses that knowledge in the production and perception of utterances.

It is often assumed that a performance model incorporates, or is based upon, a competence model. Dingwall (1971) states:

> The grammar constructed by the psychological linguist is in fact held to be an abstract representation of some functionally equivalent mechanism in the brain which in turn represents the speaker-hearer's knowledge of his language as opposed to the means by which he makes use of this knowledge. Although the grammar is thus not a performance model, it is generally assumed that it constitutes a component of such a model which in addition contains an as yet vaguely specified set of strategies for making use of the grammar in production and recogniton (Dingwall, 1971, 780-1).

Chomsky (1965) similarly notes that a correct performance model must be based upon a model of linguistic competence:

> the only concrete results that have been achieved and the only clear suggestions that have been put forth concerning the theory of performance...have come from studies of performance models that incorporate generative grammars of specific kinds--that is, from studies that have been based on assumptions about underlying competence (Chomsky, 1965, 10).

A competence model of the lexicon specifies the features of words that speakers must know in order to be able to produce and understand the words in sentences. Transformational, or 'generative' linguistics has attempted to formulate such a model. Fillmore (1968) notes that a model of the lexicon must specify, for each word:

i) the nature of the deep-structure syntactic environments into which the item may be inserted;
ii) the properties of the item to which the rules of grammar are sensitive
iii) for an item that can be used as a 'predicate' the number of 'arguments' that it conceptually requires;

iv) the role(s) which each argument plays in the situation which the item, as predicate, can be used to indicate;
v) the presuppositions or 'happiness conditions' for the use of the item, the conditions which must be satisfied in order for the item to be used 'aptly';
vi) the nature of the conceptual or morphological relatedness of the item to other items in the same language;
vii) its meaning; and
viii) its phonological and orthographic shapes (Fillmore, 1968, 1).

The above information in the lexicon is considered to be represented by categories or "features"; and each word of a language is viewed as composite of these features. Any given word will then be represented by a large number of features: Phonological features (not predictable by rule) will describe each sound which occurs in the word. Syntactic features will specify the lexical category ('part of speech') of the word, as well as defining the syntactic environment into which the word can be fitted. Semantic features will indicate the meaning of the item. (In later versions of the Standard theory of Transformational grammar, the meaning of each lexical item is represented as a hierarchical tree diagram cf. Katz, 1972). Morphological features will provide information about how a word behaves with regard to the rules of the language of which it is a member. And finally, exception features will group those words of the language which behave anomalously with regard to some or several of the rules of the language.

Thus a speaker's ability to use a word correctly shows that he must have tacit knowledge of the word's phonological, semantic and syntactic features. To produce an utterance, the speaker must have some mental image (or cognitive structure) of what he wants to say. He must find the precise words with which to say it, and must combine these words into phrases and sentences. Thus, one task of the speaker is to find the word he wants to use. A description of the production of an utterance must therefore include a description of the word-finding mechanism. Similarly, a performance model of the lexicon should include a description of how the lexicon is organized or 'indexed' so that speakers access particular words.

There has been much debate concerning the representation of the lexical items. In generative phonology the present debate centers on the extent to which such representation is abstract, i.e., different from the phonetic representation.

Psycholinguists have also been interested in this question as it relates to the serial ordering of skilled behavior (Lashley, 1961; Wickelgren, 1969, a-c). Thus, for example, while it is clear that at the stage where the 'message' is encoded into articulatory commands an ordering of the elements must take place, it is hypothesized by some that the stored form of words may be partially (or completely) unordered.

Such questions require answers if the model of performance is to be viable. A performance model of the lexicon must encompass 'competence issues' (such as what are the features that speakers 'know' about the words of their language) as well as more graphic 'performance issues' (such as what the storage network looks like and the representation of a single word looks like). The aim of the present work is to attempt to discuss some aspects of such a performance model of the lexicon.

In building such a model of the lexicon, different kinds of evidence concerning the use of words in different environments and situations must be considered: how do we use words in grammatical sentences, how do we acquire new words in our vocabulary, how do we forget the meanings of old words, how do we respond in word association tests, and how do we make "slips" in using words.

The model of the lexicon incorporated into a competence grammar is based upon evidence of how words are used in grammatical sentences, on speakers' intuitive judgements regarding grammatical vs. ungrammatical strings, synonomy, antonymy, and ambiguity of sentences, and also on metatheoretical criteria. Production and perception may provide external tests for the theory, but are not in themselves to be explicated.

In a performance model, however, we must be able to account for speech errors, linguistic games such as Pig Latin, rhyming and alliteration, subjects' responses on controlled 'semi-linguistic' tasks such as word association tests, aphasia breakdowns, etc. In addition, subjects' responses in dichotic listening tests, and patients' behavior after brain lesions provide data about the nature of the mental dictionaries of speakers. Historical evidence, such as how the meanings and shapes of words change through time, will also give us information about the nature of lexical storage. Similarly the order and manner in which children acquire individual words may also provide information about the organization of lexicon.

The present study attempts to provide a first-approximation model of the lexicon as stored and used in the production and perception of utterances. Various types of evidence will be considered and evaluated.

Chapter 2 discusses five lexical models. These have been singled out because they are more comprehensive than others suggested and because they represent, to some extent, contrasting views. The Transformational model is discussed as an example of a competence model. The remaining models are performance models. The Fromkin model and the Brown and McNeill model deal with the interrelations of items in the lexicon and attempt to outline the linguistic features that play a role in performance. The MacKay and Wickelgren models concern the form of a single lexical item; both deal with the question of whether the phonological representation of items is ordered, and, if so, if the ordering is linear or hierarchical.

Chapters 3 through 5 are concerned with the manner in which phonological information is represented in the lexicon. These report on a number of experiments conducted to investigate this question.

Chapter 3 deals with the issue of the ordering of phonological segments. Word association and experimental evidence is cited to suggest that, contrary to the model of Wickelgren, segments are ordered in lexical representation.

Chapter 4 deals with the interrelations of words in the lexicon. The linguistic features considered by Brown and McNeill as primary in the lexical representation are tested in an experiment. The issue of whether lexical items are grouped according to these features is also discussed.

Chapter 5 involves additional experiments testing the MacKay hypothesis that items are represented in the lexicon in hierarchical manner. A further discussion of the possibility of lexical groupings is provided.

Chapter 6 discusses the lexical representation of words with regard to semantic features. Data from aphasia and word association tests considered.

Chapter 7 concludes with a summary of the findings to date.

Chapter 2

Models of the lexicon

2.1 The Transformational Model

The lexicon was largely ignored in Transformational Theory until Chomsky's (1965) *Aspects of the Theory of Syntax*. Prior to this work, the lexicon as a list of items did not exist. Earlier Transformational works such as Chomsky (1957) and Lees (1960) introduced words into the grammar in the Phrase structure rules in the form of lists:

Noun ---→ boy, girl, man, woman, cat, John, Boston, city...

The inadequacy of this approach was pointed out by Schachter (1962) and Stockwell (1962). A rule of the form:

$$\text{Noun} \dashrightarrow \begin{Bmatrix} \text{Noun, proper} \\ \text{Noun, common} \end{Bmatrix}$$

would be necessary to distinguish in the syntax those nouns which would require articles from those nouns which would not. Further rules of the form:

$$\text{Noun, proper} \dashrightarrow \begin{Bmatrix} \text{Noun, proper, human} \\ \text{Noun, proper, non-human} \end{Bmatrix}$$

$$\text{Noun, common} \dashrightarrow \begin{Bmatrix} \text{Noun, common, human} \\ \text{Noun, common, non-human} \end{Bmatrix}$$

would then be needed in order to separate those nouns which required the relative markers "who" from those nouns which required the relative markers "which." But the overlapping seen in the rules above indicates that a linguistic generalization is being missed.

Because the earlier approach failed to account for the fact that words cross-classified, a new approach was taken by Chomsky (1965), and the lexicon was 'born' into Transformational Theory.

In the Standard Theory (*Aspects*), the lexicon is viewed as a dictionary of the formatives of a language, together with the information that a speaker must know about each of those formatives. Chomsky and Halle (1968) state:

> A language contains a stock of items which, under various modifications, constitute the words of the language. Associated with each such item is whatever information is needed to determine its sound,

> meaning, and syntactic behavior, given the system of grammatical rules. Hence this information ultimately determines the sound and meaning of particular words in specific linguistic contexts. Evidently, this knowledge constitutes part of the knowledge of the speaker of the language... To represent this aspect of linguistic competence, the grammar must contain a lexicon listing the items which ultimately make up the words of the language. Clearly, the lexicon may contain different items for different individuals, and a given speaker may revise and expand his lexicon throughout his life (Chomsky and Halle, 1968:380).

Thus, the lexicon is viewed in a Transformational grammar as a list of the words of the language along with information about what the word means, how it may be used syntactically in sentences, and how it is pronounced in different environments. To date no model of the lexicon of any language has been constructed. The most comprehensive description of how the phonological information about words is represented is found in Chomsky and Halle (1968). The most comprehensive description of how the semantic information about words is represented in found in Katz and Fodor (1963) and Katz (1972). The issue of how the syntactic information pertaining to lexical items must be represented is a controversial one in Transformational Theory. Two conflicting views are those of Chomsky (1965) and Gruber (1967). These will be briefly discussed below.

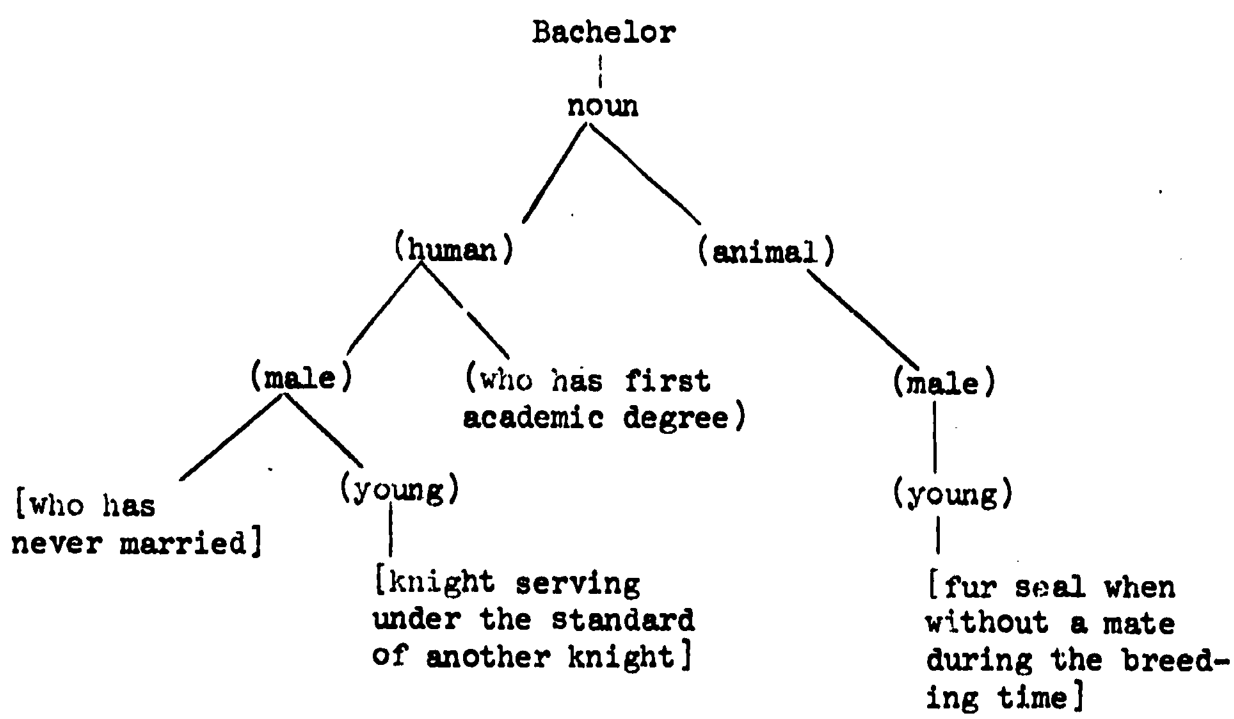
2.1.1 The Katz and Fodor Model

Katz and Fodor (1963) were interested in establishing a semantic model, or a model accounting for how speakers can understand sentences. Their model has two components: a dictionary of words, and a set of projection rules for interpreting sentences on the basis of the dictionary. The dictionary provides the following information for each word:

1. the 'part of speech' to which the word belonged
2. the number of meanings or senses the word can have
3. the semantic features of the word that are systematic to all of its meanings
4. the semantic features of the word that are idiosyncratic to particular meanings of the word

5. information about the relations between features of certain combinations into which a lexical item may enter and the senses the item bears in those combinations.

The 'part of speech' information in the dictionary is represented by means of "grammatical markers"; the systematic semantic information about words is represented by means of "semantic markers"; and the idiosyncratic information about the meanings of the word are represented by means of "distinguishers." Katz and Fodor cite the following example: (semantic markers are in parentheses; distinguishers in square brackets):



(Katz and Fodor, 1963, 500).

It can be seen from the above example that Katz and Fodor treat homophones as one word with different meanings rather than as different words. They claim that this explains how people are able to disambiguate a sentence that contains such a word.

Support for this approach was found in an experiment conducted by MacKay (1966). MacKay presented subjects with both ambiguous and unambiguous sentence fragments to complete. An example of an ambiguous fragment is "although the solution seemed clear in chemistry class, I..." where, depending on the meaning attributed to the word 'solution,' appropriate endings could be or the sort"...discovered that it was quite opaque when I took it outdoors" or "...was quite unable to solve the problem when I got home." MacKay discovered that, for such ambiguous fragments, the time required by subjects to arrive at a completion was twice that required by unambiguous fragments. MacKay further noted that this longer completion time for ambiguous sentences held true whether or not the subjects were aware of the ambiguity. This would suggest that ambiguous words may, indeed, be represented in the way Katz and Fodor propose. The longer completion time for lexically ambiguous sentence fragments would then be due to the fact that speakers had to work through more complex "trees" in order to decode the ambiguous words.

2.1.2 Syntactic Models

The Katz and Fodor model of the lexicon is primarily a semantic one: the main concern of this model is to describe the meanings of words, which is a major factor in the speaker's ability to understand sentences. Since 1965, however, the lexicon has become of concern in the field of syntax as well. Two schools of thought have arisen: the Chomsky school and the Generative Semantics school. There are various differences between these two approaches. We shall be concerned here only with the difference concerning lexical insertion. Chomsky's view will be called the Lexicalist position, and Gruber's the Transformationalist position.

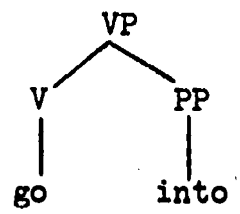
For Chomsky, lexical insertion is monocategorial. Following Stockwell and Schachter's (1962) suggestions, 'Chomsky's' 1965 model has words cross-classified with respect to various selectional features such as (for nouns) "count," "mass," "animate" and "inanimate." In Chomsky's (1965) model, the base rules generate syntactic structures in which lexical categories are rewritten as clusters of such features. The words in the lexicon are represented with these same features, and lexical insertion involves a "matching" of the features. Gruber (1967) summarizes,

> The introduction of terminal items was now accomplished by rules that were different in character from the rules of the base components, [and] these rules became entries in a lexicon. Each entry contained information regarding the syntactic environment (in terms of selectional categories such as ANIMATE, INANIMATE, MASS, COUNT) in which the lexical item...could be attached to the derived tree. Now the lexicon had a significance not only for semantics, but also for that part of syntax having to do with selectional restrictions among words. (Gruber, 1967, 10).

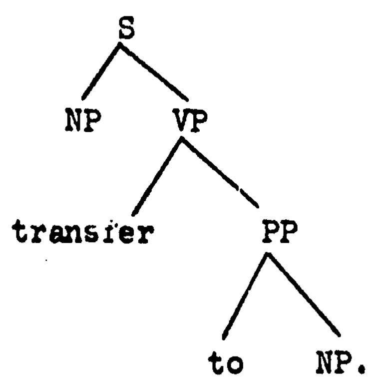
Thus, lexical insertion was effected on a one-to-one basis: one lexical item was inserted where there was one bundle of selectional features generated by the base.

For the Generative Semantics school, on the other hand, lexical insertion is polycategorial. Lexical items replace sub-trees of meanings. This model is exemplified by Gruber (1967) whose base rules generate meanings in the form of trees. The terminal nodes of these trees are meanings, not lexical items or feature complexes. Lexical items replace the meanings that they match. Thus, the representation of lexical items in the lexicon is in terms of trees representing meanings. Lexicalization is polycategorial in that there are lexical items which incorporate the meanings of several items. For example,

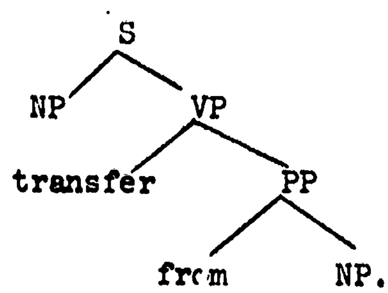
enter =



buy =



sell =



Other typical examples suggested by generative Semanticists include the representation of 'kill' as 'cause to die'; of 'remind' as 'strike as similar'; and of 'prefer' as 'like more than.' Unfortunately, none of the examples of lexical representations suggested by the Generative Semanticists to date are without counterexamples. The inadequacy of the analysis of "kill" as "Cause to die" is illustrated by the non-synonymy of the two sentences:

a) I caused him to die by hiring an assassin. and

b) I killed him by hiring an assassin.

The inadequacy of the analysis of "remind" as "strike as similar" is illustrated by the non-synonymy of the two sentences:

a) Sleighbells remind me of Christmas. and

b) Sleighbells strike me as similar to Christmas.

And, the inadequacy of the analysis of "prefer" as "like more than" is illustrated by the difference in meaning of the two sentences:

a) I prefer death to dishonor. and

b) I like death more than dishonor.

in which, as Schachter (1972) points out, the first sentence refers to the possible death or dishonor of the speaker, while the second sentence is referring to death and dishonor in general.

The various arguments for and against this type of syntactic analysis shall not be repeated here. One question that is relevant, however, is whether it is better to complicate the lexicon and base rules of a language or its transformations. In "Remarks on Nominalization" Chomsky (1970) discusses this problem with regard to derived nominals such as "John's *eagerness* to please," "John's *refusal* of the offer" and "John's *criticism* of the book." Chomsky states the two alternatives as follows:

> We might extend the base rules to accommodate the derived nominal directly (I will refer to this as the "lexicalist position"), thus simplifying the transformational component; or, alternatively, we might simplify the base structures, excluding these forms, and derive them by some extension of the transformational apparatus (the "transformationalist position") (Chomsky, 1970, 188).

To date, it is not apparent what type of evidence can resolve this question. It may, in fact, be the case that a compromise solution that adopts the lexicalist position for certain items and the transformationalist position for others is necessary.

While the issue of the abstractness of deep structures and the nature of lexical insertion is an important one in determining the model of grammar, it is less so in considering what the lexicon of a language is like. There can be little question that the lexical items of a language represent meanings and that meaning represents structure. Trees are simply one means of indicating structure: features which themselves are hierarchically ordered would be another way of indicating the presence of structure. Thus, as far as a means of representing meaning in the lexicon is concerned, the Generative Semantics approach and the Chomskyan approach may be considered notational variants. Neither scheme for representing the lexicon claims to be a performance model of how words are selected or meanings generated by the speaker. Both are simply abstract models of the knowledge that a speaker has about the words of his language. Thus, for the present purposes, the differences between these two approaches shall not be considered further.

While the Lexicalist and Transformationalist may argue about the nature of syntactic representation and the role of semantic information in syntactic representation, they are surprisingly in agreement about the nature of semantic features themselves. Binnick (1967), a Generative Semanticist, lists some characteristics of semantic features, none of which are incompatible with the views of the lexicalist school. Binnick cites, for example, the fact that some semantic categories are hierarchical and that some semantic features are less important than others. It is certainly possible to capture this fact in the lexicalist model. The fact that nouns are subcategorized first according to the feature [Common] then according to the feature [Count], then according to the feature [Animate], and then according to the feature [Human] (Chomsky, 1965, 85) indicates that these features form a hierarchy with [Common] at the top, and [Human] nearer the bottom. Binnick also suggests that semantic features are universal and are not free to combine in any way to form lexical items. Within the lexicalist model, features are also viewed as being universal for the most part. Similarly (as can be seen by the subcategorization rules in which the possible features for different classes of words are listed), semantic features are not viewed as being freely combinable. Whether or not there are some language—dependent semantic features is not really pertinent to this discussion.

2.1.3 The Sound Pattern of English Model

A view of the phonological representation of lexical items is presented in *The Sound Pattern of English* (Chomsky and Halle, 1968).

Here the lexicon is viewed as a list of lexical entries and the categories (or features) to which they belong:

> The representation of the individual items in the lexicon must incorporate the knowledge which makes it possible for the speaker to utilize each lexical item in grammatically correct sentences (Chomsky and Halle, 1968, 295).

In order for a speaker to "utilize a lexical item in grammatically correct sentences," a variety of features characterizing the item must be known. Chomsky and Halle state:

> In order for a lexical item to be used in a well-formed sentence, two types of information are required. First, we must have information about the syntactic and morphological characteristics of the item; we must know, for example, that the item *write* is a verb, that it takes an inanimate object, that it is an irregular verb of a specific subtype, and so on. As we have seen, information of this type can be provided by the syntactic and diacritic features that form part of each lexical entry. The second type of information required for proper use of a lexical item relates to its physical, phonetic actualization (Chomsky and Halle, 1968, 381).

Chomsky and Halle do not discuss the first type of information in detail, and, indeed, in a later work Halle (1973) suggests that "it seems somewhat forced" to include this type of information in the lexicon at all. Halle notes that since this type of information is largely idiosyncratic it may more properly belong in a separate "filter" through which words pass after being generated by formation rules of the language.

The major concern in *The Sound Pattern of English* is the type of information required for the proper pronunciation of lexical items in all their environments. There are many aspects of this model now being debated by generative phonologists. These include: the type of phonological/phonetic features, binary versus nary values of features, the degree of abstraction of phonological representation and how to relate semantically and phonologically similar words. The only issue pertinent to this study concerns the view that a lexical item is represented by a matrix--i.e., an *ordered* set of columns, each column representing a composite of features. This is not to say that other experimental evidence has no bearing on the issues, but rather that this study is concerned with only certain aspects of lexical representation.

While certain aspects of the transformational format are still open to question, there is general agreement that there are two primary functions of the lexicon. The first is that discussed above: the function of listing the lexical items of a language and the features of those items that speakers must know in order to use the items correctly in sentences. But, as Chomsky and Halle (1968) note, "knowledge of lexical structure goes beyond familiarity with a list of lexical items": speakers are also aware of items that are not in the lexicon ("accidental gaps"), and items that are not characteristic of the language." Chomsky and Halle state:

> part of a speaker's knowledge of his language consists of knowing the lexical items of the language. It is by virtue of this knowledge that the native speaker is able to distinguish an utterance in normal English from an utterance such as Carnap's 'Pirots karulized elatically' or from Carroll's jabberwocky, which conform to all rules of English but are made up of items that happen not to be included in the lexicon of the language (Chomsky and Halle, 1968, 295).

To account for a speaker's knowledge of this kind, "Morpheme Structure Conditions" or rules describing the constraints upon lexical items are included in the standard generative phonology model.

The Transformational model is not a performance model and does not attempt to specify how words are produced by speakers. Similarly, there is little concern for the actual organization of the lexicon in the brains of speakers. The only Transformationalist who concerns himself at all with this issue is Halle (1973) who proposes, based on the fact that paradigmatic pressure causes language change, that the lexicon must be grouped in paradigms.

Thus, in the Transformational "competence" Model, as well as in the performance models to be discussed below, there are a number of questions to be answered. These questions are relevant not only to a competence model but to a performance model as well.

2.2 The Brown and McNeill Model

In 1966, Brown and McNeill proposed a model of lexical storage in a paper entitled "The 'Tip of the Tongue' Phenomenon." This model is essentially a performance model, and its aim is to account for a particular type of performance data, namely "generic recall" of words. The model is based on one type of performance phenomenon--the 'tip of the tongue' situation in which one cannot quite recall a familiar word, but is nonetheless convinced that retrieval is imminent. The model also attempts to explain other types of performance data, such as word-perception.

Brown and McNeill's model assumes that "our long-term memory for words and definitions is organized into the functional equivalent of a dictionary" (333). This "mental dictionary" is viewed as a kind of keysorting system in which words are sorted and stored according to various linguistic features. It is explained in the following way:

> We will suppose that words are entered on keysort cards instead of pages and that the cards are punched for various features of the words entered. With real cards, paper ones, it is possible to retrieve from the total deck any subset punched for a common feature by putting a metal rod through the proper hole. We will suppose that there is in the mind some speedier equivalent of this retrieval technique. (333)

While Brown and McNeill do not elaborate on the nature of the 'features' for which the various 'cards' are 'punched,' we can easily suppose that these are the features that appear in a lexical matrix of a generative (competence) grammar. Brown and McNeill do suggest that the semantic "markers" postulated by Katz and Fodor (1963) might constitute one type of these features.

They further suggest that there is evidence to support the notion that certain 'features of words' are more prominent than other features. It is these prominent features that are more likely to appear in cases of word recall and perception. Two possible explanations for this phenomenon are suggested. The first involves the notion of "faint entries." Brown and McNeill illustrate this notion by citing the example of a person trying to remember the word "sextant," but able only to recall that the word begins with an "s" and ends with a "t":

> Intuition suggests that the features of *sextant* that could not be recalled, the letters between the first and the last, were entered on the card but were less 'legible' than the recalled features. We might imagine them printed in small letters and faintly (Brown and McNeill, 1966, 344-345).

The second proposed explanation differs from the above in that it supposes that each word is represented not just once, on a single card as it were, but on several different cards:

> Suppose that there are entries for *sextant* on several different cards. They might be incomplete but at different points, or, some might be incomplete and one or more of them complete. The several cards would be punched for different semantic markers and perhaps for different associations so that the entry recovered would vary with the rule of retrieval. With this conception we do not require the notion of faint entry. The difference between features commonly recalled, such as the first and last letters, and the features that are recalled with difficulty or perhaps only recognized, can be rendered in another way. (335)

With this second possibility, Brown and McNeill account for the greater prominance and accessibility of certain features by supposing that the more prominent features are entered on more cards, or with more punches: in effect, "they are wired into a more extended associative net." Both of the two approaches discussed have disadvantages. The notion of "faint entries" cannot account for production -- i.e., it only describes words that are never spoken. But the notion of 'multiple entries' is less economical.

The data considered by Brown and McNeill show up, as stated above, in the "tip of the tongue state," or the state that a speaker is in when he cannot recall a word that he "knows." Brown and McNeill cite a personal example:

> Unable to recall the name of the street on which a relative lives, one of us thought of *Congress* and *Corinth* and *Concord* and then looked up the address and learned that it was *Cornish*. (325)

From this example, Brown and McNeill note that there were similarities in the words called to mind. Each of the words brought to mind were two syllable words, each began with the letters Co, and each had primary stress on the first syllable. These features were also true of the target word, they therefore conclude that when complete recall fails, one may correctly recall the general type of the word, i.e., its general characteristics. This phenomenon is termed *generic recall,* and Brown and McNeill note that there seem to be two common varieties of generic recall. The first is a rather specific type of recall in which specific parts of the word are remembered: a letter or two, a syllable, or an affix. The second type of generic recall is a more general type in which the abstract form of the word is remembered: the fact that it was a two-syllable sequence with the primary stress on the first syllable, for example. In this abstract recall, the whole word is represented, "but not on the letter-by-letter level that constitutes its identity."[1]

The "ToT" Experiment

Since several months of "self observation and asking-our-friends" yielded little useful data, Brown and McNeill devised an experiment to collect sufficient data to investigate the true nature of the "tip of the tongue" phenomenon. Fifty-six undergraduates from Harvard and Radcliffe were used as subjects in the two hour experiment. In order to induce "tip of the tongue" states in the subjects, Brown and McNeill chose low frequency words (one occurrence per four million words of text) from the Thorndike-Lorge (1952) list. Definitions from the dictionary were read for each of these low frequency words, and subjects were asked to state what they thought the word was. Subjects for whom this produced a "tip of the tongue" state were asked to fill out an answer sheet which asked for guesses on the number of syllables in the word, and the initial letter of the word, as well as a list of words of similar sound and words of similar meaning.

From the information, Brown and McNeill sorted out the "words of similar meaning" that were listed by the subjects and used these as the basis of their data. "We are quite sure that the similar meaning words are somewhat more like the target than would be a collection of words produced by subjects with no knowledge of the target," Brown and McNeill observed (328). To find out to what degree and in what ways these words were "more like the target than would be a collection of words produced by subjects with no knowledge of the target," Brown and McNeill subjected their data to a detailed statistical analysis. Unfortunately, due to the difficulties in collecting the data, there were no significant tests that Brown and McNeill could be sure were appropriate. Nonetheless, the statistical analyses used did indicate several trends in the data. Subjects' responses were analyzed into two groups: words which were similar in sound to the target words, and words which were similar in meaning to the target words. The following example is given,

> When the target was *sampan*, the similar sounding words (not all of them real words) included: *Saipan, Siam, Cheyenne, sarong, sanching,* and *sympoon*. The similar meaning words were: *barge* ,*houseboat* , and *junk*. When the target was *caduceus* the similar sounding words included: *Casadesus, Aeschelus, cephalus*, and *leucosis*. The similar meaning words were *fasces*, *Hippocrates*, *lictor*, and *snake*. The spelling in all cases is the subjects' own. (328)

The first conclusion drawn by Brown and McNeill was that subjects in a "tip of the tongue" state had a "significant ability" to recall correctly the number of syllables in the word in question. Of the 224 words of similar sound listed by subjects, Brown and McNeill found that 48% had the same number of syllables as the target word. For the similar meaning words, however, only 20% matched the number of syllables in the target words.

The evidence that subjects could recall the initial letter of the target words is even stronger than the evidence for recall of the number of syllables. The initial letter of the target word was correctly guessed 57% of the time in all of the "tip of the tongue" states. Since there are 26 letters of the alphabet and many words that begin with uncommon letters, whereas the number of syllables that a word may have is only about 5, the chance result for correctly guessing the initial letter is much less than the chance result for correctly guessing the number of syllables of the word.

Another tendency in the data was for the placement of stress to be the same in the guessed words as in the target words. The "similar sounding" words were used here for the data, although a number of these words had to be eliminated from consideration since,

> (a) Words of one syllable had to be excluded because there was no possibility of variation. (b) Stress locations could only be matched if the Similar Sounding word had the same number of syllables as the target, and so only such matching words could be used. (c) Invented words and foreign words could not be used because they do not appear in the dictionary. (330)

After the words from each of the above groups were eliminated, there was insufficient data for the statistical analysis. Brown and McNeill were only "left suspecting that subjects in a Tip of the Tongue state have knowledge of the stress pattern of the target." Since they present no probabilities of the same stress occurring in words having the same number of syllables, one might question this "suspicion."

Another finding in the data was labelled by Brown and McNeill the "Serial Position" effect. Underwood (1963) has pointed out that in psychology experiments involving the memorizing of lists, subjects are able to recall the beginnings and ends of lists much better than the middles of lists. Apparently, it is the same with words. Brown and McNeill noted that recall was best for the beginning letter of a word, next best for the final letter of the word, next best for the second last letter of the word, and next best for the third to the last letter of the word.

The last observation made by Brown and McNeill about their data concerned the phenomenon of "suffix-chunking." This was explained as follows:

> The request to S that he guess the initial letter of the target occasionally elicited a response of more than one letter; e.g., ex in the case of *extort* and *con* in the case of *convene*. This result suggested that some letter (or phoneme) sequences are stored as single entries having been 'chunked' by long experience. (331)

Statistical evidence for 'chunking' was not significant, so Brown and McNeill could only conclude that chunking 'probably' played a role in recall.

To summarize their evidence, then, Brown and McNeill found that subjects in a Tip of the Tongue state had *some* idea of:

1. the number of syllables in the target word
2. the initial letter of the target word
3. the stress pattern of the target word
4. the final letters of the target word
5. the occurrence of certain affixes in the word

One piece of perceptual evidence which supports the "Tip of the Tongue" findings, in particular the "Serial Position effect" is contained in a study conducted by Bruner and O'Dowd (1958). Bruner and O'Dowd used tachistoscopic exposures of various words in which two letters in various different positions in the words were reversed. The exposures were too brief to permit more than one fixation. It was found that, in general, a reversal of the two initial letters made identification of the word most difficult, reversal of the last letters made it somewhat less difficult, and reversal of the middle made it least difficult. Evidently, in word perception as well as recall, it is the middle of the word that is, in some sense, 'least important.' Brown and McNeill conclude that "selective attention to the ends of words should lead to the entry of these parts into the mental dictionary, in advance of the middle parts." (336) But, it is possible that this phenomena is a result of the linguistic facts. The middle of the word may, thus, be 'least important' simply because it tends to carry more redundant information. It would be of interest to determine if these results are the same in all languages, indicating whether or not these 'perceptual strategies' are learned. For example, in French, where the end of the word carries important grammatical information, speakers may attend first to the end of the word.

It is suggested by Brown and McNeill that for low frequency words, where recognition rather than production is what is usually required, the middle sections of the words may never be entered in the mental dictionary:

> If knowledge of the parts of new words begins at the ends and extends toward the middle we might expect a word *numismatics*, which was on our list, to be still entered as NUM_____ICS. Reduced entries of this sort would in many contexts serve to retrieve a definition. (337)

This assumes that there is a separate lexicon (or subset) which includes words comprehended (spoken or written) which are not used in production. It does not however tell us much about the regular representation of the active vocabulary. It is clear that no word used in speaking can be so under-represented. What we are seeking is how such words are stored.

One last piece of evidence for this model was provided by an analysis of children's spelling errors made by Jensen (1962). Jensen discovered a serial position effect similar to the one noted by Brown and McNeill and by Bruner and O'Dowd, in that spelling errors were most common in the middle of the words, next most common at the end of the words, and least common at the start of the words. It is possible here however, that the facts of the orthography may be at least partially responsible. Vowel sounds present more difficulty in spelling than consonant sounds: there are more vowel sounds in English than there are letters to represent them. Also, most vowel sounds may be represented in the orthography in more than one way. These facts, coupled with the fact that vowels tend to occur in the middle of words whereas consonants tend to occur in the beginnings and ends may account for Jensen's findings.

One criticism that can be made against Brown and McNeill has been noted by them: they admit that their results are not statistically significant due to the "fragmentary data problem" (328). Thus, they are careful to preface their conclusions with comments to the effect that "we cannot be sure that the matching tendency is significant" (330), "We do not know the chance level of success for this performance..." (329), and "for the tests we shall want to make sure there are no significance tests that we can be sure are appropriate " (328).

Putting aside these considerations of the validity of the experiment, another type of criticism may be made, having to do with the validity of Brown and McNeill's model itself. The model is an attempt to explain how words--all words--are stored. Yet their data deals with a very particular kind of word and may not be generalizable at all to the totality of words that a speaker has in his lexicon. It will be recalled that the words used in Brown and McNeill's experiment were rare or low-frequency words which, according to Thorndike and Lorge, occurred only once in four million words of English. The actual examples cited by Brown and McNeill were "nepotism, cloaca, ambergris, sampan, and numismatics." That the subjects were familiar, even in a "tip of the tongue" manner, with such words is rather surprising, and makes one wonder if the subjects were merely pretending to have some familiarity with the words in order to please the experimenters--a not uncommon phenomenon among experimental subjects. But this possibility is not the major concern here. Rather it is the fact that these words are so strange that they are not likely to have been learned until subjects were at a fairly advanced stage of education. The words upon which Brown and McNeill have based their model are "learned" words: they are words that were undoubtably first encountered in readings, or on the school blackboard, and were probably encountered at some age past puberty, or after "linguistic set" was achieved. It is possible that words are not stored in a uniform manner, but rather that different types of words are stored in different ways. If this hypothesis is valid (see Aphasia, Chapter 6), then Brown and McNeill's model would be inadequate to account for the storage of all lexical items. It is possible, for example, that words that are acquired differently are stored differently. Words that are learned through reading and writing, then, would be stored differently than words that are learned "at the mother's knee" by hearing and saying them. It is also likely that words that are learned very late in life are stored differently from words that are learned during the original language acquisition task.

It is of course true that a more 'elegant' model would represent all words as stored in the same fashion. We are unable to conclude at this point whether such is the case. If, however, a model of this kind can account for all the evidence it would be preferable to one which posits different representations. (However, the Brown and McNeill model has more substantive problems).

It is also important to note that Brown and McNeill's model is heavily 'spelling oriented.' Subjects were asked to guess at initial and final *letters* (rather than phonemes or sounds). Similarly, subjects were asked to guess the number of vowel letters (or vowel digraphs) in spelling.

Since the very words selected by Brown and McNeill were words that were probably initially learned via reading and writing, it is not surprising that the subject's ability to recall features of their spelling is good. It may be the case that Brown and McNeill have constructed a valid model not of language storage, but of one small part of it.

Brown and McNeill's model will be discussed further in Chapter 4 where the "prominent linguistic features" cited are examined experimentally.

2.3 The Wickelgren Model

Wayne Wickelgren (1969a,b,c) proposed a model which deals with the question of the form in which words are stored in the lexicon. Wickelgren's model is a performance model, rather than a competence model, and attempts to account for the units used in the production of words by speakers. It can however also be considered as a model for lexical representation but it will not fare any better as such. There are at least two problems to be considered in constructing a production model: the first is the size and kind of units that are stored, and the second is the ordering of these stored units in the actual production of speech. In Wickelgren's model, the proposed stored unit is the allophone. Words are represented by *unordered* context-sensitive allophones.

Wickelgren's work was stimulated by Lashley's (1961) paper, "The problem of serial order in behavior." Lashley dealt with a number of problems including serial order in noncreative behavior, the mental planning (or "priming") of future behavior, syntax in language behavior, the role (or lack of any role) of sensory feedback in the control of rapid coordinated movement, space coordinate systems, rhythmic action, the interaction of temporal and spatial systems, and the activity of the nervous system. Lashley concluded that behavior sequences are composed of a number of "elementary motor responses" (emrs) which can occur in a large variety of orders. These elementary motor responses are considered to be the same regardless of the context of other elementary motor responses in which they occur. Thus, whether or not the elementary motor responses are changed by their context, the internal representatives of these elementary motor responses are assumed to be identical for all contexts. The particular problem with which Lashley concerned himself is that of the serial ordering of these elementary motor responses. It was Lashley's conclusion that the serial ordering of elementary motor responses could *not* be accounted for by a context-free associative chain model.

With regard to linguistic behavior, a context-free associative chain model would be a model in which words are stored in representations consisting of (context-free) phonemes. The ordering of these phonemes would be achieved by means of associations between them: with each phoneme in sequence being triggered by its preceeding phoneme. For example, the word "right" would be stored as the sequential activation of the phonemes /r/, /a/, /y/, /t/ in that order.

The inadequacy of such a model is based upon the fact that language consists of a relatively small number of phonemes (approximately 50) and an enormous number of possible orderings(approximately 10^6). Pair-wise associations between phonemes is inadequate in providing information concerning the ordering information for any particular word. For example, consider the phonemic anagrams "struck" (/struk/) and "crust" (/krust/). Since the two sets of phonemes for the two words is identical, but the ordering is different, it is obvious that phoneme-to-phoneme associations cannot be the basis of serial ordering. If it was a chain of associations that produced the ordering, then only one word, not the existing two words, could be generated. Lashley concludes that the ordering of the elementary motor responses must come from some outside source, not from associations between the internal representatives of the elementary motor responses themselves.

Wickelgren's model, while inspired by Lashley's model, sharply diverges from it. Wickelgren assumes that the underlying units of linguistic storage are unordered allophones, and that their ordering in speech is indeed effected by means of an "associative chain." Wickelgren states,

> I define a context-free code for words to consist of an ordered set of symbols for every word, where some symbols in some words give insufficient information concerning the adjacent symbols to determine them uniquely out of the unordered set for the word. That is to say, the same symbol can be used in a variety of contexts of left and right adjacent symbols, and the ordering of the symbols in a word carries information not found in the conjunction of the unordered set of symbols with the sequential dependency rules (Wickelgren, 1969a p. 85).

An example of a context-free representation for words would be a phonemic representation. Wickelgren feels that this type of representation is, however, inadequate and that a context sensitive allophonic representation is necessary. For Wickelgren, then, words are represented in the mental dictionary by an unordered set of context-sensitive allophones such that each allophone represents essentially an ordered triple of immediately adjacent phonemes in the phonemic spelling of the word. For example, under Wickelgren's model, the representation of the word "right" would be:

$$\overset{r}{\#\ a}\qquad \overset{a}{r\ y}\qquad \overset{y}{a\ t}\qquad \overset{t}{y\ \#}$$

The fact that the allophones are spelled out in the correct order in the example above is irrelevant: Wickelgren points out that this is done merely for ease of recognizing the words, and that, in reality, the allophones are not ordered. Because the allophones are context-sensitive, their order can be uniquely reconstructed "from associations in long-term memory."

For Wickelgren, then, the concept of an associative chain is an acceptable one. He first explains that the selection of the unordered set of phonemes in any given word is not a difficult problem for an associative memory:

> If the coding of a word in the visual or auditory some abstract (verbal) conceptual system is 'distinct enough' from the coding of all other words, then the strengths of associations from this word-representative to the phoneme-representatives in the articulatory system provides adequate information concerning the unordered set of phonemes in the pronunciation of any given word. That is to say, the phoneme-representatives of the word are the ones to which the word-representative is strongly associated (1969b, p. 4).

Wickelgren does not have the problem of distinguishing between "crust" and "struck" in his model. He notes that, "Written in terms of context-sensitive emrs (context-sensitive allophones), the unordered sets for these two words are no longer identical" (1969b p. 6). Thus, "struck" is represented as $/\#^{s}t\ s^{t}r\ t^{r}\wedge\ r^{\wedge}k\ \wedge^{k}\#/$ and "crust" is represented as $/\#^{k}r\ k^{r}\wedge\ r^{\wedge}s\ \wedge^{s}t\ s^{t}\#/$. Assuming that the unordered set of context-sensitive emrs is partially activated by the word representative, then all that is needed to generate the correct order for each word is the association from "begin" to the initial allophone. In the case of "struck," this will be $/_{\#}s_{t}/$ and in the case of "crust," it will be $/_{\#}k_{r}/$.

Conceptually, then the ordering of the allophones is achieved by interlocking the allophone representatives "puzzle-fashion." From the point of view of linguistic production, the ordered articulation of the allophones is explained by Wickelgren as follows:

> First, the word representative "primes" (partially activates) all of the context-sensitive allophone representatives either as an unordered set or with a slight temporal ordering favoring the earlier allophone representatives. The selection of the correct unordered set of around 7 allophone representatives from a total set in the tens of thousands is obviously an extremely important step, but one which is easily achieved by an associative memory. The slight temporal ordering could come about because the long-term associations between the word representative and its allophone representatives are ordered in strength by degree of remoteness from the beginning of the word...The basic mechanism by which a word's unordered set of context-sensitive allophone representatives is converted into an ordered set is by starting with the initial allophone representative ${}_{\#}u_{v}$ which activates ${}_{u}v_{w}$, and so on to the terminal allophone representative ${}_{y}z_{\#}$ (1969a p. 91).

Wickelgren's evidence for the allophone as basic unit involves co-articulation and speech perception data and is not relevant to the present discussion. The choice of an *unordered* representation is apparently made chiefly due to 'simplicity;' although in his later works, Wickelgren does cite experimental support for this decision. One such piece of evidence is an experiment conducted by Warren, Obusek, and Farmer (1969) showing that human beings are extremely poor at recognizing the order of even an extremely short series of context-free elements such as hisses, buzzes, and tones. After repeated trials, however, subjects were able to distinguish the order of these sounds much more accurately. Wickelgren takes these findings as evidence for an associative chain, noting that "presumably frequent exposure to sequences of different events permits the establishment in the organism of units that represent something like overlapping triples of events" (1972, p. 255). The alternative explanation (of a very similar experiment) is that given in Ladefoged & Broadbent (1957). They suggest listeners learn to name e.g., 'buzz hiss buzz' as "buzz hiss buzz" although they perceive it as a unit.

Thus there is no conclusive evidence for an unordered lexical model. Speech errors, in fact, seem to reveal phenomena which can be accounted for only by assuming ordering.

Because Wickelgren's model is unidirectional, it would predict that in speech errors reversed segments would occur much more frequently following repeated segments. Thus, one would expect errors of the sort ABCBDA--→ABDBCA, or *cavalerie*---→*calaverie*. Similarly, one would expect that the positions of reversals would be random as long as the reversed segments share similar contexts in the chain. MacKay (1970), using evidence from German, noted that this was not the case: repeated segments followed the reversed segments as often as they preceded them, and errors of the sort *wasserflasche*--→*flasserwasche* were most common.

Further criticisms of the model include the vast number (approximately 10^6) of units that must be stored and the fact that higher features (such as plural and tense markers) are not accounted for.

Wickelgren's model will be discussed further in Chapter 3 where experimental evidence concerning the unorderedness of lexical representations is brought up.

2.4. The Fromkin Model

The two performance models discussed thus far have dealt with two different aspects of lexical representation. Both models are concerned with the representation of phonological features of words. The Brown and McNeill model deals with the representation of predominant phonological characteristics of words and describes the interrelation of words in the lexicon according to these features. The Wickelgren model, on the other hand, is concerned with the representation of a single word and describes this representation in terms of unordered allophones. No attempt to discuss the interrelation of lexical items is made.

The Fromkin model deals with both the form of a single lexical entry and the form of the network of lexical entries. Fromkin provides speech error evidence to show that the feature (or allophone), the segment (or phoneme) and the syllable must all be basic units of performance. Evidence is also provided about the representation of other linguistic features in the lexicon.

One such linguistic feature is that of syntactic word class. The fact that in speech errors "a mistakenly selected word always or nearly always belongs to the same word class as the intended word" (Nooteboom, 1969, 130) indicates that syntactic word class is represented in the lexicon in some "psychologically real" way. The fact that, for example, when nouns are switched, they only transpose with other nouns indicates that there must be some independent grouping of nouns in the lexicon. Fromkin summarizes: "When words are switched, nouns transpose with nouns, verbs with verbs, etc" and provides the following examples,

> a computer in our own laboratory—→a laboratory in our own computer
>
> I have some additional proposals to hand out—→I have some additional proposals to hang out
>
> How come if you're a Scorpio you don't read—→wear oriental spice?
>
> (p. 44).

The importance of syntactic category information is, of course, shown by non speech-error evidence. If speakers did not in some sense 'know' what is a noun and what is a verb they would be unable to produce (or judge) utterances which conform to the rules of grammar. The speech error data are merely further evidence.

There is also evidence that words are grouped in the lexicon according to semantic features. "Blends," or errors in which non-existent words are produced as the result of composites of two words with similar semantic features, are one such piece of evidence. Fromkin provides the following examples of blends (the words that are combined are indicated in brackets):

My data consists [mownlij]-[mejstlij]	(mainly/mostly)
I swindged [swɪndžd]	(switch/changed)
She's a real [swɪp] chick	(swinging/hip)
it's a [spajrətəv]	(spirant/fricative)
a tennis [æθlər]	(player/athlete)

(p. 46)

Fromkin's explanation of what has happened when blends are formed is the following:

> A speaker has in mind some meaning which he wishes to convey. In selecting words, it appears that he is matching semantic features. Where there are a number of alternative possibilities, rather than making an immediate selection, he brings them both into a buffer storage compartment, with their phonological specifications. Either a selection occurs at this point, or the words are blended, resulting in the above kind of errors (p. 46).

Verification that the lexicon is probably grouped according to semantic features of words is provided by another group of speech errors, errors which involve the substitution of antonyms. Examples include,

I really like to--hate to get up in the morning

It's at the bottom--I mean--top of the stack of books

This room is too damn hot--cold

the oral-written part of the exam

(p. 46).

Antonyms, as well as synonyms, may also be stored close together in semantic sub-sets in the lexicon. Since antonyms are words that have identical features and differ only in the value of one of those features, this is not to be unexpected.

A third type of speech error evidence that words are stored according to their semantic features is provided by a number of examples which were originally discussed by Nooteboom (1967). These are errors which seem "to involve a semantic switch from the space to the time dimension:"

> the two contemporary, er, sorry, adjacent buildings
> during the apparatus, er, behind the apparatus
> the singular, sorry, the present time
>
> (Nooteboom, 1967, 14)

Apparently words with similar semantic features are stored together in the lexicon. Errors occur when some feature of the word is changed, resulting in some near-meaning word, or (depending upon whether words are actually stored as complexes of semantic features) when some near-meaning word is chosen. The evidence is that words are, however, stored as complexes of semantic features, and an interesting question that results is exactly which features may be changed. Presumably (as was the case with phonetic feature changes in speech errors) some semantic features are "higher level" in a hierarchy and are, thus, less susceptible to being switched.

There is some evidence in speech errors that words are also grouped in the lexicon according to similarity of phonological structure. It was originally noted by Nooteboom that in many cases of word substitution the substituted word has some phonetic similarity to the target word. Fromkin's examples of this phenomenon include:

naturalness of rules--→naticnalness of rules

bottom of page five--→bottle of page five

proposals to hand out--→proposals to hang out

(p. 4).

Fromkin notes that errors such as these suggest "that our stored lexicon is ordered in some dictionary-like fashion, and any crossword puzzle addict can confirm this fact."

One final piece of evidence about the nature of the lexicon brought out in speech errors has to do with the morphemic structure of words. It was found, for example, that in speech errors, there was a rigid separation between stems, prefixes, and suffixes. Stems were only switched with stems; prefixes only switched with prefixes; and suffixes only switched with affixes. Fromkin comments:

> derivationally complex items may be stored as combinations of separate formatives, i.e., stems and affixes. Exampl...above, natural+ness--→national+ness, attests this, as do the following examples:

infinitive clauses--→infinity clauses

grouping--→groupment

intervening node--→intervenient--→intervening node

and so in conclusion--→and so in concludement

(p. 45).

Fromkin further concludes:

> Given the higher than chance probability that prefixes and suffices are involved in syllable errors (MacKay, unpublished), one can further assume that, even if words are stored with their affixes, the stem and affix have a separate status. Thus it is not unlikely that *grouping* is stored as group+ing, which permits a substitution of *ment* for the affix *ing* (p. 46).

Fromkin then posits a model of the lexicon that consists of listings of both stems and affixes, as well as idioms, compounds, and whole words. Fromkin's model is, of course, a performance model, which describes a speaker's "stored lexicon" and its use in producing utterances.

Like Brown and McNeill (described above), Fromkin bases her model on data revealing what speakers must "know" about words, and that must, therefore, be represented in the speaker's mental lexicon. Based upon speech error information, Fromkin concludes that a model of the lexicon must, for each formative, specify all the phonological, syntactic and semantic features involved. Referring to Brown and McNeill's findings, Fromkin also notes that the number of syllables in a word must also be indicated, as well as the orthographic spelling of the words. To account for speakers' abilities to form rhymes, Fromkin also suggests that the final sounds or letters of words must be specified. However, Fromkin also suggests that rhymes may be based more on surface phonetic forms than on stored phonemic forms. Fromkin notes that this shows that a speaker has both knowledge of the abstract representation and of the surface phonetic pronunciation.

In Brown and McNeill's model, the various pieces of information about a word were conceptualized as various "punch cards," each with the word and some one piece of information about it being represented. Fromkin's model accounts for the various pieces of information about a word that must be stored by viewing words as being stored or indexed in many networks of groups. Because speech errors involved switches only of words of the same syntactic class, Fromkin concluded that words must be grouped in the lexicon according to syntactic class. Because words with semantic features in common tended to be switched, Fromkin concluded that words must also be grouped by semantic features. And, because speech errors often involved words of similar phonological shape, Fromkin notes that words must also be grouped in the lexicon according to phonological features. In Fromkin's model, then,

> vocabulary is stored in a thesaurus-like lattice structure. It is possible to conceive of this network as a listing of all the stems and affixes in some fixed phonological order, each one with all of its feature specifications, and each one with a particular address. The separate semantic section of this lexicon may then be divided into semantic classes, with semantic features under which are listed, not the particular vocabulary item, but the addresses of those items which satisfy the features indicated. One might suggest also that the listings under the semantic headings are grouped under syntactic headings such as [+noun] [+verb.] etc... (p. 47).

Fromkin's model will be discussed further in Chapters 4 and 5 where Experimental evidence as to the phonological grouping of words is presented. In Chapter 6, evidence for semantic groupings is discussed.

2.5 The MacKay Model

Two of the basic issues to be dealt with in establishing a model of the lexicon are: the issue of the form of the storage network, and of the form of a single stored item. Brown and McNeill and Fromkin proposed models which attempt to describe the interrelations of words in the lexicon. Wickelgren dealt with the more narrow issue of the form of a single stored item: he pictured words as being represented by chains of allophones.

The model presented by MacKay (1972) describes one representation of a single word as being a hierarchical, rather than a chain, structure.

MacKay's model is a performance model. The underlying units of this model include morphemes, syllables, and phonemes. MacKay also suggests that features are probably elements but does not elaborate on this. For MacKay, as for Wickelgren, the basic units are stored in an unordered representation. Order is achieved in MacKay's model by a hierarchy of abstract recoding rules. The exact mechanism of these rules is vaguely described: it appears, however, that words are generated in terms of progressively smaller and less abstract units as the series of rules is put into use. Syllables, for example, are generated first as an "initial consonant group" plus a "vowel group." The initial consonant group is then expanded into one or more consonants while the vowel group is expanded into a vowel plus a final consonant group. The final consonant group is then expanded into one or more consonants. MacKay explains,

> the general nature of these rules is quite simple. Single units such as S [syllable] are expanded into two or more subunits...Then the leftmost subunit is expanded or specified until "terminal elements" are generated...Once a terminal element is reached, rules for the next unexpanded unit are applied, until all of the segments are generated (MacKay, 1972b, 2).

The abstract recoding rules, then, determine the serial order of first, units in a word, and then, segments in a syllable. Thus, unlike Wickelgren's model in which words viewed as consisting of a chain of equal units, MacKay's model claims that words are stored in basic groups of units that are themselves broken down into further subgroups of units. For words, these basic groups are "stem-groups" and "prefixes." The subgroups are stems and suffixes. For syllables, the basic groups are the "initial consonant group" and the "vowel group." Without actually listing all of MacKay's recoding rules, the simplest illustration of how words are treated is found in his diagrams of the words "stand" and "ungentlemanly." (Figures 1 and 2).

A question of interest concerns the "psychological reality" of the groups and subgroups posited by MacKay. His model is based chiefly on a certain type of speech error, "synonymic intrusions." "Synonymic intrusions" are speech errors which result in the inadvertent combination by the speaker of two words having roughly the same meaning. MacKay cites Hockett's (1967) example "Don't shell," from the involuntary combination of "Don't shout" and "don't yell." MacKay was interested in the factors which determined where the initial word of the "synonymic intrusion" or blend left off and the sequel word began. After examining different factors for their statistical significance, MacKay reached the following conclusions:

1. Breaks sually fall between, rather than within syllables

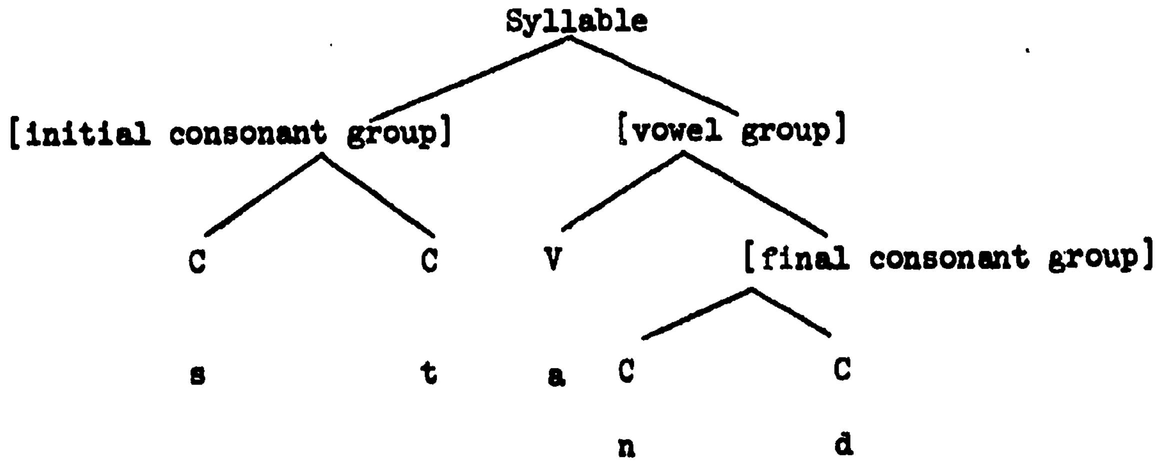
2. Breaks rarely fall between the consonants in consonant clusters

3. Breaks falling within syllables are usually before, rather than after, the vowel

4. Breaks usually fall between, rather than within, morphemes

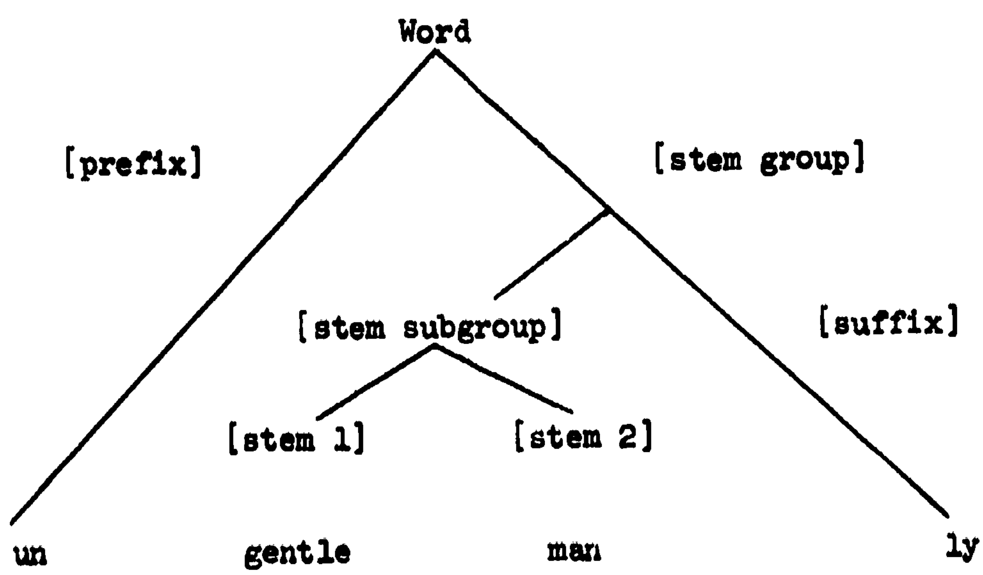
5. Breaks are between the prefix and the stem more often than between the stem and suffixes.

FIGURE 1



(I have added labels--in brackets--to MacKay's diagrams). (MacKay, 1972a)

FIGURE 2



(MacKay, 1972a)

From these findings, we are provided with performance evidence that syllables, consonant clusters, the vowel and its following consonants, morphemes, and the stem of a word and its following suffixes act as units. MacKay concludes:

> The fact that breaks fell inside syllables with less than chance probability suggests that speech segments are grouped into syllables in the production of speech. At the same time, syllables cannot be 'the basic smallest units in speech production,' but must themselves be composed of at least two smaller groups of segments. The consonant cluster must represent one of these groups since breaks separated consonant(s) must form another group with the vowel since breaks rarely fell between final consonant(s) and the vowel (MacKay, 1972a).

Of interest here is the fact that Fromkin does not note a similar phenomenon in her data. She states (personal communication) that in her data, there are many more examples of split consonant clusters than the MacKay model would seem to account for. While it is true that MacKay's model does not disallow split consonant clusters, this difference in the two corpus' is of concern since MacKay's model is statistically based. Fromkin concludes "one should perhaps not base a model on statistical frequency unless the corpus is much much larger."

MacKay however cites five further pieces of evidence for his model: word games, abbreviations, spoonerisms, universal facts about language acquisition, and finally a rate of speech experiment. The word game evidence is a game called "Double Dutch." MacKay explains,

> To speak Double Dutch, one begins with the initial consonant group of a word, then adds the dummy vowel group (AWL), followed by the dummy initial consonant group (F) and the vowel group of the original word. Thus the word DUTCH in Double Dutch is rendered: DAWL + FUTCH (MacKay, 1972b, 5).

This game lends support the the abstract recoding theory, according to MacKay, because the rules for the game "always operate on natural units as defined in the Syllabic Recoding model, i.e., Syllable, Initial Consonant group, Vowel Group, and Final Consonant Group, and never on unnatural sequences such as the CV in a CVC syllable." It must be noted, however, that the above quote is MacKay's only example of how the game works: it would be much more convincing, for example, if he had chosen a word such as "strike" with a consonant cluster at the beginning to show us what it would become. As it is now, with his lone example, MacKay has not shown us anything about the behavior of an initial consonant *group*.

Also, there are language games that represent just the opposite of MacKay's claim. Thus in German there is a game in which there is a contraction of the words such that only the first CV of each word remains:

Kaufhaus des Westens → Kadewe

And in Murut one finds the vowel of the final syllable deleted but with the consonant retained:

mapanday kow kia ra ragu → mapan ko ki ra rag nu Mur

Then there are the games in which there is a reversal of first and last consonants:

English: look at → cool ta. (back slang)

French: con → noc, cul → luc, folle → loffe

There are also games a little more complicated but which show the 'cohesion' of CV as opposed to VC:

English: Get work → gerriger worriger
Get a bit of light labor → gerriger ariger biriger origer liriger lariger
will you go with me → wiggery youggery goggery wiggery miggery (or → withus youvus govus withus mevus)
sorry → soraka, yes → yeraka

Dutch: ga jij met mij in den tuin spelen gavere jijvere meevere mijvere invere devere tuivere speelevere
(all of the above examples taken from Laycock, 1972).

Also, Jesperson reports on a game which consists of replacing the first consonant in an initial consonant cluster with *wa* and inserting 'p' or 'g':

breeches → wareechepes

Thus, while it is true that there are language games which support MacKay's hypothesis, it is also true that there are a fair number of language games which do not support the hypothesis.

Another piece of evidence that MacKay cites to support his model is abbreviation evidence. MacKay examined a large collection of abbreviations in Webster (1904) and discovered:

> When the abbreviations stopped within a syllable (e.g., *manuf.* for *manufacturing*), they usually stopped after the initial consonant group (e.g., *contr.* for *contracted; Sw.* for *Swedish)* MacKay, 1972a, 18).

Thus, abbreviations are apparently like "synonymic intrusions" in that the breaks do not seem to occur between members of a consonant cluster or a vowel group. It must be remembered, however, that the facts of the orthographic conventions of a language need not reflect the facts of speech production for that language.

An example that does however, concern the facts of speech production is the case of spoonerisms. It will be remembered that "Spoonerisms" are errors in the serial ordering of segments involving the metathesis of two initial segments. MacKay notes that Spoonerisms involving the switching of syllable initial consonants with syllable final consonants never occur. This fact is explained in MacKay's model by the fact that such segments would represent expansions of different recoding rules ("Initial consonant group → ____ "versus" "Final consonant group → ___".) MacKay notes further that:

> transpositions of a consonant with a consonant group are possible in this theory, e.g., Coat Thrutting where THR is transposed with C (MacKay, 1972a, 16).

This is because units of the same term of "natural unit" in the recoding theory are interchangeable.

Another fact that MacKay claims his model accounts for is that the CV syllable seems to represent a universal syllable type. It was Jakobson (1966) who noted that the CV syllable was present in all languages of the world, and was easiest for children to remember and produce. MacKay explains that this is because the CV syllable results (in his model) from the "simplest expansion of the one universal or obligatory rule in the model:" Syllable → Initial Consonant group + Vowel Group.

The last piece of evidence for the syllabic recoding theory relates to an experiment conducted by MacKay on the rate of speech for different syllable types. MacKay showed subjects nonsense syllables consisting of three segments in permuted order: for example, sku, kus, and usk. Subjects were asked to repeat the syllables at the maximal rate for a period of five seconds. MacKay discovered that syllables of the structure CCV were spoken at a significantly faster rate than syllables of the CVC form; and that syllables of the CVC form were spoken at a significantly faster rate than syllables of the form VCC. MacKay claims that this difference in maximal rate of speed is due to the fact that, for example, CVC syllables require fewer recoding rules in their generation than VCC syllables. It may well be as MacKay claims that ease of production is directly related to the number of recoding rules that must be applied in the generation of a syllable. However, one is reminded by this claim of the similar claim in early psycholinguistic investigations that the perceptual complexity of a sentence was determined by the number of grammatical rules employed in its derivation: a claim proved false by Fodor, Garrett, and Bever (1968).

Another difficulty with this claim has to do with the issue of when, in relation to the actual articulation, the recoding rules are applied. This is a significant question, and one that MacKay does not deal with at all. It seems likely, however, that at the point where the muscles are moved (i.e., when the motor commands are issued) the recoding must have already occurred. If this is the case, the differences in rate of speech for the CVC and VCC syllables could not be due to the number of recoding rules that must be used to generate the syllables.

In addition, MacKay never explains how a word is represented in the lexicon. From his tree diagram (above) we can infer, however, that there would be no linear order in the lexical representation, but rather a representation like:

word → 1 syllable
syllable → Initial Consonant Group + Vowel Group
IC group → C_1C_2
Vowel group → VC_3C_4
C1 → s
C2 → t
V → a
C3 → n
C4 → d

Each segment would, presumably, be rewritten as a feature matrix. This complicated scheme seems highly unlikely and unnecessary. If there is indeed a greater cohesion between parts of a syllable, then this internal structure could be more easily accounted for by an internal syllable boundary, of the sort:

$/st^{=}a_{\#}nd/$.

This would account for MacKay's evidence of hierarchical structure, if indeed such evidence is supported by further research.

As both "support" and elaboration of this theory of hierarchical specification of serial ordering, MacKay (1972c) suggests that the semantic selection of a word is also a hierarchical process. Thus, prior to the phonological specification of a word (by means of word and syllable recoding rules), the semantic representation or the word itself must be generated. MacKay claims that this process of semantic generation consists of the activation of a hierarchy of underlying features.

> word production depends on the activation of a hierarchy of underlying features. The first feature elaborated is the syntactic or form class feature (Noun, Verb, etc) which determines how the word functions in the sentence. Then a hierarchy of semantic features is elaborated. The word MAN for example might be specified by the ordered activation of features such as LIVING, HUMAN, ADULT, MALE among others (MacKay, 1972a, 8).

MacKay's support for the claim that words are generated semantically by the activation of a hierarchy of features is a variety of speech errors. MacKay cites word substitutions, synonymic intrusions ("blends"), child language errors, and malapropisms as examples of phenomena explained by this model.

Such errors according to MacKay, are due to the fact that only some of the semantic features of the intended word have been activated. These would, of course, be those features which are at the top of the feature hierarchy for a given word. MacKay notes that speakers do not always know all of the semantic features for a word, yet they can use the word correctly in speech. From this observation, MacKay concludes that it is possible to produce words that are only "partially activated," or that have only some of their semantic features activated. Errors arise when certain features necessary for specifying one word rather than another are omitted. MacKay cites the following example:

> the feature (+COMPARATIVE) is necessary for specifying the word LONGER rather than LONG, or BETTER rather than GOOD. But suppose that due to fatigue or lack of time a speaker fails to specify this low level distinguishing feature. He has activated the syntactic feature ADJECTIVE and the semantic features corresponding to the concept GOODNESS say, b.t has left unspecified the feature (+Comparative). Thi. means that the word GOOD will be determined in the lexicon rather than the required BETTER.
>
> This Incomplete specification assumption would clearly explain the erroneous substitution of GOOD for BETTER as well as the fact that word substitutions usually occur under time pressure of fatigue (MacKay, 1972c, 9).

Simple word substitutions, malapropisms and the word substitutions of children are errors that are explained by the incomplete specification hypothesis. MacKay notes

> Malapropisms reflect a failure to learn the full meaning and phonology for a word--a deficit in the individual's past history rather than an error or transitory malfunction of the speech production system. However they resemble transitory word substitutions to some extend since the output seems to be determined by incomplete semantic and phonological specification.

and

> Wher a child says PAPA instead of MAN he is said to overgeneralize or overextend the word PAPA. Under the Incomplete specification hypothesis, these overgeneralization errors are neither overgeneralizations nor errors in the sense of transitory malfunction. Rather the word substitutions of children are an automatic consequence of incomplete acquisition of the meaning of a word. In this view the child uses the term PAPA instead of MAN because he has only acquired part of the meaning of PAPA, let's say the features (+NOUN +MALE +HUMAN +ADULT). Consequently the word PAPA means MAN for the child until he adds the low level feature cluster (+PARENT) to his internal lexicon (MacKay, 1972c, 12).

MacKay explains that children's overgeneralizations and adult's word substitutions are basically the same phenomena, a result of the hierarchical semantic structure of words. However, whereas children's errors are due to incomplete learning of the lower level semantic features of a word, adult's errors are due to incomplete activation of those same lower level semantic features.

As well as explaining how these errors occur, MacKay's model accounts for certain facts about substitution errors. For example, the fact that substitution errors always involve words of the same syntactic class is explained by the hierarchic specification model because the feature for syntactic class is the highest feature on the hierarchy and is, therefore, the one feature that does not get lost when partial activation occurs.

According to MacKay, the fact that word substitutions involve phonologically similar words is also explained by the hierarchical model:

> the procedure or routine for generating a word involves a hierarchically ordered series of choices or coding operations. If this coding process is stopped short due to lack of time, then the required word will not be exactly specified, but a whole class of words which are similar within the limits of the specification reached. Erroneously substituted words would come from this class, the result of incomplete specification at the phonological level (MacKay, 1972c. 11-12).

It must be noted, however, that this is not the only possible explanation for this phenomena. It will be recalled that Fromkin's model attributed the substitution of phonologically similar words to the fact that these words were stored near each other in the lexicon.

A further fact that MacKay claims is explained by his model is the "unmarked tendency:" in speech errors, unmarked words tend to be substituted for marked ones. For example, errors tend to be singular rather than plural (for nouns); unmarked for person (for verbs); (-polar) (for adjectives); (+male) (for nouns) and (non-comparative) for adjectives. MacKay explains that the features that differentiate marked from unmarked words are very low level on the hierarchy and hence are most often omitted when partial specification occurs.

MacKay's model is unable to account for substitutions in which the 'marked' form is substituted for the unmarked, and many such errors do occur. In addition, if 'singular' and 'plural' are features on nouns one cannot account for the fact that in many errors the 'plural morpheme' remains (unordered) in a phrase while the 'unmarked' cannonical (or stored) is moved, as in the following:

We have many ministers in our church → we have many churches in our minister

Furthermore, his model can not account for errors of 'overspecification.' Not only do we find 'good' used instead of 'better,' one also finds 'more better' occurring in speech errors. (See Fromkin, 1973).

Fromkin (1973) accounts for the errors cited by MacKay by positing that what MacKay calls 'features' are rather syntactic nodes (e.g., Comparative, plural, past tense etc). These nodes may be disordered, or the error may result from the failure to apply a rule, or due to the misapplication of a rule.

MacKay's model will be discussed further in Chapter 5 where experimental evidence for a hierarchical representation of the phonological items is presented. Chapter 6 includes a discussion of the possibility that semantic features are hierarchical.

2.6 Summary

Five models concerned with the lexicon have been described. The transformational model, embodied in the works of Katz and Fodor, Chomsky, Gruber, and Chomsky and Halle, is a competence model which aims to describe the knowledge which speakers have about the words of their language. The remaining models, established by Wickelgren, Fromkin, MacKay, and Brown and McNeill, are performance models. In order to decide between these models, performance evidence is crucial. Indeed, various types of performance data, including "tip of the tongue" data, speech recognition data, and speech error data have been cited by the various authors as support for their models. A brief summary of the different models and the types of evidence discussed with regard to them can be found in Table 1.

As can be seen from the chart, various proposals have been made about the form of the lexicon. Consideration of these various models brings to light a large number of questions to be resolved.

TABLE I

"Models of the lexicon"

NAME OF MODEL	TYPE OF MODEL	BASIC LEXICAL ISSUE	EVIDENCE CITED	FORM OF MODEL
Brown and McNeill	Performance	Interrelations of words--prominent features of words & how represented	Generic recall or 'tip of the tongue' phenomena	Mental dictionary viewed as keysort system: each word is 'punched' for, or entered under, several categories.
Wickelgren	Performance	Form of a single word		Assumes words stored in unordered form: ordering achieved through association of context-sensitive allophones.
Fromkin	Performance	Interrelations of items & form of single entry	Speech errors	Stored form of words is in syllables, phonemes & features. Network of words involves a complex grouping system according to semantic, syntactic & phonological features
MacKay	Performance	Form of single lexical entry	Speech errors (statistical)	Hierarchical representation of words. Linear ordering achieved through 'recoding rules'
Transformational	Competence	Single words: knowledge a speaker has of each word in lexicon		Words represented in terms of feature matrices; each feature representing some aspect of knowledge a speaker has about the words

Questions that can be raised about the nature of the lexicon can be divided into two groups: those that deal with the linguistic aspects of the lexicon, and those that deal with the storage aspects of the lexicon. Needless to say, these two aspects are not terribly divergent: it is to be expected that the form in which the lexicon is stored will reflect the linguistic features of the lexicon, just as performance data normally reflects the nature of competence.

The performance model of the lexicon (or "storage aspects") has itself two facets: the first is the question of how the various lexical items are interrelated, and the second is the question of the representation of an individual lexical item.

With regard to the question of how lexical items are interrelated, a number of answers are possible. Perhaps the lexicon is simply a randomly ordered list of items. Possibly the list is ordered according to order of acquisition of the items. Possibly, as Fromkin suggests, the various lexical items are stored in complex groupings.

The question of the representation of a single lexical item is also a complex one. One issue to be considered is what the actual units of storage are: Wickelgren proposed the context sensitive allophone, but, there is also good evidence for both the phoneme and the syllable as the unit of storage. Possibly, as Fromkin proposed, all of these are relevant units.

Once the units of storage have been determined, there remains the question of whether or not these units are stored in an ordered form. Within the Transformational model, for example, there are mechanisms for both ordered and unordered storage: most segments are stored in ordered form, but diphthongs are stored as single complex segments that are later (by phonetic rule) realized as two separate ordered segments. Wickelgren's model states that all units are ordered by later mechanisms, and are stored in unordered form.

One must also decide if there is any other structure to the stored form. Most of the models henceforth proposed have not dealt with such a possibility, but MacKay's model supposes that there is a hierarchical structure in which words are stored. Using this concept of a hierarchy, MacKay is able to explain why certain features of words seem less important than other features. Brown and McNeill were able to account for this same phenomena by means of the notion of "faint entries" and "multiple entries." Further investigation should shed light upon the possibility of hierarchical storage, as well as upon the question of which features belong at the top, middle or bottom of the hierarchy.

The present work attempts to shed light upon these performance issues.

Chapter 3

Experiment 1:

Order in the Lexical Representation

3.1 Introduction

In all forms of Transformational grammar, one function of transformational rules is to specify the order of elements in a string. These rules apply to phonologically preordered lexical items. The output of the grammar then is an ordered string of phonetic segments (or feature matrices). The lexical formatives are inserted into the surface structure with the order of the phonological segments given. Only in the case of metathesis does reordering occur; phonological rules, however, may delete or add segments in fixed places in the string. Serial ordering of phonological elements is thus assumed in this model. There is an implicit assumption that the representation of morphemes or words, as actually stored and used to produce and comprehend speech is also in fixed linear order.

As noted in Chapter 2, Wickelgren's model (which is concerned with linguistic behavior) challenges this assumption for a performance model. He assumes that a model which does not specify ordering, but which is based on a chain-associative mechanism is in some sense 'simpler.' Clearly, his approach has little to offer to a model of competence, for unordered segments would require a set of ordering rules which would be meaningless and would reveal nothing about the language. Wickelgren's proposal then is important only in its behavioral psychological implications.

Wickelgren's primary concern is with the segmental 'sound' units. His proposal however, if shown to have merit, should also include higher-level units, such as the formation of sentences from unordered sets of words. That is, if ordering is not present at the word level it should not be present at the phrase or sentence level.

Some of the data on word association is related to the question of the serial ordering of words.

An examination of the Kent and Rosanoff (1910) data on word association (see Chapter 6), reveals that by far the largest number of responses were paradigmatic. The data involved multiple responses of 500 subjects, and a small number of syntagmatic responses were shown. A noticeable feature of the syntagmatic responses is that they often involve the completion of some common two-word (or "compound") expressions. For example, to the stimulus word "short" there was one response "waisted" (from 'short-waisted'),one response "cake" (from 'short-cake'), and one response "cut" (from 'short-cut'). Other responses that involved two-word expressions were "cheese," which occurred once in response to "cottage;" "house" which occurred once in response to "white;" "cake" which occurred twice in response to "fruit;" "bald" which occurred once in response to "eagle;" "room" which occurred six times in response to "bath;" "dog" which occurred eight times in response to "sheep;" and "hypodermic" which occurred twice in response to "needle."

While there were clearly not a large enough number of responses of this type for any statements made about them to have statistical significance, a trend is noticeable. Syntagmatic responses of the type 'filling in a two-part expression' seem to involve filling in the second part of an expression more often than filling in the first part of an expression. This trend suggests that some directionality (and, in fact, some order) may be involved in lexical representations.

It is clear that noun compounds must be stored as separate items in the lexicon. Many of these compounds are idiomatic and a separate lexical entry is needed to account for their meanings. The meaning of "cottage cheese" cannot, for example, be derived from a knowledge of the meaning of "cottage" plus the meaning of "cheese." Similarly, a "hot dog" is not a 'dog that is overly warm;' a "moving van" need not necessarily be in motion; a "pineapple" is no more apple-like than is a mango; nor is a "grapefruit" particularly grape-like; the primary function of a "bathroom" is not bathing; and the majority of today's "sheepdogs" have never even seen, much less herded, sheep.

Word association data suggests ordering is involved in the lexical representation of these two-part items. "Cottage" elicits "cheese," but "cheese" does not elicit "cottage;" "short" elicits "cake," but "cake" does not elicit "short," and "bath" elicits "room," but "room" does not elicit "bath." If the morphemes were not ordered, then one would expect that "cheese" would be just as apt to bring to mind "cottage" as "cottage" is apt to bring to mind "cheese." Since this does not appear to be the case, we are lead to assume that some left-to right ordering exists in the mental dictionary.

In order to gain more conclusive data on this topic, a short "word association" type experiment was conducted.

3.2 Description of the Experiment

Experiment 1 consisted of a list of forty compound words, all of which were orthographically one word. In the list of words, one 'part' of the word was omitted and participants were asked to guess the whole word by filling in on the answer sheet the missing 'part' of the word. For half of the words in the experiment (twenty words), the first 'part' of the word was omitted, and for the remaining half of the words (another twenty words), the second 'part' was omitted.

It was hypothesized that, if words are stored in the lexicon in an ordered representation, then it would be easier for participants to guess the words for which the second part had been omitted. If, on the other hand, lexical items are not stored in an ordered form, then it should be no more difficult for participants to generate words in the "forward" manner than in the "backward" manner.

Participants were timed and were given one minute to guess each of the twenty "forward" words and one minute to guess each of the twenty "backward" words.

Two versions of the experiment were conducted with each participant doing either Version One or Version Two of the experiment. The two versions of the experiment used exactly the same words to be guessed, and the only difference between the versions were the particular 'parts' of the words that were to be guessed. Thus in version one the 'first parts' of twenty words were given and participants were to guess the 'second parts' of the words: and in version two of the experiment, the 'second parts' of these same twenty words were given and participants were to guess the 'first parts' of these words. Similarly, the words for which the 'first parts' were to be guessed in version one of the experiment were the words for which the 'second parts' were to be guessed in version two of the experiment. This switching of the parts of words to be guessed was done in order to balance for the possibility that some of the two-part words chosen might be easier to guess in general (i.e. in either direction) than others of the two-part words chosen. Four other types of balancing were also done.

First, efforts were taken to ensure that all of the forty words chosen were of approximately the same 'frequency of occurrence.' One exception, for which no frequency count was available, but whose frequency may be assumed to be higher than the other words used, was the word "Watergate."

The order in which the parts of the words were to be filled in was balanced across participants. For each version of the Experiment, half of the participants did the "fill in the first part" first, and half of the participants did the "fill in the second part" first.

Efforts were taken to find two-part words which were unambiguous: words such as "singsong" in which "sing___" could elicit only "song," and "___song" could elicit only "sing." Unfortunately such words were difficult to find since most of the compounds were made up of parts that could combine with more than one word. Thus, for example, "butter" could be followed by either "milk" or "fly;" "water" could be followed by either "gate" or "melon;" "cow" could be followed by "boy" or "hide;" and "quick" could be followed by either "sand" or "silver." In the other direction, "way" could be preceeded by either "free" or "high;" "wood" could be preceeded by either "dog" or "drift;" and "stick" would be preceeded by either "lip" or "chop." Since it was all but impossible to avoid them, words such as these were included in the Experiment, but care was taken to balance their occurrence. Thus, for each word that could be followed by more than one response that was placed on the Experiment, a word that could be preceeded by the same number of responses was also included.

One final area in which the choice of words used was balanced was the area of semantic influence. In some two-part words, the meaning of at least one part of the word is in some way included in the meaning of the whole word. For example, "shellfish" may, fairly accurately, be defined as 'fish with shells;' and "driftwood" may be defined as 'wood that has drifted.' On the other hand, there are two-part words in which the meanings of each of the words making up the compound have nothing to do with the meaning of the whole word. For example, "cocktails" have nothing to do with either "cocks" or their "tails" but are merely "alcoholic drinks;" and "Watergate" is merely the location of a particular political scandal, having nothing to do with either "water" or "gates." In the Experiment, both "semantic" and "non-semantic" two-part words were used.

People have access to the lexicon in at least two ways. People can cite examples of words having the same or related meanings, and can match words to definitions; this indicates that the lexicon can be accessed according to semantic criteria. The fact that people can cite examples of words having particular sounds, on the other hand, shows that access to the lexicon is also possible according to phonological criteria. The interaction of these two types of lexical access and representation is not completely understood. It is possible, however, that speakers' behavior in Experiment 1 will shed some light upon this problem.

Experimental Procedure: The following are the instructions that were given to participants. (The instructions were typed on a card, and participants were asked to read them).

> The following experiment concerns words which themselves are made up of two words; words like "uphill," "flyleaf," "blackboard," "jackass," "pocketbook," "necklace," and "gooseberry."
>
> A list of such words is given, but one part of the word is missing. Your task is simply to guess the missing part.
>
> The experiment is divided into two sections. Work as quickly as possible: you will be timed and given only one minute to complete each section.

After allowing participants to read the instructions, they were asked if they had any questions. Generally, there were no questions, although a few participants asked if the two-part words were always spelled as one word. They were assured that this was the case. The fact that the example words were all orthographically one word was intended to indicate this. The example word "necklace" was included to suggest that the words being sought in the Experiment would not always (semantically) 'feel' like two parts, but would always be spelled as such. The example word "gooseberry" was included to indicate that the meanings of the word being sought might have nothing to do with the meaning of one (or more) of the parts of the word.

3.3 Results of the Experiment

Experiment 1 was administered to twenty participants. Balancing occurred across participants such that ten participants did "version 1" of the experiment and ten participants did "version 2" of the experiment; and ten participants answered with the 'first-part blank' first whereas ten participants answered with the 'second-part blank' first.

For each participant, the number of correct responses in each 'direction' was then tallied. These results can be seen in Table 2. It can be seen from Table 2 that the results indicate a definite trend. In all but two instances (participants 10 and 12), participants were able to provide a greater number of responses when filling in the second part of the compound than when filling in the first part of the compound. The differences in number of correct responses for the two different 'directions' of operation were not always particularly great, although they were consistent. In several instances (participants 2, 3, 7, and 9) the difference between the number of correct responses for the two 'directions' was only one. Nonetheless, the trend was apparent, and

Table 2

Results--Experiment 1

PARTICIPANT	NUMBER OF CORRECT RESPONSES ____ word	____ word
1	13	9
2	5	4
3	8	7
4	8	6
5	14	7
6	10	8
7	13	12
8	7	5
9	9	8
10	6	6
11	15	9
12	9	12
13	12	8
14	7	4
15	9	6
16	11	8
17	8	4
18	13	9
19	12	8
20	9	6
TOTAL	198	146

was verified by the impressionistic remarks made by participants while they were filling in the answer sheet for the Experiments. In a number of instances, participants commented "this is easier" (referring to filling in the second-part of the compound words) and "this is harder" (referring to filling-in the first parts of the compounds).

These impressionistic comments, as well as the trends found in terms of number of responses obtained were verified by the results of statistical analysis. Two statistical tests were performed: a one-way analysis of variance and a chi square test. The one-way analysis of variance, designed to test the reliability that the numbers of responses for the two groups was, indeed, different indicated a significance better than .01. The chi-square test is designed to test the reliability of the results being different from expected (or 'chance') results. For this test, the results obtained were compared to 'chance' results of an equal number of responses for each group. The chi-square test indicated the experimental results were significant to better than .001.

As mentioned in the description of the experiment (above), some of the target 'parts' were ambiguous: that is, a given 'part' of a word could sometimes combine with more than one word. Efforts were taken to balance these 'ambiguous' possibilities such that for each word that could be preceded by more than one possibility, there was a word that could be followed by more than one possibility. Because of these ambiguous possibilities, however, a simple counting of the results according to the number of responses given for each 'part' in either direction is not particularly indicative of the trend involved. The trend is evident only when the data is taken as a whole (so that the balancing effects are included) and when the unambiguous words are considered by themselves.

Below in Table 3 is a list of these unambiguous target words that yielded the largest number of responses across participants. ("Unambiguous" refers to the fact that, regardless of which 'part' of the word was given as stimulus, the target word listed was the only response ever given). For each of these unambiguous target words, the number of responses given in each 'direction' by all of the participants is noted.

The question of how participants may have arrived at their responses is a complicated one. The question of whether "semantically transparent" compounds are easier to guess than "semantically opaque" compounds is complicated by the fact that, in the majority of cases, it is impossible to assign the stimulus words to one of these categories: "wheelchair"

TABLE 3

SOME STIMULI AND RESPONSES—EXPERIMENT 1

UNAMBIGUOUS RESPONSE	NUMBER OF RESPONSES FIRST PART IS STIMULUS		SECOND PART IS STIMULUS	
"mincemeat"	"mince____" →	15 responses	"____meat" →	0 responses
"motorcycle"	"motor____" →	14 responses	"____cycle" →	8 responses
"driftwood"	"drift____" →	10 responses	"____wood" →	2 responses
"wholesale"	"whole____" →	4 responses	"____sale" →	0 responses
"singsong"	"sing____" →	7 responses	"____song" →	5 responses
"rattlesnake"	"rattle____" →	6 responses	"____snake" →	0 responses
"shellfish"	"shell____" →	10 responses	"____fish" →	0 responses
"fortnight"	"fort____" →	6 responses	"____night" →	4 responses
"lipstick"	"lip____" →	10 responses	"____stick" →	0 responses
"earthquake"	"earth____" →	0 responses	"____quake" →	13 responses

TABLE 4

MOST FREQUENTLY GUESSED WORDS

EXPERIMENT 1

WORDS	NUMBER OF TIMES GUESSED (FOR ALL PARTICIPANTS)
"mincemeat"	15
"rawhide, cowhide"	20
"earthquake"	13
"quicksand, quicksilver"	15
"suitcase, briefcase"	16
"motorcycle"	22
"wheelchair"	16
"watergate"	19
"porkchop"	19
"singsong"	12

TABLE 5

LEAST FREQUENTLY GUESSED WORDS

NEVER GUESSED	SELDOM GUESSED
"threadbare"	"peacock
"pitchfork"	"widespread"
"copyright"	"snapshot"
"gangplank"	"honeymoon"
"fourscore"	"grapefruit"
"cocktail"	
"pineapple"	

is definitely "semantically transparent"--it is a 'chair on wheels,' and 'cocktail' is definitely "semantically opaque"--it has nothing to do with either 'cocks' or 'tails.' But what about "mincemeat"--it is at least 'minced,' even if it is not 'meat.' And 'pineapple' may not be the least 'pine'like, but it is at least to a small degree apple-like insofar as it is a fruit. The data, in terms of number of responses for particular words, at least, did not show any startling trend towards the greater ease for either "transparent" or "opaque" words. Below, this can be seen in Tables 4 and 5 in which the most frequently guessed and least frequently guessed words are listed along with their number of correct guesses for all participants. (In the case of ambiguous responses for one stem, both are listed, and tallied together).

Those responses counted as correct for the Experiment were compound words that were orthographically one word and that were composed of two free morphemes or 'words.' In a small number of the questionnaires, responses were given that did not meet these criteria. Such responses were not counted as correct when the total numbers of responses were tallied. This condition was imposed upon responses in order to limit, as much as possible, the occurrence of expressions which are not compounds. Clearly, in some cases, this condition proves too strong. "Pine needle" and "egg yolk," two of the discounted responses, are compounds as is indicated by their stress patterns.

Nonetheless, the omission from consideration of these responses does not significantly affect the results since the inclusion of these responses would have made the trend showing that the second-part of words is easier to fill in than the first part more apparent. Thus, there seems little question that it is easier for speakers to retrieve in a 'forward' direction. The errors that were eliminated (along with their stimulus cues) were: rawness (from 'raw____'), earthling (from 'earth____'), cockney (from 'cock____'), pine needle (from 'pine____'), and egg yolk (from 'egg____'). Each of these errors occurred only once, with the exceptions of 'pine needle' which occurred 6 times, and 'egg yolk' which occurred 5 times.

The response 'pine needle' was particularly interesting since it occurred several times in response to the stimulus 'pine____', where the expected response had been "pineapple." None of the participants, in fact, did make the expected 'pineapple' response. Since 'pine needle' is obviously semantically related to 'pine,' whereas 'pineapple' is not at all semantically related to 'pine,' this pattern of response may argue for the fact that it is on a semantic basis that participants make their responses. Several other response patterns found tend to verify this trend. For example, there were no occurrences of the expected response "cocktail." However, in response to the stimulus 'cock____.' a number of participants responded with "cocksure;" a word in which 'cock' has some semantic transparency unlike the word 'cocktail' in which the word 'cock' has no meaning at all. Another example of this was found in the fact that the stimulus "____tail" never elicited "cocktail," but did elicit "cottontail" once. Similarly, the stimulus word "____apple" did not elicit "pineapple," but did elicit "crabapple" in 3 instances. Obviously a "cottontail" is more tail-like than is a "cocktail;" as is a "crabapple" more apple-like than a "pineapple." But these responses indicated only a small trend. The stimulus "honey____" elicited an equal number of "honeysuckle" and "honeycomb" responses although it is apparent that "honeycomb" is more related semantically to "honey."

3.4 Implications for a Lexical Model

The results of the Experiment indicate that it is significantly easier for participants to retrieve words from the lexicon when the words are specified in a "forward" direction. This indicates that the speaker's mental lexicon must consist of words that are represented in the form of ordered strings. If, as Wickelgren has proposed, words are stored in an unordered form, then it would be expected that speakers could retrieve words equally well regardless of what part of the word was specified. The fact that the participants in the experiment found it easier to fill in the second parts of compound words than to fill in the first parts indicates that words must be stored in an ordered form such that they are somehow catalogued according to the first part of the word. Experiment 2 (below) will investigate this question further.

The results of the experiment suggested (but did not indicate conclusively) that the semantic retrieval of words may be more basic than the phonological retrieval.

Chapter 4

Experiment 2: Lexical Organization

4.1 Introduction

Two models discussed above (see Chapter 2) which deal with the question of lexical organization are the Fromkin model and the Brown and McNeill model.

The Fromkin model views the speaker's mental lexicon as a kind of very complex library system of indexing and storage. In an ordinary library books are indexed several times: once for author, once for title, and once for subject matter. Fromkin hypothesizes that in a speaker's "library" of words, indexing also occurs more than once. Fromkin suggests that words are stored in listings that are grouped according to semantic headings, syntactic headings, and phonological headings. In an ordinary library, the books may not be grouped in the same way they are indexed: books of the same author are usually grouped together, but books having similar titles may not necessarily be found near each other on the shelves. Fromkin's model of the lexicon envisions a similar arrangement. In general, words which are indexed together are grouped together in the lexicon. However, Fromkin also allows for the possibility of 'indirect indexing' by which words not necessarily stored together in the lexicon can be indexed together. Fromkin's theory of an 'indirect indexing' system is similar to Brown and McNeill's 'parameters of storage' discussed below, while Fromkin's model of a general indexing system is much more powerful. In Fromkin's general system, then, words that are phonologically similar are grouped close to each other in a part of the speaker's lexicon. A precise definition of "phonologically similar" is not provided; but Fromkin suggests that Brown and McNeill's 'parameters of storage' may be examples of types of phonological similarity according to which words are grouped.

Like Fromkin, Brown and McNeill's model assumes that words are classified a number of times according to various phonological criteria. They propose as examples of these criteria for grouping (or 'parameters of storage') the initial letter of a word, the final letter of a word, the number of syllables in a word, the middle consonant in a word, the final syllable (or affix) of a word, and the stress pattern of a word. Unlike Fromkin, however, Brown and McNeill do not propose that the words which are similar with regard to one of these criterion are stored near each other in lexical groups. Rather, they liken the storage system to a system of punched cards, each word being a "card" that is punched for its various features.

Fromkin's hypothesis that phonologically similar words are stored near each other in the lexicon has been criticized by Hotopf (1972). Hotopf states that Fromkin's hypothesis is a circular one:

> No reason is given for considering the similar sounding words as near one another, except that this would 'explain' the sound similarity phenomenon. Nor does the 'nearness' assumption lead to directly testable predictions (Hotopf, 1972).

Hotopf's criticisms, however, do not appear to be valid: Fromkin posited the nearness of phonologically similar words not to explain the similarity, but rather to explain the fact that these similar words are often confused with each other in speech errors. Nor is Fromkin's hypothesis 'untestable.' Other types of linguistic behavior besides 'anomolous utterances' can shed light upon the question of whether phonologically similar words are stored together.

One such aspect of linguistic behavior involves people's ability to list groups of phonologically similar words. The fact that people can easily give lists of words that have, for example, the beginning consonant /b/ suggests that these words may be grouped together in the speaker's lexicon.

Of course, it is possible that the speaker's ability to list words beginning with a particular sound may be due to the fact that the words in the lexicon are represented by ordered phonemes and that the speaker simply 'scans' the list, selecting out those words that begin with the particular consonant. This approach seems counter-intuitive because of the ease with which people can list words having a particular first consonant. However, since no one knows how the brain operates, or even the speed with which it may perform 'scanning' operations, this possibility must be considered. If, however, this 'scanning operation' were the mechanism by which speakers are able to select words sharing certain features,then we would expect that speakers would be equally proficient at selecting out words with any given feature. There is no reason to suppose, for example, that it would be more difficult for speakers to scan according to first consonant than according to third consonant. If, then, speakers are found to be less able to select words according to third consonant than according to first consonant, this would suggest that a "scanning" method alone is not the way in which the words are selected. In fact, the ability of speakers to select words according to first consonant, but not according to third consonant, would support Fromkin's model, suggesting that words are grouped in the lexicon according to first consonant, but not according to third consonant.

Fromkin's model, then, is making an empirically testable claim: the claim that because words are grouped in certain ways in the mental dictionary of speakers, it will be easy for speakers to list words in such groups. This claim (and the opposing claim of the possibility of a scanning method) will be investigated in Experiment 2 discussed in this chapter.

Brown and McNeill's model differs from Fromkin's model and resembles the 'scanning model.' According to Brown and McNeill, it should be possible for speakers to list groups of words according to particular features whenever words are marked (or "punched") for those features. Brown and McNeill's model lists a number of features for which words are said to be marked or 'punched.' According to the model, there should be no reason to expect speakers to perform better in some categories than in others. In fact, such 'uneven performance' can be explained only in Fromkin's model by the "nearness hypothesis."

In order to test the validity of Fromkin's "nearness hypothesis" as opposed to other methods of storage, a type of word association experiment was devised in which participants were asked to respond to stimulus words with a list of words whose phonological structure was, in some specific way, similar to the stimulus word. Participants were given a fixed amount of time to respond to each of the various categories of response. It is assumed that, for manners of response that consitute natural 'parameters of storage,' the number of responses that will be given in the fixed amount of time will be larger than those in which the variable does not represent such a parameter. Thus, if lexical groups of a certain type exist in speakers' minds, it should be easy for speakers to generate lists of such groups. If, on the other hand, words are not grouped according to the specific category, then it should be very difficult for speakers to be able to think of many words belonging to this group in the given period of time. The number of responses that are given for groups that do not involve natural 'parameters of storage' will, therefore, be small.

Since the experiment afforded an opportunity to provide evidence or counter-evidence for Brown and McNeill's suggested 'parameters of storage,' these were the parameters that were chosen to be tested.

4.2 Description of the Experiment

Many different studies involving many different types of word association tasks exist. Basically, a word association test consists of asking a participant to respond with the "first word that comes to mind" after some stimulus word has been presented. There are many variations on this approach, however. Subjects may give "free responses" ('the first word that comes to mind') or "controlled responses" in which they have been told to limit their type of response to some category, (for example, verbs). Subjects may give "discrete" responses (one response for each stimulus) or "continued" responses (several responses for each stimulus). Continued responses may be "successive" or "continuous," depending upon whether or not other stimuli occur in between the various responses *given for* a *particular stimulus*.

The present experiment is a controlled, continued word association test. Participants were asked to respond continuously for a period of one minute and the types of responses were limited to a specific phonological category (for example, having a particular initial consonant).

Seven groups of instructions and stimuli were recorded. Participants were asked to write down their responses on answer sheets. The instructions given were as follows:

1. You will hear a word. Please write down as many words as you can think of that have the same *vowel sound* as the word given.

2. For the next group of words, list as many words as you can think of that have the same *first consonant sound*.

3. For the next group of words, list as many words as you can think of that have the same *last consonant sound*.

4. For the next group of words, list as many words as you can think of that have the same number of syllables.

5. For the next group of words, list as many words as you can think of that have the same *middle consonant sound*.

6. For the next group of words list as many words as you can think of that belong to the same *'part of speech.'*

7. For the next group of words, list as many words as you can think of that have the same *last syllable*.

(The instructions for the sixth task were purposefully worded somewhat vaguely and left without examples in order to see how the participants would respond). After each set of instructions, the tape was stopped and participants were asked if they had any questions. Following the instructions, the stimulus words were played. Each stimulus word was followed by a 1 minute period of silence during which subjects wrote down their responses, until they heard the word 'stop.'

Five stimulus words were given for each response task. The stimulus words for the first three tasks were all nouns of the form CVC. The nature of the remaining tasks sometimes made longer stimulus words necessary, but in all cases efforts were taken to choose relatively 'simple' words. All of the stimulus words chosen were of approximately the same degree of frequency of occurrence, according to Kucera and Francis (1967) words lists.

Table 6 indicates the stimulus words used for the various tasks.

A pilot study was run with 20 participants and, after minor changes, the experiment was run using 50 students in a beginning (first quarter) linguistics class at UCLA as participants.

4.3 Results for Experiment 2

Experiment 2 is based upon the premise that information about the ease of access for different groups of words will provide clues about the storage mechanisms for these groups of words. Two types of information about ease of access are relevant here: (1) the *number* of responses that can be elicited for a particular association task, and (2) the *kind* of responses that are elicited for the task.

The *number* of responses varied considerably according to the different association tasks. The bar graph in Figure 1, indicates the total of the average numbers of responses elicited (by all 50 participants) for each of the different association tasks given. This information is also presented (in greater detail) in Table 7. It can be seen from the graph that the two tasks for which participants were able to elicit the greatest number of responses were the "same first consonant sound" task and the "same part of speech "task. For both of these groups, about 1,320 responses were obtained, an average of 26 responses for each participant. The ease with which participants were able to provide responses for both of these association tasks suggests that these

TABLE 6

STIMULUS WORDS EXPERIMENT 2

TASK 1 "same vowel"	TASK 2 "same #C–"	TASK 3 "same –C#"	TASK 4 "same no. of syllables"	TASK 5 "same –C–"	TASK 6 "same part of speech"	TASK 7 "same last syllable"
1. bone	1. boy	1. rim	1. survival	1. final	1. sit	1. hunter
2. hen	2. toy	2. bag	2. desk	2. lesson	2. man	2. photo
3. tick	3. fan	3. bat	3. chapter	3. horror	3. toy	3. lesson
4. [illegible]an	4. cone	4. mass	4. American	4. milage	4. yellow	4. milage
5. cake	5. man	5. cab	5. hippopotamus	5. ladder	5. quick	5. pretty

TABLE 7

AVERAGE NUMBER OF RESPONSES FOR EACH PARTICIPANT IN EXPERIMENT 2

	Sbj.	-V- TASK 1	#C TASK 2	-C# TASK 3	-C- TASK 5	Pt. of sp.	-syl # TASK 7
1	CN	5	28	5	4	29	2
2	SF	4	26	5	3	32	1
3	SB	13	21	6	3	24	3
4	LB	6	24	13	3	30	2
5	NA	5	24	7	1	27	4
6	AC	7	29	10	3	23	2
7	BL	4	27	5	1	29	3
8	GM	8	28	5	4	25	2
9	KK	9	23	6	3	30	2
10	RY	6	23	5	1	25	3
11	SH	3	30	13	2	20	1
12	AK	8	30	10	1	26	2
13	DK	7	24	5	1	27	2
14	CY	8	31	5	3	28	2
15	CB	4	28	6	2	23	1
16	YD	6	31	5	1	25	2
17	MU	8	27	7	3	31	3
18	PP	15	25	5	3	27	1
19	IP	9	22	13	4	24	3
20	PH	10	23	8	2	23	2
21	DM	5	27	3	2	29	2
22	DG	10	25	5	4	24	1
23	RF	6	27	12	3	23	3
24	RG	6	30	7	2	24	3
25	SS	10	25	4	3	20	2
26	SB	4	28	5	3	25	3
27	SK	3	22	7	1	21	3

TABLE 7

AVERAGE NUMBER OF RESPONSES FOR EACH PARTICIPANT IN EXPERIMENT 2 (Continued)

	Sbj.	-V- TASK 1	#C TASK 2	-C# TASK 3	-C- TASK 5	Pt. of sp.	-syl # TASK 7
28	SR	7	24	6	2	31	3
29	GB	6	24	3	1	23	2
30	SS	5	21	10	2	24	2
31	DA	8	24	11	3	29	2
32	RH	8	23	8	1	27	1
33	LS	6	30	5	3	32	3
34	PL	5	20	6	2	23	4
35	DB	7	27	2	3	20	4
36	JF	9	29	5	2	28	2
37	NE	6	26	3	4	25	5
38	RA	3	23	5	1	30	1
39	HM	5	26	5	1	30	3
40	BR	6	34	10	2	29	5
41	DK	5	23	5	4	25	2
42	HP	4	31	7	2	30	5
43	EM	9	28	5	3	25	1
44	NF	6	26	4	1	33	3
45	FK	7	31	7	2	29	2
46	GD	13	28	10	3	27	2
47	GM	8	31	5	2	24	3
48	RW	5	27	5	2	26	3
49	SC	3	22	4	4	31	2
50	HR	5	33	5	2	21	1
	TOTAL	335	1320	328	117	1319	120
	Avg.	7	26	6	2	26	2

are natural 'parameters of storage.' For each of the other association tasks given, ease of access was considerably more difficult as is evidenced by the much smaller numbers of responses obtained (an average of 6 for the "same final consonant sound" task, 7 for the "same vowel sound" task, and 2 for the "same middle consonant" and "same last syllable" tasks).

It must be noted here that for all groups except task 4 the number of responses for each of the stimuli was approximately the same (plus or minus one) for any one participant. In this way, it was easy and natural to obtain an average number of responses for each participant for each association task. In task 4, "the same number of syllables" task, this was not the case: each stimulus word elicited a very different number of responses. For this reason, a more detailed presentation of the data for section 4 of the experiment is necessary. This is presented in Table 8.

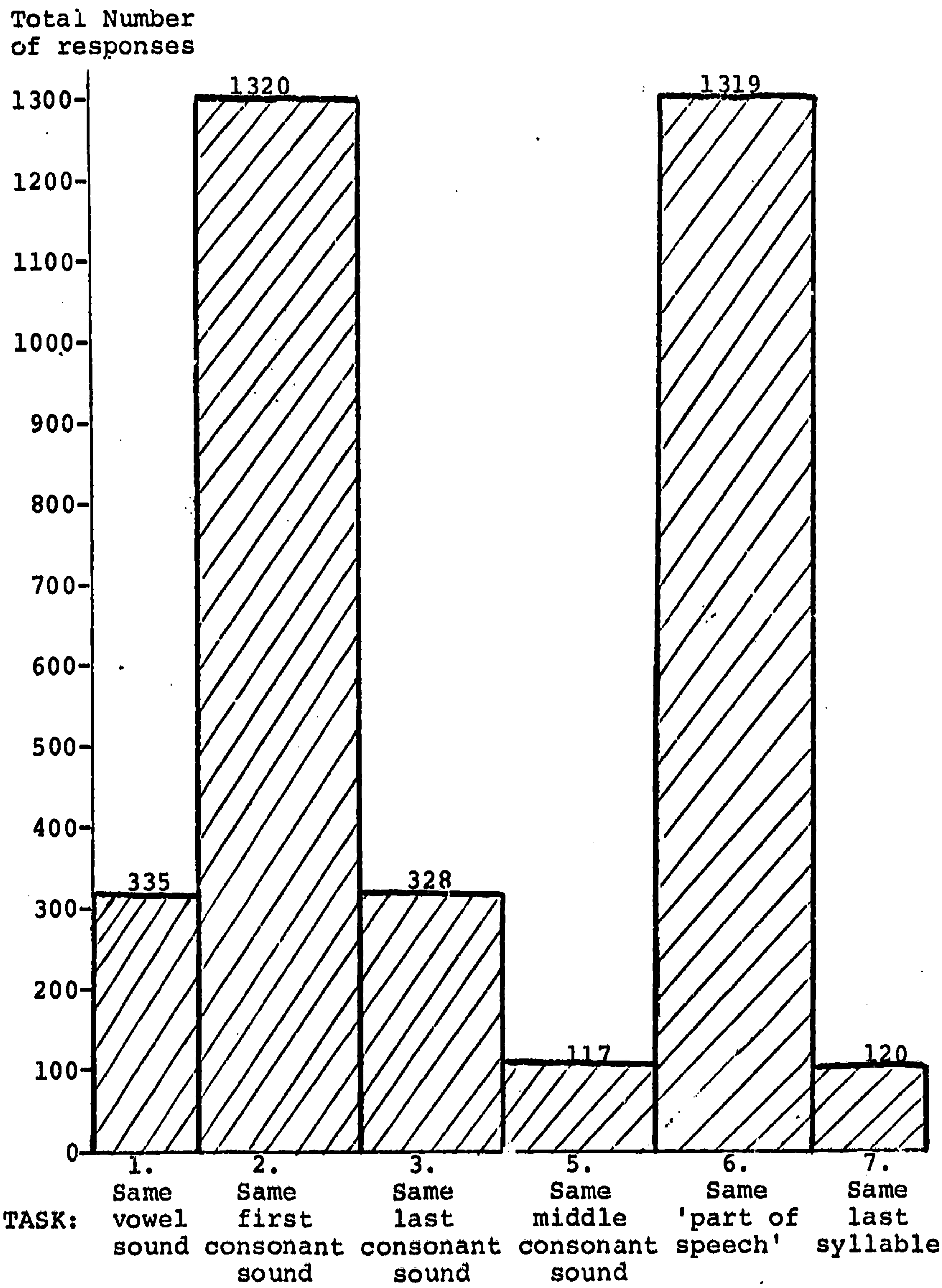
4.3.1 Statistical Analyses

Two types of statistical analysis were performed on the data from Experiment 2. These were a one-way analysis of variance and a "chi-square" test.

Figure 1 (the graph of number of responses for the various tasks) indicates the large diversity in numbers of responses for the different association groups. The two groups in which it was easiest for participants to respond each had a total of approximately 1,320 responses for their total of the average numbers of responses for each participant. The groups in which it was most difficult for participants to respond had approximately 120 as the total of their average numbers of responses. Without any reference to statistics, it is clear that there is a very large difference in the degree of ease of listing responses for the different groups. A one-way analysis of variance was performed, and an F-ratio of 83.89 was found. For the results to have been significant to the 1% level, an F ratio of only 3.11 or greater was necessary. Thus, it is apparent that the results for the different numbers of responses for the different groups is highly significant.

Thus, the different results are (clearly) statistically significant. We must now turn to the question of the cause of these results. It is the hypothesis of the experiment that the results are due to the manner in which lexical items are represented in the lexicon. However, the results could have been due to the distribution of words in the language. Thus, speakers might have been able to respond better to the instruction asking them to list words beginning with /b/, than to the instruction asking them to list words having /s/ as their middle consonant simply

FIGURE 1


Total Number
of responses
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
1320
1319
335
328
117
120
TASK:
1. Same vowel sound
2. Same first consonant sound
3. Same last consonant sound
5. Same middle consonant sound
6. Same 'part of speech'
7. Same last syllable

because words beginning with /b/ are more common and frequent in the language than words with medial /s/. This hypothesis is the 'null hypothesis.' To determine if the experimental results could have been the result of the null hypothesis rather than the experimental hypothesis, a 'chi-square test' was performed. In the chi-square test, the results obtained in the experiment (the number of responses for each group) was compared to the results expected by the null hypothesis. These results were obtained by counting the number of possible responses to each of the instructions in the experiment from the 2,500 most frequent words in the language, according to Kucera and Nelson's (1967) word lists. The comparison made in the chi-square test is illustrated in Figure 2.

The chi-square test was carried out twice: once for experimental tasks 1, 2, 3, 5, and 7, and once for experimental task 4 (the "same number of syllables" task in which a separate value had to be determined for each stimulus). It was necessary to omit task 6 from the statistical analysis due to the number of words on the Kucera and Nelson list that are ambiguous as to the 'part of speech.'

The results of the chi-square test, in both instances, rejected the null hypothesis with a 99.5% degree of certainty. Thus, the number of responses elicited for each of the association tasks gives information about the organization of the speaker's lexicon. Further information about the Lexicon is provided by an examination of the types of responses given on each of the association tasks. These results will be described below.

4.3.2 Results for Each Association Task

Task 1: "Same Vowel Sound:"

When the pilot studies for the experiment were run, it was found that when speakers were asked to list words having a particular vowel sound, they would invariably list words having not only the same vowel sound as the stimulus words, but the same final consonant sound as well. Of a total of 402 responses "with the same vowel" for 20 participants in the pilot study, 78% had the same final consonant as the stimulus word as well. In order to avoid this confusing rhyming effect, the additional instructions "Do not give rhyming answers" were given to the participants for this section. It is these "non-rhyming" answers that made up the total 335 responses given. Needless to note, the total number of responses would have been several times this, had the rhyming responses been allowed.

FIGURE 2

EXPECTED/OBTAINED RESULTS

EXPERIMENT 2

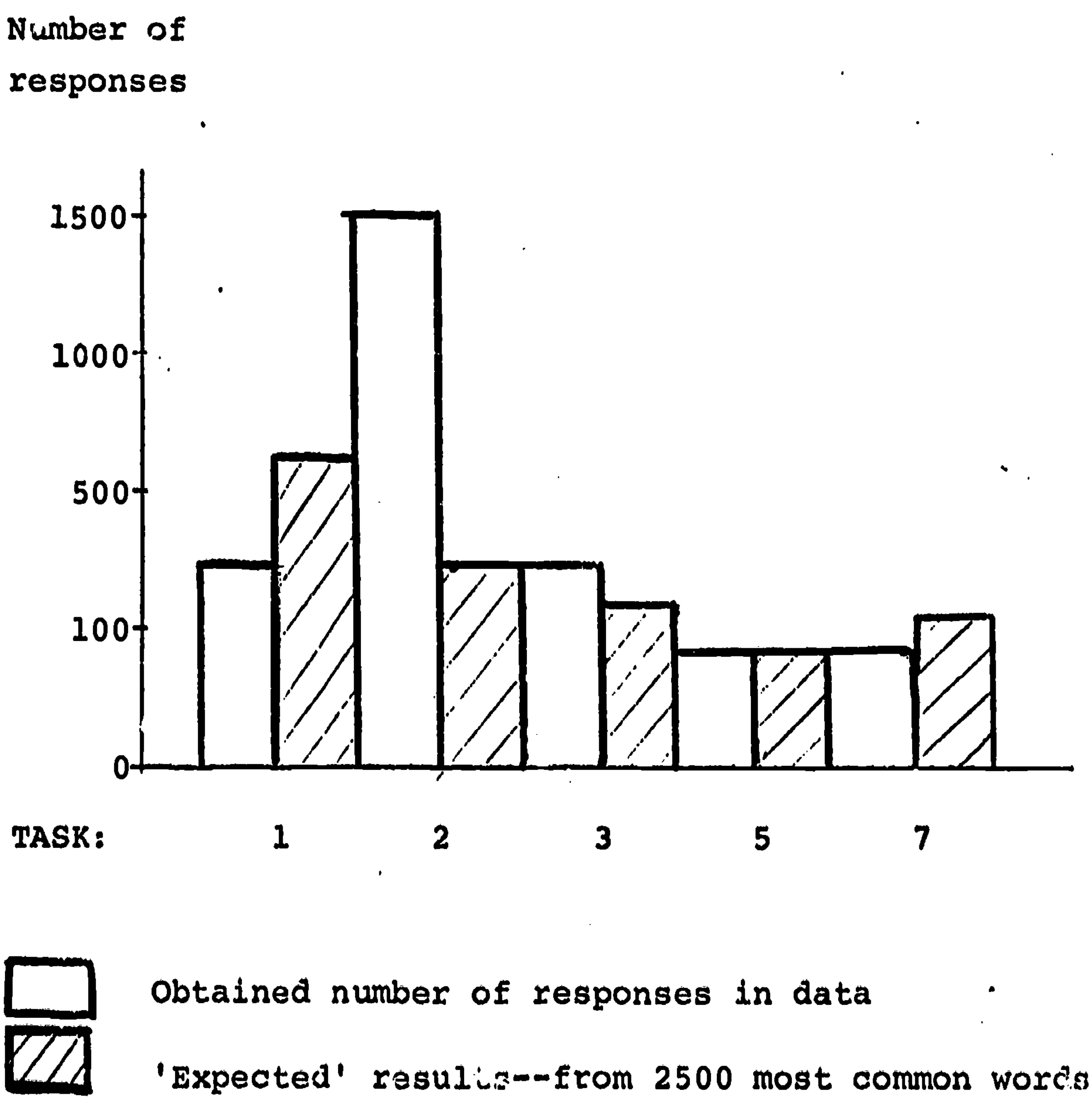


TABLE 8

NUMBER OF RESPONSES BY PARTICIPANTS FOR "SAME NUMBER OF SYLLABLES TASK"

PARTICIPANT	ONE SYLLABLE	2 sylls.	3 sylls.	4 sylls.	5 sylls
CN	11	9	3	2	1
SF	20	7	3	3	1
SB	14	5	1	1	0
LB	25	6	4	1	0
AA	10	4	0	0	0
AC	9	3	1	0	0
BL	20	8	3	2	1
GM	10	7	2	2	0
KK	14	10	2	0	0
RY	9	3	2	1	0
SH	10	6	2	0	0
AK	15	7	3	1	1
DK	9	5	3	2	0
CY	10	4	2	0	0
CB	20	9	4	2	1
YD	15	7	3	2	1
MU	10	4	2	0	0
PP	7	5	1	0	0
IP	20	8	4	0	0
PH	17	6	0	3	1
DM	8	3	1	0	0
DG	25	9	4	3	1
RF	9	2	2	0	0
RG	7	2	2	0	1
SS	6	2	1	2	0
SB	13	8	3	2	1
SK	14	6	1	0	0
SR	6	6	2	0	1
GB	20	5	3	1	0

TABLE 8

NUMBER OF RESPONSES BY PARTICIPANTS

FOR "SAME NUMBER OF SYLLABLES TASK" (Continued)

PARTICIPANT	ONE SYLLABLE	2 sylls.	3 sylls.	4 sylls.	5 sylls.
SS	15	8	0	2	1
DA	17	6	1	3	0
RH	18	5	2	0	0
LS	12	2	3	2	0
PL	20	6	2	3	1
DB	16	5	3	1	1
JF	15	7	4	1	1
NE	8	5	1	1	0
RA	10	3	3	0	0
LN	7	4	4	0	1
BR	20	9	5	2	1
OK	9	9	3	0	0
HP	8	5	4	3	1
EM	12	6	4	2	0
NF	11	5	3	2	1
FK	10	4	2	1	0
CD	10	6	2	2	1
GM	9	5	3	1	0
RW	11	6	3	0	0
SC	9	5	2	1	0
HR	12	7	3	0	1
JS	8	6	0	2	1
TOTALS	540	290	122	58	22
AVERAGE	10	6	2	1	0

Task 3: "Same Last Consonant Sound"

In the pilot study for this experiment, the same effect was noted for the "same last consonant" task as for the "same vowel" task: that is the tendency for the vowel and last consonant to be treated as a unit. Of the 380 responses given by the 20 pilot participants, 85% had the same vowel sound as well as the same last consonant sound as the stimulus word. In order to obtain less "mixed" results, the instructions "Do not give rhyming answers" was added when Experiment 2 was run.

Task 4: "Same Number of Syllables"

Table 3 indicates the distribution of the number of responses for each participant in the experiment for the "same number of syllables" task. It can readily be seen that the ease with which participants are able to respond is inversely related to the number of syllables being asked for. For the "one syllable" words, an average number of 10 responses were obtained; for the "two syllable" words, an average number of 6 responses were obtained; for the "three syllable" words an average number of 2 responses were obtained; for the "four syllable" words an average number of 1 response was obtained; and the "five syllable words, an average of 0 responses was obtained. When it came to searching for three, four, or five syllable words, the responses given indicated that the participants had adopted the tactic of "looking around the room" for semantic clues to appropriate responses. Evidence that this was the accessing tactic adopted was the frequency with which responses that were semantically related to the experiment were given: "experiment" was by far the most common 'four syllable' responses; "answer," "native" and "language" (the very words at the top of the mimeographed answer sheets given to the participants) frequent 'two syllable' responses. There were also a number of wrong answers (i.e., words with different numbers of syllables than the stimulus word): For example: "activity" was cited as a "three syllable" response; "patriot," "Washington," "Englishman," "discussion" and "recital" were cited (by five different participants) as 'four syllable' responses. Even for the 'two syllable' stimulus, participants had difficulty coming up with responses: one person answered with the 'two syllable word' "no-no."

The fact that incorrect responses were given on this section of the experiment, when they did not occur in any of the other sections of the experiment may cause one to wonder whether the participants understood the instructions. It has often been suggested that speakers of a language intuitively know how many syllables a word has. If, indeed, the concept 'syllable' is unknown, then one would not expect speakers to store words according to number of syllables.

The data obtained leads one to think that words may be grouped into two classes: long words and short words. It appears that for the categories in which words of more than one syllable were required as responses, participants may have adopted the strategy of thinking of a long word, then counting the number of syllables in the word before (or after) writing it down. Support for this hypothesis is given by the corrected errors on the answer sheet. One such example is the word "aristocratic" which had been written down as a response to the 'four syllable' stimulus, with the -ic crossed off.

ong the (relatively few) correct responses given there was no consistency with regard to the stress patterns of the stimulus and response words.

Both the small number of responses given for this task and the type of responses given (semantic responses as well as incorrect responses) indicate that the "number of syllables" is not a parameter of storage.

Task 5: "Same Middle Consonant"

The 'unnaturalness' of "same middle consonant" as a parameter of storage is similarly indicated both by the inability of participants to produce many responses (there were only 117 responses for all 50 participants--an average of less than 2 per person) and the nature of the responses given. In this task, 60% of the responses given involved the use of affixation: in order to find a word with a particular 'middle consonant,' a word with that consonant as its final consonant was selected and a suffix was added to it so that this final consonant became the medial consonant of the new word. For example, when asked to list words with the same middle consonant sound as in the word "horror" participants listed "gored," "boring," "starry," "fairer" and "barring;" and when asked to list words having the same middle consonant sound as in the word "lesson," participants listed "missing," "kissing," "hissing," "messy," "dressy," "Bessy," "classy," "glassy," and "loosen."

As the above example indicates, the strategy of rhyming was used by some participants, and once a suitable response was arrived at, subsequent responses were often rhymes, sometimes even rhyming non-words (a word with the same middle consonant sound as "horror" was said to be 'shorer'). Besides the strategies of affixation and rhyming, an appeal to spelling was made in at least two occasions. When asked for a word with the same middle consonant *sound* as "lesson," one participant wrote "mission" and another wrote "casual."

Task 6: "Part of Speech"

For the "same part of speech" task, participants responded with 1,319 correct and diverse responses. Slightly more responses were given for the "nouns" than for the other categories, but a large number of responses were given to all the stimulus words. More than for any of the other tasks, there was a tendency for the responses to be in semantic "sets." To the stimulus word "yellow," for example, participants tended to respond first with other color words, and to the stimulus word "man," there was a slight tendency to respond with [Human] nouns. The examples below are typical in illustrating the extent to which this occurred.

Participant	Stimulus	Responses
S.R.	"man"	woman, child, father, mother, son, daughter, husband, wife, brother, sister, siblings, aunts, uncles, cousins,
	"yellow"	red, blue, green, sad, poor, docile, active, pathetic, energetic, lazy,
S.H.	"man"	dog, woman, girl, sister, chair, desk, paper, pen, pencil, leg, arm, hand, toe, finger, wrist, shirt, cuff, skirt
	"yellow"	blue, pretty, green, red, orange, big, small, brown, grey, black, ugly, purple, fine, nice
D.A.	"man"	woman, boy, girl, chair, table, book, shelf, desk, cover, pencil, doctor, nurse, needle, patient
	"yellow"	green, big, little, blue, ugly, pretty, big, enormous, small, tiny, petite, nice, neat, clean

Participant	Stimulus	Responses
S.B.	"man"	woman, girl, boy, dog, cat, animal, person, house, home, car, boat, airplane, hydroplane, skiis, (sic) ship
	"yellow"	red, orange, green, brown, gold, blue, purple, maroon, chartreuse, lime, red, pretty,pink, white, black, grey, big, fat, enormous, little, small, fair, peachy

(See Chapter 6 for further discussion of this data).

As occurred in S.B.'s responses (above), the participant would sometimes list the same word more than once. When this happened, it was counted as only one response. This occurred in all sections of the experiment, but, since for the "part of speech" task and the "first consonant" task there were a greater total number of responses, this occurred more for these tasks.

Task 7: "Same Last Syllable"

When asked to list words with a particular final syllable, participants responded more poorly than in any of the other tasks. For all 50 participants, only 120 responses were given, an average of only 2 responses per person. Again, there was evidence of "fudging" in which participants used particular strategies in order to arrive at some responses. For example, although participants were instructed to list words with a particular "*last*" syllable," and were given example words of two syllables, they often gave monosyllabic responses. For example, "son" was cited as a word with the same "last syllable" as in the word "lesson," and "toe" was cited as a word with the same last syllable as in the word "photo." In this category of responses also, a number of incorrect rhyming responses occurred ("row," "bow," "show," and "foe" were, for example, cited as words with the same final syllable as in the word "photo").

It must be kept in mind that none of the stimulus words contained a stressed final syllable. Under such conditions it is possible that different results might have occurred. Responses were never consistent with regard to affixes, even when the stimulus word itself consisted of a stem plus affix. For example, the stimulus word "hunter," which can be analyzed into a stem plus an agentive suffix, did not elicit particularly many responses consisting of a stem plus an agentive suffix. In fact, for this stimulus there were less than 40% responses of this type, and typical responses included words such as "smarter," "better," and "slower" with a comparative affix, as well as words that could not be analyzed into stem plus affix at all such as "mother," "daughter," "other," "motor," "blunder," and "hinder."

The above examples indicate a typical trend in the responses: that the last "syllable" was regarded by participants as the last vowel plus consonant, not as the last consonant-vowel-consonant sequence.

There were no more responses in this task when the final syllable was a suffix than when it was not.

General Findings

Generally the responses were common words. However the most frequent responses were not the most common words in the language (according to the Kucera and Francis word lists). Although some of the consecutive responses were semantically related (notably in the part of speech group) there was not a general tendency (in any category) for this to be so. Nor were the consecutive responses phonologically related according to any pattern except the required criteria for each task. The 'part of speech' of the responses was difficult to make generalizations about since the majority (approximately 70%) of the responses were ambiguous between nouns and verbs. Responses were typically one syllable words, with occasional two syllable responses. Longer words were extremely rare.

There was sometimes a tendency for the same response to be repeated by the same participant, as well as for participants to make up (or at least misspell) responses. These errors were particularly apparent in the more difficult categories such as "same middle consonant." It is clear that speakers have the ability to construct 'possible but non-occurring' words; i.e., that they know the phonological sequential conditions of the language.

4.4 Lexical Implications

4.4.1 Lexical Search by Scanning and the Ordered Phonological String:

Experiment 2 in all but one case asked speakers to select from their lexicons examples of words having a particular phonological structure. Two explanations are possible as descriptions of the manner in which this task was carried out: 1. It is possible that, as suggested by Fromkin, speakers simply use some 'indexing system' to go to that section of the lexicon listing words of the particular structure being looked for. 2. Another possibility is that speakers may simply start by randomly 'scanning' their lexicon, pulling out words of the particu..r form being looked for when they are found.

The results of the Experiment pose difficulties for the 'scanning' model. The findings of the experiment show that it is easier for speakers to supply responses for words defined in one way than for words that are defined in another way. For example, for the "same vowel sound," an average of 7 responses per participant were obtained as compared to an average of 26 for the "same first consonant sound" and 2 for the "same last syllable" category. There is no explanation within the 'scanning' model as to why it should be easier for speakers to scan for one type of phonological feature than for another. The only possible explanation for the different degrees of ease of scanning would have to be the order of the phonological segments in the word. Thus, 'first consonant' is easy to scan for because it is the first consonant, whereas the middle and last consonants are more difficult to scan for because of their later position in the word. This 'explanation' is circular and not particularly revealing. [One would also expect that the middle consonant would be 'easier' to locate than the final consonant by such a method]. Also, as will be discussed below, there is evidence that 'scanning' does not accurately describe the manner in which participants sought for their responses. Nonetheless, this explanation is mentioned here because it is contradictory to Wickelgren's model.

Wickelgren's model, it will be recalled, proposed that words are represented in the lexicon by unordered strings of allophones. His model predicts that, except for the initial consonant of a word, it should be equally easy for speakers to 'scan' for any segment in the word. A greater proficiency for selecting the first consonant of the word might be expected in Wickelgren's model, since this sound has "greater force" in the representation in order to begin the chain association of the allophones of the word. But all the other segments in the word are represented with the same amount of 'force.' Thus, according to Wickelgren, speakers should be equally adept at selecting words with a particular middle consonant as in selecting words with a particular final consonant. But this was not the finding in the experiment: there was an average of 7 responses in the "same last consonant" group as opposed to an average of 2 in the "same middle consonant" group. (It will be recalled that this difference is statistically significant).

Thus, even if one supposes that the search required in the experiment was conducted by scanning, it is impossible to account for the experimental results within an "unordered" model such as Wickelgren's.

4.4.2 Lexical Scanning Versus "Indexing" or the "Nearness Hypothesis"

The above findings indicate that it is necessary to assume that the lexical string is represented by ordered, not unordered, segments. But, even if ordering is assumed, the assumption of lexical 'scanning' is not necessary. This is the view taken by Fromkin, whose model assumes ordering of lexical segments and search by 'indexing' rather than scanning. (However, her model does not exclude scanning within the sub-sets of the lexicon).

The scanning model does not provide any natural explanation of why speakers perform differently when scanning for different features. Similarly, there is no explanation as to why speakers might not be able to scan at all for some categories and might, thus, have to resort to other means of search.

Yet the findings of the Experiment indicate that in many cases methods other than simple 'scanning' were employed by participants in order to arrive at responses. It will be recalled that, in the "same number of syllables" task, there was evidence of semantic accessing via visual input--or, simply, 'looking around the room.' In this category, participants listed responses including the words "experiment," "stimuli," "native," "answer," and "linguistics." Other devises employed in order to supply responses included rhyming (in the "same middle consonant" task) and affixation (in the "same number of syllables" and "same middle consonant" tasks). The fact that these strategies were employed indicates that simple 'scanning' is inadequate to account for the manner in which participants supplied responses.

In short, a model of the experimental approach by participants based upon 'scanning' is explanatory only if it is assumed that the string of phonological segments is ordered in the lexicon. Scanning cannot explain the experimental findings unless the lexical representation of words is composed of ordered segments.

If scanning were employed, one would expect that speakers would be able to pick out (with equal ability) words of any specified form. However, it was apparent that speakers were not always able to retrieve words by the same method and sometimes had to resort to special 'strategies.'

It will be recalled that in the "same number of syllables" task participants resorted to a number of strategies including "looking around the room" and employing affixation. In the "same middle consonant" task, participants resorted to the strategy of affixation and rhyming. This suggests that it is not possible for speakers to simply randomly scan the lexicon looking for words of a particular type.

4.4.3 Search by Indexing and "Nearness"

The results of Experiment 2 revealed a great range in peoples' ability to give examples of particular types of lexical items. For lexical items defined according to certain criterion (for example "initial consonant") it was very easy for speakers to give many responses. For items defined according to other criterion (for example "middle consonant") it was very difficult for speakers to give examples, so much so that they were forced to resort to particular "strategies" in order to produce any responses at all. We have seen that it is difficult, assuming that the lexicon is randomly ordered and that lexical search is accomplished by scanning this random listing, to explain this diversity of ability for search. A model of the lexicon such as Fromkin's can, however, account for this diversity of ability of search. Fromkin's model assumed that the lexicon is grouped, or "indexed" according to certain features of words. The fact that words are indexed for certain features would explain why it is easy for speakers to give examples of words according to these features. The inability of speakers to give many examples of words defined by other features, and their need to resort to "strategies" to produce any examples of such words can be explained by assuming that these are not features by which words are stored and indexed.

The specific findings of the experiment can all be accounted for within the "indexing" model:

Initial Consonants

The extreme ease with which participants in the experiment were able to list words beginning with a particular first consonant (recall speakers gave an average of 25 responses to each stimuli) can be explained within the "indexing" model by assuming that the words in the lexicon are "indexed" and grouped together according to their first consonant. Thus, when a speaker wanted to exemplify words beginning with, for example /b/, he needed only to go to that section of the lexicon where the #/b/ words were listed.

Grammatical Category

The ease with which speakers were able to list words according to their grammatical category (an average of 26 responses to each stimuli) suggests that words are also lexically "indexed" or grouped according to such syntactic features.

Number of Syllables

In the "same number of syllables" category of the experiment, a low number of responses was obtained for all but the one syllable words. The inability of speakers to list words of two or more syllables indicated that the lexicon is probably not divided into sub-sets of one syllable words, two syllable words, three syllable words and so on. If this were the case, it should be easy for a participant to go to that section of the lexicon and produce the requested responses. The fact that participants had to resort to strategies such as affixation and use of semantic cues suggests further that there is no lexical grouping simply according to number of syllables. The number of incorrect responses given (both those corrected and those left incorrect by the participants) further indicates both the difficulty in terms of response according to number of syllables and the unlikelihood that lexical items are categorized according to this feature.

Middle Consonant

The sparsity of responses in the "same middle consonant" group indicates that lexical items are not "indexed" or grouped according to this parameter. The fact that the participants in the experiment were unable to access words according to an "index" or listing of words with particular middle consonants was also exemplified by the manner in which participants did access responses: the use of affixation and rhyming were two of the more common devices used in this regard.

Last Syllable

Both the low number of responses given and the fact that participants were forced to resort to "strategies" in order to produce any responses indicate that words are not listed according to their final syllable.

4.4.4 Lexical Groups and Brown and McNeill's 'Parameters of Storage'

We have seen that a model of the lexicon involving a random listing of items and a scanning devise is less explanatory than a model assuming the existence of lexical groups and an 'indexing' devise. The results of the Experiment indicated that words are grouped in the lexicon into sub-sections classified according to first consonant and part of speech. The results of the experiment further indicate that words are *not* sub-grouped according to their middle consonant, their number of syllables, or their final syllable. These findings are incompatible with Brown & McNeill's model which claims that features such as number of syllables, middle consonant and final syllable are retained because they are 'parameters of storage.' A discussion of this incompatibility follows:

Number of Syllables

Brown and McNeill found that in their 'tip of the tongue' experiment 48% of the guessed words matched the target word in number of syllables. It was noted, however, that the accuracy of the words such guessed fell off for words longer than three syllables: Brown and McNeill suggest that words may be grouped according to whether they have one syllable, two syllables, or 'three or more' syllables. The findings of the present experiment indicate that words are not stored according to number of syllables, although there is a marked difference in performance between one syllable (and possible two syllable) words and longer words.

Brown and McNeill "did not ask their subjects to guess the stress patterns of the words." Nonetheless, they, noted that, for those guesses that had the same number of syllables as the target word, there was a tendency for the same stress pattern also to be exhibited. Although this tendency was not statistically significant, Brown and McNeill concluded "we are left suspecting that S in a TOT state has knowledge of the stress pattern of the target." In the present experiment, participants were not asked to give examples of words with a particular stress pattern either. But among those few words with the correct number of syllables (for the "same number of syllables" group), there was no correlation for stress between the stimulus word and the response word. It is, of course, possible that had participants been asked to list words with a particular stress pattern, they might have been able to do it (at least for two syllable words), but following Brown and McNeill's method of analysis, no corroboration was obtained. The findings of this experiment provide no information as to whether stress is part of the representation of words or is added by rule.

Middle Consonant

Brown and McNeill noted in their subjects a strong tendency for the guessed words to match the target word in the last three letters. They related this finding to the 'serial position effect,' a perceptual law derived from tachistoscopic and other experiments. In the present experiment, the "middle consonant" on the stimulus words was also the third consonant from the end of the word (since only five-phoneme stimulus words were used). Participants were unable to retrieve words according to this criterion with any degree of efficiency.

Final Syllable

Brown and McNeill found in the 'Tip of the Tongue' experiment that there was a tendency for the last syllable (when it was a suffix) to be correlated between the target word and the guessed words. In the present experiment, it was found that words were not sub-grouped according to final syllable--in other words, that participants could not ennumerate words with a particular last syllable. Further, it was no easier for speakers to list words with a particular last syllable that was a suffix than one that was not a suffix.

Discussion

Both Brown and McNeill's 'tip of the tongue' experiment and the present work are aimed at providing a description of the lexicon. Both Brown and McNeill's work and the present experiment suggest that the best model of the lexicon is one based on an indexing of the representation(s) of words according to certain features. But Brown and McNeill's work and the present work do not agree upon what features are involved. What possible explanation can there be for this disparity?

Apparently some linguistic features can be prominent even though words are not sub-grouped according to these features. It is possible that this prominence may be due to factors aside from the manner of storage in the lexicon--for example, extra-linguistic features. In particular, facts such as the redundant structure of language and the manner of language acquisition may be relevant.

There are two basic differences between Brown and McNeill's study and the present study which could explain the differences in results that were obtained. These two differences are the type of words being investigated and the means of access being employed.

Brown and McNeill's study deals primarily with rare, little-known words. This was necessary in Brown and McNeill's study since common, frequently used words seldom (if ever) evoke the 'tip of the tongue' state. However, (as discussed elsewhere), there are reasons to expect that these words are stored differently from other, 'ordinary' words.

The manner of access in the two experiments is another way in which the studies differed, and this difference may account for further differences in findings. In Brown and McNeill's study words were accessed in a 'semantic' way: speakers were given semantic definitions of words and asked to supply the matching word. In the present study, speakers were asked to access words in a phonological way: a definition of some feature of the phonological structure of a word was given and speakers were asked to supply words that met that definition.

We know that language contains a certain amount of redundancy. This redundancy makes certain aspects of the structure of language predictable. For example, we know that agentive nouns often end in -er, and that adverbs may be formed from adjectives by the addition of the suffix -ily. Thus, if we know certain things about the meaning of a word we can predict certain facts about its phonological form. In Brown and McNeill's experiment, subjects were given information about the meaning of words: it follows that from this information coupled with the initialized knowledge that speakers have about the form of the redundancy in their language, speakers may be able to make certain predictions about the form of the word involved. This could explain why Brown and McNeill's subjects were able to predict the final syllables of target words when the final syllables were suffixes. This ability could also account for the ability of speakers to guess the 'third from the last consonant' of words.

There seems little need to attempt to account for the differences in findings between the two experiments with regard to the stress patterns of words since Brown and McNeill admit that their findings are not statistically significant. But, it does seem apparent that the remaining differences in findings between the two experiments can be accounted for if one assumes that orthographic learning, semantic effects and the redundancy of language are involved. Thus it is possible (at least with regard to the 'last syllable' and 'last consonant' effect) that Brown and McNeill's findings are not so much indicative of the storage mechanism of language as of the fact that speakers have knowledge of the structure of their language, complete with knowledge of redundant features of structure.

4.5 Conclusions

In summary, the following conclusions have been drawn as a result of the findings in Experiment 2:

1. The phonological string of segments in the lexicon is an ordered representation.
2. A system of 'indexing' of lexical grouping exists. Within this system of grouping:
3. Words with the same initial consonant sound constitute a sub-group.
4. Words belonging to the same 'part of speech' constitute a sub-group.
5. Words having the same number of syllables do not constitute a sub-group.
6. Words having the same middle consonant sound do not constitute a sub-group.
7. Words having the same final syllable do not constitute a sub-group.

(Points #5 through 7 above contradict Brown and McNeill's model).

Chapter 5

Experiment 3: Groups and Hierarchies

5.1 Introduction

The continued controlled word association experiment described in Chapter 5 indicated that there is a statistically significant difference in a speaker's performance for listing words according to different criteria. This experiment further indicated that this difference was not due to facts about the language itself, but rather was due to facts about the manner in which words are represented in the internal lexicon. To obtain additional information about the structure of the lexicon, a second experiment was conducted employing the same format as was used in Experiment 2.

It will be recalled (see Chapter 2) that a performance model of the lexicon must deal with two issues: the form of the storage network and the form of an individual stored item. Data from this experiment should shed light upon both of these basic issues. In particular, with regard to the form of a single stored item, the possibility of a hierarchical representation is considered; with regard to the form of the storage network, the possibility of alphabetic and rhyming lists are considered.

5.1.1 Hierarchical Structure

The phonological segments comprising the stored word may be stored in either a linear string or in a grouping of some kind. MacKay's model is of the latter variety; segments are said to be stored in groups which themselves constitute larger storage "units." Words are made up of units called "syllables;" syllables are made up of units called the "initial consonant group" and the "vowel group;" the vowel group is made up of a "final consonant group" plus a vowel. According to this proposal these units function in the production and perception of speech.

Experiment 3 investigates this issue by comparing speakers' abilities to produce different groups of segments.

5.1.2 The Storage Network

a) The Possibility of Alphabetic Lexical Listings

Some evidence was provided in Experiment 2 for the proposal that lexical items are listed according to their first consonant sound--as in a dictionary. The experiment, however, provided no data as to how these words were listed within the initial consonantal sets. If the 'basic' list follows the dictionary type listing one might also expect words beginning with the same consonant clusters to follow each other and, in addition, words beginning with the same consonant followed by the same vowel. If this is the case it should be as easy for speakers to provide a list of 'br' or 'st' words as initial 'b' or 's' words, and also it should be as easy for speakers to provide a list of words beginning with the same consonant followed by the same vowel as to produce words with the same initial cluster.

Experiment 3 was designed to test this hypothesis.

b) The Possibility of Rhyming Listings

If speakers are adept at listing words according to their vowel and last consonant (as a group), this could be evidence that words are subcategorized in such a sub-set in the lexicon.

5.2 Description of the Experiment

Like Experiment 2, Experiment 3 was a controlled, continued word association test. There were six different "phonological forms" being asked for: words having a particular first consonant sound, words having a particular vowel sound, words having a particular final consonant sound, words having a particular vowel plus final consonant sound, words having a particular first consonant plus vowel sound, and words having the same two first consonants.

Again as in Experiment 2, the groups of instructions and stimuli were recorded, and participants were asked to write down their responses on answer sheets. The six groups of instructions given were:

1. You will hear a word. Please write down as many words as you can think of with the same *first consonant sound* as the word given.

2. For the next group of words, list as many words as you can think of with the same *vowel sound* as the word given. Do not list rhyming words among your responses.

3. For the next group of words, list as many words as you can think of with the same *last consonant* sound. Again, do not list rhyming words.

4. For the next group of words, list as many words as you can think of with the same *vowel plus final consonant* sounds.

5. For the next group of words, list as many words as you can think of with the same *first consonant plus vowel* sounds.

6. For the next group of words, list as many words as you can think of with the same *first two consonants*.

Following each group of instructions, the tape was stopped, and participants were asked if they had any questions. If there were questions, the instructions were replayed. Each set of instructions was then followed by five stimulus words. Each stimulus word was followed by a 90 second period of silence during which participants were to write down their responses.

For all but the last group of words (the "same first two consonants" group), the stimulus words were all of the form CVC. All of the stimulus words used in the experiment were of approximately the same degree of frequency of occurrence, according to Kucera and Francis' (1967) word lists. A list of the stimulus words used for experiment 3 is given in Table 9.

The experiment was administered to 30 undergraduate beginning linguistics students at UCLA.

5.3 Results of Experiment 3

As in Experiment 2, information about both the number of responses obtained for each task and the kind of responses given is relevant.

In terms of number of responses, the results are clear. The task for which the greatest number of associative responses was obtained was the "same vowel plus last consonant" task. For this task, participants generally totalled around 32 responses. The task for which the smallest number of responses was obtained was the "first consonant plus vowel" task, in which a total of about 4 responses were given by the participants. For the other tasks, the total number of responses ranged from an average of 30 for the "first consonant sound" task to 10 for the "same vowel sound" and "same last consonant sound" tasks and 26 for the "same first two consonant sounds" task. The total number of responses given by each participant for each task is noted in Table 10.

TABLE 9

STIMULUS WORDS FOR EXPERIMENT 3

TASK 1 #C	TASK 2 -V-	TASK 3 -C#	TASK 4 -VC#	TASK 5 #CV-	TASK 6 #CC-
1. boy	1. bone	1. rim	1. pine	1. cat	1. stand
2. toy	2. hen	2. bag	2. sight	2. night	2. trot
3. fan	3. tick	3. bat	3. bet	3. bone	3. brink
4. cone	4. fan	4. mass	4. man	4. fan	4. skip
5. man	5. cake	5. cab	5. bone	5. pine	5. clip

TABLE 10

NUMBER OF RESPONSES BY EACH PARTICIPANT

EXPERIMENT 3

PARTICIPANT	TOTAL NUMBER OF RESPONSES					
TASK	1	2	3	4	5	6
1.	30	14	12	31	4	22
2.	26	11	11	28	3	26
3.	28	9	10	29	5	29
4.	32	11	14	35	4	27
5.	21	9	9	40	3	25
6.	30	15	10	28	5	30
7.	36	15	11	38	5	25
8.	30	8	8	31	6	23
9.	24	10	11	24	6	28
10.	29	7	10	30	3	22
11.	20	9	10	30	6	35
12.	30	11	10	27	4	30
13.	25	10	6	35	5	35
14.	34	11	11	38	4	26
15.	33	15	9	35	5	23
16.	36	9	8	42	4	24
17.	31	9	14	26	3	21
18.	24	10	11	40	5	28
19.	35	14	10	33	5	26
20.	40	10	10	36	5	36
21.	32	8	10	35	6	22
22.	24	8	9	30	6	32
23.	34	10	10	34	6	24
24.	35	13	14	36	5	23
25.	25	9	12	25	4	30
26.	36	8	11	35	5	21
27.	48	14	13	42	5	26
28.	36	9	12	36	4	23
29.	29	9	9	37	5	24
30.	35	10	15	35	3	24
TOTAL	903	315	320	966	140	790
AVERAGE	30	10	10	32	4	26

TASK	#C-	-V-	-C#	-VC#	#CV-	#CC

A graph has been prepared showing the total responses for each of the association tasks by participant in Experiment 3. (See Figure 3).

It will be noted that three of the association groups tested in the present experiment were also tested in Experiment 2. By comparing Figures 1 and 3 and Tables 7 and 10, it can be seen that, while the actual number of responses obtained differs (due to the different amount of response time allowed), the results of Experiment 3 are in general agreement with those of Experiment 2. Thus, in both experiments, there is an approximately similar number for the "vowels" and "last consonants," and this number is considerably smaller than the number obtained for the "first consonants."

As in Experiment 2, two types of statistical analysis were performed for experiment 3. The 'one-way analysis of variance' was performed in order to determine whether the differences between the number of responses for the different groups was significant. This was found to be significant to the .01 level.

Again, as was the case in Experiment 2, Experiment 3 assumes that the results found are due to the nature of storage in the lexicon. A null-hypothesis would claim that the results are merely the product of the distribution of different structures of words in the language. To determine the validity of the null hypothesis, a chi-square test was performed comparing the results of the experiment with the distribution of different structures of words in the 2,500 most common words of English (from Kucera and Francis,1967). The null hypothesis was rejected with 99.5% of certainty.

In two of the response categories, particular comment on the types of response made is necessary.

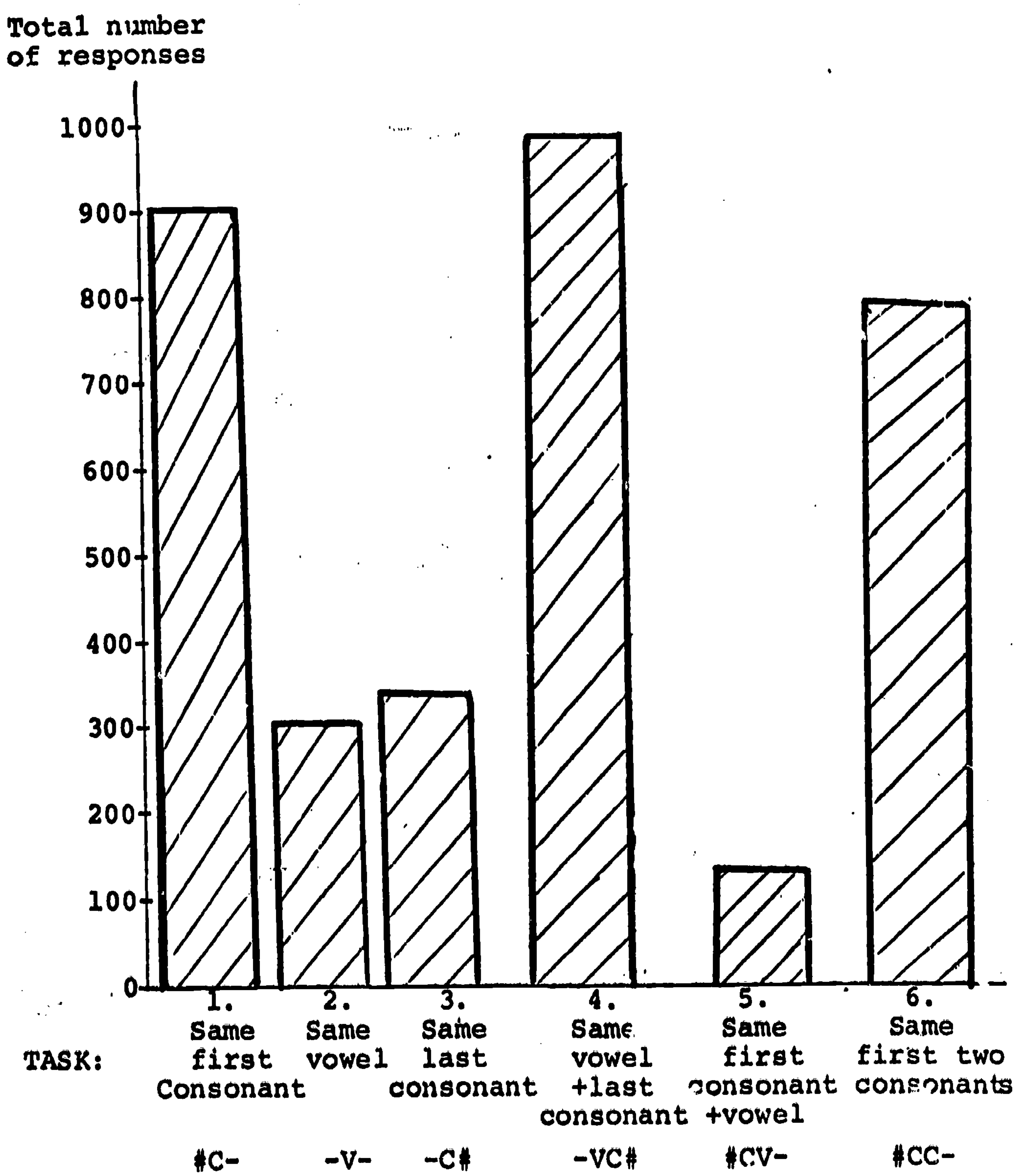
Task 5: "Same Consonant plus Vowel"

It will be recalled that for the "same first consonant plus vowel sounds" task, the lowest number of responses (an average of 4 for each participant) was obtained. Yet, these small numbers of responses made were in no way typical of the responses made in the rest of the experiment. Whereas for the other tasks in the experiment, few incorrect responses were given, for this task, some 20% of the responses made were incorrect. These errors involved the failure on the part of the participants to supply words with the correct vowel SOUNDS, even though the orthographically 'correct' vowel had been supplied. The mechanism involved in the selection of these responses is not completely understood and whether structure of the orthographical system is responsible

FIGURE 3

GRAPH - NUMBER OF RESPONSES

EXPERIMENT 3



remains to be seen. It is possible, for example, that these results were obtained simply because it is a much easier task to list words spelled with a certain vowel than words pronounced with a certain vowel since there are fewer orthographic vowels than phonetic ones.

Examples of errors involving the "spelling strategy" are numerous. When asked to list words with the same first consonant and vowel sound as in the word "bone," participants replied with "boss," "boot," "bout," "box," "bon," "body," "Boston" and "bossanova." When asked for words with the same initial consonant plus vowel sounds as in "night," participants replied with "niche," "nigger," "nip," "nil," and "never." When asked for words with the same two beginning sounds as in "cat," two participants responded with "cake," and one participant responded with "carbon." "Fan" yielded "fail," "father," "farther," and "pharmacy." It is obvious that this final incorrect response was not thought up by the mechanism of looking for a word beginning orthographically with "fa-."

Further evidence that suggests that participants were not choosing their responses as a result of scanning orthographic listings is the responses containing 'silent consonants' that occurred. When asked for examples of words with the same initial sounds as in the word "night," 20% of the responses given began with an initial orthographic k . The fact that these responses were intermingled with responses beginning with n indicates that the words beginning with kn- are probably not stored separately from the words beginning with n alone. Similarly, when asked to list words with the same final consonant sound as in the word "rim," 11% of the responses given contained a final silent consonant. The actual responses given included such words as 'lamb,' 'limb,' 'crumb,' 'climb,' 'tomb,' 'bomb,' amd 'womb' intermingled with words ending in -m . The fact that these words ending in -b were given as examples of words ending with the phoneme /m/ indicates that it is easy for speakers to retrieve words according to their phonemic shape without becoming confused by the orthographic shape of the word.

Further, when asked to list words with an initial /f/ sound, speakers performed equally well whether the stimulus word was "fan," or "phone." Even more dramatically, the same number of responses (3%) occurring with an orthographic ph- occurred for each stimulus. When the stimulus word 'cone' was given and participants were asked for words "beginning with the same sound," approximately equal numbers of responses orthographically beginning with k, c, and g occurred. Responses beginning with the even rarer ch- (pronounced /k/) also occurred. This suggests that words are stored in sub-groups according to their phonemic or phonetic shape, and independent of their orthographic shape.

Thus, despite the fact that erroneous responses sometimes suggested an appeal to orthographic information, it is apparent that this is not how responses were generally made in the experiment. Another type of erroneous response that occurred was the non-existent, made-up word. For example, "carandescent" appeared as a word having the same first consonant and vowel sounds as in the word 'cat,' and "fanctitude" appeared as an example of a word having the same first consonant plus vowel sounds as in the word 'fan.'

Task 1: "Same First Consonant Sound"

When considering the types of responses to the "same first consonant" section of the experiment, there are two issues to be investigated. The first has to do with sets of responses, if such exist, and the second has to do with responses involving consonant clusters rather than single consonants.

With regard to the issue of sets of responses, it was of interest to find out whether there was any pattern in the responses given. Thus, for example, did participants tend to respond with a group of words beginning with the consonant in question plus a certain vowel, followed by a group of words with the consonant plus a second vowel, followed by a group of words with the consonant plus a third vowel, and so on. It was found that, for none of the participants, was this the case. The examples below (from the responses of one participant selected at random) illustrate this:

Stimulus word	Responses ("Same first consonant group)
boy	beer, business, blue, bra, best, bind, bore. brat, brown, bee, Basilica, blouse, book, ball, bare, bead, bitch, bum, bang, bottle, battle, bit, box, bed, bad
toy	Tom, Ted, tree, tray, tout, time, tend, term, twenty, trace, tape, took, time, try, tablet, touch, tip, tap, trouble, tease, tangle, top, titter tall, target
fan	found, foot, four, five, fifth, funky, fidget, food, fascist, fashion, fad, free, freak, favorite, phallic, fine, finish, finesse, facade, fun, frolic
cone	combine, camera, consonant, consistent, careful, creative, coon, calendar, cat, cow, cattle, caper, keep, kitchen, cake, cookie, cook, kindergarten, cream

Since the instructions for this response group did not specify whether participants should respond with words beginning with the first consonant named only, or whether consonant clusters beginning with the named consonant would be permissible, it is of interest that consonant clusters occurred in the responses approximately 15% of the time. There was no tendency for the consonant clusters responses to occur in a group: these responses were intermingled with the single consonant responses.

It should be mentioned here that examples of cluster responses occurred in other sections of the experiment as well, although less frequently. Thus, some responses given for words ending with the same consonant as "mass" were "cast," "fast," "baste," and "must." It is not known whether the speakers who made these responses were speakers of a dialect that deletes final t's in st# clusters. If they were this would be further evidence that (as instructed) speakers were responding to phonetic structure. If not, however, a more basic fact about the linguistic status of these clusters might be responsible. It appears that the -s is more prominent and that speakers do not view -st# as a cluster. Examples of cluster responses occurred in initial position also. "Flab" was given as an example of a word with the same first consonant plus vowel as in the word "fan," and "snipe" was given as an example of a word with the same first consonant plus vowel as in the word "night."

5.4 Lexical Implications

5.4.1 The Storage Network

a) Alphabetic Listings

The inability of participants to list examples of words according to their first consonant plus vowel suggests that there is no lexical sub-group defined by this structure. For, if words were listed in groups in the lexicon in an alphabetic sort of listing with words having the same first consonant and vowel being listed together in a group, then it should have been easy for participants to have gone to that section of their lexicon and retrieved many examples of such words.

Similarly, the ease with which participants were able to retrieve examples of words beginning with particular clusters could be due to the fact that these words are all stored together in a lexical sub-group. For example, experiment 2 supports the view that words in a speaker's lexicon that begin with /b/ are grouped together. It is also possible that a further sub-grouping system exists such that all the words in the lexicon beginning with /b/ are sub-grouped into three groups: those words beginning with /br/, those words beginning with /bl/, and those words beginning with /bV/. (The evidence--discussed above--of the difficulty in listing words with a particular first consonant and vowel indicates that the /bV/ grouping is not further divided into /b/ plus the particular vowels).

But the large number of responses given on the "same first two consonants" task can have two explanations. It may be due to the fact that the 'consonant cluster' is a unit in the hierarchical representation of words; or, it could be due to the fact that words are listed in the lexicon in a sub-group defined by the consonant cluster. An examination of the kind of responses given, and the order in which responses were given, provides insight into which of the two possible explanations is valid. In the "same first consonant" task, a number of responses were given that began not only with the desired first consonant, but that began in particular with consonant clusters the first member of which was the consonant being asked for. Since no specific instructions were given about the acceptibility of these responses, it is of significance that participants often chose to respond in this manner. The presence of such responses suggests two facts about the structure of the lexicon First, the fact that 'consonant clusters' and single consonants may in some way be the 'same thing'--in particular that they might both be members of a larger, more important hierarchical structure: the consonant cluster. Conversely, the fact that cluster responses occurred when single consonants were asked for tends to suggest that the single consonants and the consonant clusters are not as separate as one might suppose: in particular, that they are not stored in separate lexical 'sub-groups.' The order in which responses were given gives further support to this. Thus, if the cluster responses (for the "same first consonant") task had been elicited in groups, this would have given support to the notion of a lexical subgrouping according to first two consonants from which participants were retrieving examples. Since the consonant cluster, responses did not occur in groups but rather intermittantly, interspersed among the single consonant responses, one can conclude that there is no separate lexical subgrouping for the consonant cluster words, but rather that they are interspersed among the single consonant words.

The difference in number of responses for initial consonants versus consonant clusters is significant. One explanation for this difference is that, if consonant clusters are part of the "first consonant" group, then the scanning of the consonant group for clusters will take longer and therefore fewer cluster responses will occur. (That this difference is not due to the different numbers of such words in the language is shown by the statistical rejection of the null hypothesis).

Similarly, it will be remembered that the low number of "same first consonant plus vowel" responses indicated that this was not a lexical sub-group. If, however, the responses for the "same first consonant" group had been of the order of a list of words with the consonant and one vowel, then a list of the consonant and another vowel, and so on, then this might have suggested that words were subgrouped according to their different vowels within the "same first consonant group." The responses given indicated that this was not the case: the vowels given varied randomly, and, in fact, seldom did the same vowel occur twice in a row in the responses.

b) Rhyming Listings

The ease with which participants were able to retrieve words according to the "same vowel plus final consonant" instruction indicates that words are grouped in the lexicon according to their vowel and final consonant. It was found in the pilot studies for the experiment, that in the "same vowel" and the "same last consonant" tasks, 'rhyming' responses having both the same vowel and the same last consonant as the stimulus word were often given. The fact that these responses tended to occur in groups suggests that there may, in fact, be a lexical subgroup defined by this 'rhyming structure.'

With regard to the possibility of a 'rhyming' lexical sub-grouping a number of comments are necessary. First, the low number of responses obtained (in Experiment 2) for the "same last syllable" task indicates that if a listing according to vowel and consonant occurs, the listing is actually according to stressed vowel and following consonant, rather than to the absolute (unstressed) vowel and following consonant. The finding that responses for the "same last syllable" task in Experiment 2 invariably analyzed the 'syllable' as consisting of vowel plus final consonant (VC) rather than as consonant plus vowel and consonant (CVC) gives further evidence of the importance of the -VC unit.

With regard to the vowel plus final consonant section of the experiment particularly, the question of experimental strategies (a question relevant to the whole experiment as to Experiment 2 as well) arises. The high number of responses obtained for the "same vowel and consonant" and for the "same first consonant" tasks is reflected in literature by the prevalence of rhyming and aliteration. Aliteration is rare outside of written language or literature; but rhyming is more common in spoken language as a form of language game. Thus, the question arises with regard to the responses obtained in the "vowel and last consonant group": is the participant responding by accessing his lexicon and retrieving words or is he purposefully applying the 'rhyme rule' to arrive at his answers? Thus, we need to know if the experiment participants are actually scanning the lexicon to arrive at their responses or if they are merely randomly applying a 'rule' or strategy of the form "change initial consonant." If the participant were merely substituting one sound for another from the possible permissible set of sounds of the language, we would expect that non-occurring responses would have occurred. Thus, i speakers were merely applying a rule to produce rhymes with, for example, "cat," incorrect responses such as "lat" might occur. However, no such incorrect 'rhyming responses' were given. This indicates that a lexical listing of rhyming words is a better explanation for the experiment results.

5.4.2 Hierarchical Structure of Items

The results of the experiment are relevant to MacKay's claim that words are stored in the brain in a hierarchical fashion. MacKay claims, for example, that the representation of a CVC or CCVC syllable in the brain would be as in Figure 4 and not as in Figures 5 and 6. MacKay's model would predict that speakers would be adept at performing linguistic tasks in which consonant clusters, or vowels plus following consonants are treated as a unit. Tasks in which consonants and following vowels are treated as a unit would be difficult for speakers to perform.

The number of responses for the different response categories tend to give some support to MacKay's claim. For example, the task in which participants were able to provide the greatest number of responses was the "same vowel plus last consonant" task in which a total of 966 responses were given. Similarly, participants also had little difficulty thinking of words with "the same first two consonants" as a particular stimulus word. For this task, a total of 790 responses were given. On the other hand, splitting up the CVC syllable as in Figure 8 was considerably more difficult for participants. They were only able to list a total of 320 words having a specific final consonant, and 140 words with specific initial consonant plus vowel. The difficulty in treating the initial consonant plus vowel as a unit is also reflected by the large number of incorrect responses obtained. The incorrect responses, it will be remembered, were either non-existent words made up by the participants or responses made to spelling rather than phonological structure.

FIGURE 4

STRUCTURE OF SYLLABLE

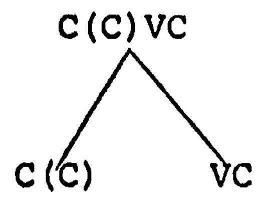


FIGURE 5

STRUCTURE OF SYLLABLE

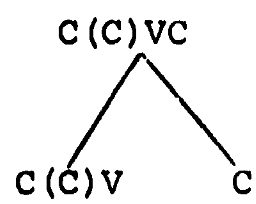
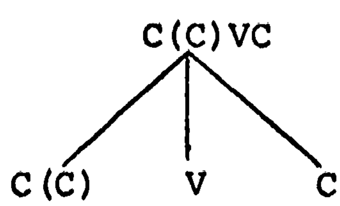


FIGURE 6

STRUCTURE OF SYLLABLE



It has been seen above that another interpretation for the 'rhyming' results is the existence of a lexical sub-categorization of rhymes. But the ease with which participants were able to list words containing specified combinations of consonants provides evidence of the 'psychological reality' of the consonant cluster. This finding does not, however, prove that words are stored in the form of a hierarchical structure in which the consonant cluster is a unit. It is possible, for example, that words are stored as ordered strings and that prior to articulation a further structure (e.g., syllables or clusters) is imposed.

5.5 Summary and Conclusions

Below is a list of the findings of ~~Experiment 3 and their~~ implications for a model of the lexicon.

1. Participants were extremely poor at retrieving words according to the first consonant and vowel of the word. This suggests that the lexicon is not an "alphabetic" type listing of words according to first consonant plus vowel.

2. The poor results in retrieving words according to their first consonant and vowel supports MacKay's claim that this is not a unit in the minds of speakers.

3. The large number of responses obtained on the "same first consonant task" suggests that the consonant cluster is a 'psychologically real' unit in the representation of words.

4. The order of responses given on the "same first consonant task" suggests that the "initial consonant cluster" is not a parameter by which words are sub-grouped in the lexicon.

5. The large number of responses given on the "same vowel plus last consonant" task suggests that this is a parameter by which words are sub-grouped in the lexicon.

6. The results of Experiment 2 (with regard to the number of responses for the "same first consonant," "same vowel," and "same last consonant") are confirmed.

Chapter 6

Semantic Features

In Chapters 1 through 5, the representation of words in the lexicon and the organization of the lexicon with regard to phonological features was discussed. The fact that speakers are able to rhyme, to list words beginning with a certain sound, and to otherwise list words according to a specified phonological structure indicates that the lexicon is organized in such a way as to permit lexical retrieval according to phonological specifications.

But, obviously, the lexicon must be structured so as to allow for retrieval of words according to semantic specifications also. The fact that speakers are able to list words belonging to semantic sets without hesitation-- i.e., 'kinds of fruit,' 'musical instruments,' or 'names of colors' provides evidence of this. Also, it is intuitively obvious that semantic selection must be possible: for, although no complete model of how an utterance is generated exists, it is generally assumed that such production occurs when a meaning is generated, and the appropriate words to produce this meaning are somehow selected. Thus, the lexicon must somehow be indexed according to semantic features or meanings. It will be recalled that, when faced with the task of guessing compound words, speakers did slightly better in guessing those compounds in which the meaning of the compound was related to the meaning of the parts.

A few hypotheses about the semantic structuring of the lexicon have been proposed. Fromkin's model, for example, of lexical groupings can be extended to the lexical representation of semantic features: thus, words sharing particular semantic features may be 'indexed' or grouped together into lexical sub-groups. Investigation is necessary to determine which semantic features are the semantic 'parameters of storage.' MacKay's model can also be used to describe the lexical representation of semantic features: it is possible, thus, that certain semantic features are stronger, in terms of a semantic hierarchy, than others. Again, investigation is needed to determine which the hierarchically 'strong' and 'weak' features would be.

As in the case of the phonological representation of the lexicon, it is possible to gain information about the semantic structure of the lexicon via experimentation. A continuous, controlled, 'listing' experiment in which participants would be asked for words having particular semantic characteristics would be one possible approach. However, other sources have already provided data regarding semantic features of words, and this data can be applied in such a way as to gain insight into the structure of the lexicon.

The two sources of semantic feature data to be examined here are: brain data (in particular, aphasia data) and word association data.

6.1 Aphasia and Brain Study

Linguists are concerned with the characterization of language in the brains of speakers. Thus, a linguist's grammar is an attempt to capture in a formal way the 'black box' contents of the human brain. But the brain is of a more than metaphorical concern to linguists. Whitacker (1969) explains,

> If Linguistics is seriously and honestly seeking the characterization of the *actual* "knowledge" a man has of his language, then it is in fact seeking the representation of language in the human brain...What we say and what we hear comes from and goes to the brain; it is a product of brain structure and mechanisms--the closer we get to the brain, the more likely we are to be discussing the realities of the structure of language (Whitaker, 1971:135).

Since it is not possible to look into the brain, it is only possible to make hypotheses about the brain's functioning from other available data. One type of such data results from the study of aphasia. In linguistic phenomena, as well as in non-linguistic phenomena, the study of abnormal behavior can provide insights into the structure and organization of normal behavior. We have already seen that insight into the structure of the lexicon can be provided by information pertaining to 'anomolous' types of behavior: speech errors, tip of the tongue states, and the mislearning of words being a few examples. Aphasia is a more dramatic and particular type of linguistic malfunctioning, but it is nonetheless informative about the structure of language in general and of the lexicon in particular.

Below, a discussion of aphasia evidence occurs, along with indications of its relevance for a model of the lexicon.

6.1.1 Classes of Lexical Items

Aphasia is a disruption of language that can affect the linguistic system on any level; phonological, semantic, or syntactic. Furthermore, these linguistic levels of representation may be independently affected in aphasia. Thus, there are types of aphasia in which the pronunciation of words (i.e. their phonological representation) is intact, but the words are used incorrectly: while retaining his knowledge of the phonological features of words, the patient has lost his knowledge of the semantic features or meanings. Conversely, there are cases in which aphasic patients are able to use words correctly in context, but have difficulty with the phonological representation. In such cases, errors involving phoneme sequencing, phonetic articulation of phonemes or syllables, or prosodic features may occur.

One particularly interesting example of how the semantic and phonological components of a language may be separately affected in aphasia is provided by Sasanuma and Fujimura (1971). The study involves Japanese aphasia patients suffering from a disruption of the phonological system of the language. It was found that this disruption was carried through all linguistic modalities: writing and reading, as well as speech was affected. The Japanese writing system involves two different types of symbols: "Kanjis" or ideograms and "kanas" or phonograms. For the aphasia patients being studied, there was a significantly greater number of errors made in the processing in tachistoscopic and writing tasks of kana symbols than of kanji symbols.

The fact that the phonological representation of words may be disturbed independently from the semantic representation of words indicates that the phonological representation of the word is stored separately from the semantic representation or at least that they are in some way distinct so that access to either may be selectively impaired.

The results of experiments 2 and 3 (Chapters 4 and 5) indicate that words are grouped in the lexicon into subgroups according to their phonological characteristics. Aphasia evidence provides support for this. Often word substitutions in aphasic patients involve words that sound alike. In particular, rhyming words are very frequent substitutions: "coat" becomes "goat", "lake" becomes "rake". But aphasia evidence suggests also that words may be grouped in the lexicon according to others, non-phonological features.

Thus, aphasia is a disturbance of language. However, aphasia is not always a language disturbance, but is often restricted to certain classes of words defined by syntactic or semantic features.

The fact that different 'parts of speech' are affected differently in aphasia suggests that words belonging to these different syntactic classes may be stored separately in the brain. One example is provided by Luria and Tsvetkova (1968). They performed a short experiment similar in style to experiments 2 and 3. Two groups of subjects (one group 'normals', and the other group patients with dynamic aphasia) were given one minute in which to list as many "names of objects" or "names of actions" as possible. For the normal subjects, there was no significant difference between the number of responses given: an average of 30"names of objects" were given, as compared with an average of 31 "names of actions". But for the aphasia patients, a considerably different finding was obtained. The dynamic aphasia patients were able to list an average of 10.3 "names of objects" and only an average of 2.7 "names of actions". Luria and Tsvetkova conclude "we can see that in these patients finding of names of actions (verbs) is about 4 times as difficult as finding names of objects (substantives)". One possible explanation for these findings is that nouns and verbs are stored in separate places (or "subgroups") in the brain, and that, for patients with dynamic aphasia the storage center for verbs has been affected.

Whitaker (1971) describes a more complex phenomenon, but one which illustrates, indirectly, this same separation of syntactic classes in the lexicon. Whitaker tested aphasia patients by giving them a word and asking them to use it in a sentence. The words were presented orally. Whitaker noted that,when the stimuli words were ambiguous between nouns or verbs (eg. /siy/=see or sea), patients invariably interpreted the word as a noun. The following examples were given:

HW /siy/
KT sea is in the ocean, it's usually a boat

HW /riyd/
KT well they have in the, what we would call the 'boonies', it's a weeds, how is it? a week is a, you just, something like grass or reed.

(Whitaker 1971:182-3).

In the second case, the patient interpreted /riyd/ as *reed*, rather than as *read*, even though the noun *reed* is significantly rare in its frequency of occurrence, particularly when compared with the verb *read*, which is very common. One interpretation of the patient's behavior is that the "verb" section of the lexicon has been disrupted or destroyed, whereas the noun section is considerably more intact. Thus, the patient is in control of even very rare nouns despite the fact that he cannot use even the simplest of verbs without difficulty. The evidence is in agreement with Luria and Tsverkova's: there are separate, syntactically defined lexical classes of words, and these classes are not necessarily uniformly affected in aphasia.

Luria and Tsvetkova's experiment illustrates that different syntactic classes of words are affected differently in aphasia, but it does not illustrate exactly how such classes may be affected. Commonly, it is the semantic features of words that are lost or disturbed. This suggests that words are divided into syntactic classes, which are then sub-divided or sub-specified by semantic features.

Whitaker (1970) provides the illustrative example of a patient who had lost the semantic representations of locative prepositions. This disturbance became apparent when Whitaker provided a stimulus word and asked the patient to use the word in a sentence. The following were among the results obtained:

Stimulus word	Patient's response
a. under	there is under a horse a new side saddle
b. next to	next to me is a new return
c. behind	it is behind the end
d. out of	out of the end is the middle

(Whitaker 1970:49).

In the responses given, the syntactic constraints on the prepositions used are acceptable, but the patient apparently did not know their meaning. Whitaker was able to verify this by asking the patient to indicate whether an object (a cigarette lighter) was behind, in front of, under, on top of (and so on) other objects such as an ashtray or a table. The patient was completely unable to do this. Whitaker concluded: "he had lost the semantic features of the locative prepositions; he *used* locative prepositions in his response, but almost invariably he used the incorrect one." Thus, within a syntactic class of words, specific semantic features may be disturbed. Often, it is not all the semantic features that are lost; nor all the members of a syntactic class of words that are affected. In many instances, aphasia affects only a sub-set of the members of a syntactic class. This sub-set is normally one that can be defined by means of semantic features. This phenomenon suggests that words may be sub-grouped according to semantic features, and that these narrowly defined sub-groups may be disturbed in aphasia while leaving the rest of the words in the lexicon unaffected. There are examples of aphasic patients who have lost the use of color words, despite the fact that they were able to use other adjectives normally. Thus, it is not necessarily the whole syntactic class of adjectives that is affected, but merely a small, semantically defined sub-class. This phenomenon is apparent not only in the adjective class, but in all classes of words. Thus, there are cases of aphasia involving loss of object names, but without letter or number names being impaired. Object names, number names and letter names all belong to the syntactic class "nouns". The fact that these various subclasses of the class of "nouns" are disrupted independently in aphasia suggests that these sub-classes must be stored separately in the brain. Further examples are abundant. Goodglass, et al. (1966) describes a patient with aphasia resulting in impairment of auditory comprehension for the names of parts of the body, but not for the names of objects. Another patient is described whose aphasia affected all categories of lexical items except numbers. The fact that different types of aphasia have resulted in the loss of these different classes of words lead Goodglass et al. to draw the following conclusion:

> In view of the predominantly anterior location of lesions for Broca's aphasia and posterior site of the lesions in fluent aphasia, it seems natural to consider an anatomical basis for our findings. It is possible to postulate that the word-finding system is subdivided anatomically according to the psychological character of different word categories. Thus, we might assign letter naming to anatomic structures which are more likely to be injured or isolated in Broca's than in fluent aphasia (Goodglass, Klein, Carey and Jones:1966: 87).

Thus, Goodglass et al. suggest that words are stored in different groupings which are located in different sections of the brain. These different groupings may be independently affected by aphasia. The groups involved are groupings defined by syntactic features (such as 'nouns', 'verbs', 'adjectives' and so on) and sub-groups defined by semantic features (such as color words, object names, letter names, number names, and body part names). But there is evidence that not only are semantic, syntactic, (and phonological) features classifications by which words are grouped or sub-grouped in the lexicon, but that other features are involved. It has been suggested earlier in this work (notably with regard to the work of Brown and McNeill) that words that might be labelled 'learned' (i.e. words that are acquired through other than the normal childhood mechanisms of hearing and repeating) may be stored separately or differently in the lexicon. Indeed, aphasia evidence suggests that 'learned' words do constitute a sub-class of words in the lexicon. Schnitzer (1972) describes a patient whose aphasia was virtually undetected in everyday speech, but became apparent when she attempted to use complicated 'learned' words of Latin origin. In words of this sub-type aphasia was most apparent: words were pronounced with misplaced stress, incorrect vowels and deleted syllables. Thus, as Kehoe and Whitaker (1971) have concluded with regard to this patient, the:

> residual language problem was a difficulty in using--reading, spelling, writing or speaking--words of more than two syllables in length of a certain complexity which might be designated *literary* words (Kehoe and Whitaker, 1971:8).

The fact that these learned words, words that were acquired and stored in memory later in life were uniquely disturbed suggests that such words are not ever fully integrated into the lexicon, but rather remain as a separate lexical sub-class. Schnitzer has provided a list of words thus affected which includes: abdomen, admirable, admiralty, Aegean, albino, algebraic, allege, allegory, alphabetize, Alsatian, amalgam, ambiguity, amelioration, analogize, and analogous. It can be seen from the above examples that words belonging to all parts of speech are affected. It is not apparent whether these learned words constitute a subclass of the syntactic groupings or whether they are totally segregated from other 'vulgar' words of their part of speech.

Thus aphasia affects syntactically or semantically definable classes of words rather than random selections of lexical entries. This data does not, however, rule out the possibility that what is affected by aphasia is certain cognitive non-linguistic aspects rather than lexical classes themselves. Thus, aphasic errors indicating the cohesiveness of word classes are especially valuable data. For example, comprehension errors often involve substitutions of words within the same 'semantic field'. Weigl and Bierwish (1970) cite the case of a patient who read "trousers" for "blouse", "tie" for "cuff", "bodice" for "cardigan", "sandals" for "socks", "peaches" for "oranges", "bananas" for "figs", and "potatoes" for "vegetables". Marshall and Newcombe (1966) describe a case history in which the following errors were made: "liberty" was read as "freedom", "canary" was read as "parrot", and "abroad" was read as "overseas". These aphasic errors resemble normal 'slips of the tongue' in that the word substitutions always involve the same 'part of speech' for the stimulus and target words; and the stimulus and target words share a number of semantic features. Thus, aphasic errors often represent not a 'jumbling' of the whole lexicon, but only a jumbling of a small sub-group of the lexicon.

Dichotic listening data is a different type of 'brain' data--but it, too, indicates that words may be grouped into classes in the speakers' brain.

Dichotic listening involves the simultaneous introduction into different ears of two different words having the same duration and intensity. Measurements of the number of words correctly identified by the respective ears indicates which hemisphere of the brain is predominantly processing the words. Work currently in progress at the UCLA phonetics lab indicates that "automatic language" (swear words, and expressions such as 'please', 'thanks' and 'how are you' as well as things learned in lists such as the alphabet, days of the week and numbers), is processed differently from ordinary 'propositional' language.

6.1.2 Hierarchical Features

Thus, an examination of the aphasia data reveals that 'natural classes' of words defined by syntactic or semantic features are affected in aphasia. The question arises whether these classes of disturbed words are random across patients, or whether there is some kind of consistency. For example, are there certain classes that are seldom disrupted in aphasia as opposed to other classes that are more frequently disturbed? If such 'strong' and 'weak' classes of words exist, this would support a hierarchical theory such as that of MacKay in which some semantic features are viewed as being hierarchically stronger than others.

In the domain of phonological features, such a theory was expounded by Roman Jakobson (1968). Jakobson noted that the sounds that are most likely to be lost or disturbed in aphasia are just those sounds that are acquired last by children learning language and are rare in frequency in the languages of the world. Conversely, the sounds that are immune to aphasic disturbance are the sounds that are acquired first by children learning language and appear frequently in the languages of the world. Jakobson proposed a hierarchy of phonological features in which the first group of sounds is placed on the bottom, and the second group is placed on the top.

If there is to be a similar hierarchical arrangement of semantic and syntactic features, then one of the pieces of evidence for this would be the consistently strong or weak behavior of words having these features. The condition of aphasia is one condition under which such strength or weakness might be made apparent.

There is some evidence of a strength hierarchy for syntactic features. The finding that nouns are much easier for patients to list or to decode than are verbs has already been discussed. It appears that the syntactic feature [Noun] is a stronger feature than the syntactic feature [Verb]. Whitaker's (1970) findings suggest that [Conjunction] may also be a strong syntactic feature.

Cases of impairment of conjunctions are sufficiently rare that Whitaker has been motivated to comment, "I have not encountered a loss or even serious impairment of conjunction short of nearly total language loss." Another syntactic class of words that are apparently quite strong are determiners. Whitaker (1970) comments, "if determiners are used at all, they seem to be used correctly; that is definite, indefinite and generic NP's are correctly produced if there is a determiner system in the first place." Thus it seems there are syntactic classes of words that are more likely to be affected or disturbed by aphasia, just as there are classes of words defined by syntactic features that are more immune to the effects of aphasia. This finding suggests that there is a hierarchy of syntactic features. Is the same thing true of semantic features?

The aphasia evidence suggests that the syntactic features of words are stronger features than the semantic features. There are many examples of aphasic speech in which the semantic features of words have been lost, but the syntactic features remain. Whitaker (1971) describes a patient who always used a personal pronoun where it was required, but generally did not use the correct one. Whitaker concluded:

> that the distinguishing semantic features for the personal pronouns--person, number, gender--and the case features as well, could be disrupted even though the formative feature identifying these as personal pronouns was not lost (Whitaker, 1971:102).

Goodglass (1968) describes a similar case in which the patient:

> always used *me* in subject position. After innumerable reminders by his therapist to say *I*, he burst out with 'I...I...,everybody tell me 'I',...but me forget! (Goodglass, 1968:198).

The findings in the aphasia data are the same as the findings of normal 'speech error' data: while words are often confused, the various 'parts of speech' are seldom, if ever , confused. Thus, the syntactic features of words seem particularly strong, while the semantic features of words are somewhat less strong.

Of the semantic features themselves, are there some that are stronger (or weaker) than others? In order to determine if such features exist, an examination of the types of words *within one word class* that are more (or less) prone to disturbance in aphasia is necessary.

A number of studies have attempted to capture the essence of those words that appear immune to disturbance in aphasic speech. Wepman, Bock, Jones and Van Pelt (1956) characterized anomia as a loss of all but the most general words of the language. This conclusion was drawn from an examination of some 20,000 words of aphasic speech in which it was found that all but the most general nouns ('thing', 'person'), verbs ('is', 'has', 'do', 'like') and modifiers ('good', 'nice', 'wonderful') had been eliminated.

Yet, it seems such generalizations do not hold up across different types of aphasia. Goodglass, Hyde, and Blumstein (1969) compared the speech of Wernicke and amnesic aphasics to that of Broca's aphasics. For the first group, speech was characterized by an over-representation of general ("non-picturable") words. But, for the Broca's aphasics, speech was characterized by a high degree of picturability and specificity. Thus, it appears that no general statement can be made about the stronger or weaker semantic features: it appears to be the case that different features are affected differently in different types of aphasia. Thus far, there do not seem to be any semantic classes of words that manifest consistently "weak" or "strong" tendencies.

This conclusion is supported by experiments conducted by Goodglass, Klein, Carey, and Jones. One hundred and thirty-five aphasia patients were tested for word discrimination along two parameters: word evocation and auditory comprehension. Six different categories of words were tested, and their results compared. The categories tested were: object names ("chair", "comb", "key", "glove", "hammock", and "cactus"), geometric forms ("circle", "square", "triangle", "spiral", "cone", "star"), letter names ("L", "H", "R", "T", "S", "G"), names of actions ("smoking", "drinking", "sleeping", "running", "falling", "dripping"), numbers ("7", "42", "15", "700", "1963", "7000") and colors ("blue", "red", "gray", "brown", "pink", "purple"). The results of the experiment were not consistent with the notion of a hierarchy of semantic features based upon "strength" as characterized by immunity to aphasic disturbance. The different classes of words behaved differently for the naming versus the comprehension tasks. Thus, the class of words for which naming was easiest was not the class for which comprehension was easiest. This suggests that a feature hierarchy is not in effect (although it does not rule out the possibility of several hierarchies--one for each language modality--being in effect). The experimental results were as follows:

> object names are the easiest category for comprehension and the most difficult for naming. Precisely the reverse was true for Letter-Naming. The relation of Letter-Naming to Number Naming was the reverse of the relation of Letter Comprehension to Number Comprehension (Goodglass, Klein, Carey, and Jones, 1966:85).

It is apparent that these results cannot be explained by differences in the different types of words (or semantic features) involved, since, as Goodglass et al. note, "If vocabulary difficulty were a major factor, we would find the same order of difficulty for the semantic categories in both the expressive and receptive performance modalities, because the same words are used in both."

6.1.3 Summary and Conclusions

An examination of aphasia data leads to the following conclusions about the structure of the lexicon:

1. The lexicon consists of sub-classes of words that are affected independently in aphasia.

2. These lexical sub-groupings may be defined syntactically (eg. nouns, verbs, prepositions), or semantically (eg. color words, numbers, letter names, body part names, clothing names).

3. There is also evidence that words learned later in life (eg. Latinates or 'learned words') are stored in a separate lexical sub-grouping and are not fully integrated into the lexicon.

4. The syntactic features appear to be stronger (or higher on a feature hierarchy) than are the semantic features. It further appears that words are grouped first according to syntactic features, and that these syntactic feature groups are sub-grouped for semantic features.

5. The syntactic features by which lexical entries are represented may be hierarchical. (Nouns, conjunctions and determiners appear to belong high up on the hierarchy.)

6. There is no evidence that the semantic features are hierarchically structured.

7. A final finding about aphasic language was noted by Schuell and Jenkins (1961). This is the fact that patients who misname objects frequently use the same words that normals use in word association tests. This leads into an examination of word association data, which occurs below.

6.2 Word Association Tests

A large number of studies have been conducted using word association tests. The data gathered from these tests typically involves the effects of different types of stimuli upon either the amount of time required for the response or the number of responses given.

In studies of reaction times to various stimuli, for example, it was found by Glanzer (1962) that nouns elicited a faster response than adjectives or conjunctions. Epstein and Fenz (1962) discovered that 'neutral' words elicited a faster response than 'emotional' words. Pollio and Lore (1965) found that reaction time was faster for 'pleasant' words than for 'unpleasant' ones, and in Eriksen's (1952) study, reaction time was faster for familiar words than for unfamiliar ones.

The studies analyzing the number of responses to particular types of words were less conclusive. Cramer (1965) found no correlation between the familiarity of words and the number of responses that they elicited. Matthews (1965) noted that there was no correlation between word frequency and the number of responses elicited. Palermo (1963), however, found that nouns generally elicited fewer responses than other classes of words, a surprising finding given Glanzer's study.

The information gathered from these studies is normally used for "psychological" investigations. In particular, the results found for reaction times and number of responses given by "normals" under certain conditions are often compared with the results of patients known or suspected to be mentally disturbed. Thus, the idea that word association test will reveal something about the workings of the mind is not a new one.

However, the idea that word association tests might reveal something about the representation of linguistic structure in the mind is relatively unexplored. In this chapter, the assumption is made that such tests may reveal something about the structure of language, and, in particular, the mental storage of words.

It has been found that there are three "levels" of word association (Clark, 1970). When subjects are given a long time to respond, they tend to give unusual, idiosyncratic and personally-revealing associations that may require lengthly narratives to explain the associative connection. When, on the other hand, subjects are asked to respond extremely rapidly, they tend to give "clang responses" which sound like (often rhyming with) the stimulus word. However, when subjects are given some intermediate amount of time to respond, their responses tend to be more semantically based, non-idosyncratic, and generally immediately understandable. Among the responses in this final group, there is a general consensus across subjects, indicating the validity of these responses as clues to linguistic competence.

Various authors have compiled norms for word association, and these norms indicate surprising agreement among subjects producing "the first word that comes to mind" after hearing various words. Kiss (1967) comments that this agreement seems to "indicate that the word association experiment is a valid approach to a study of general language behaviour, at least in these overall statistical aspects." (157).

In order to understand why this concensus of results on word association tests is indicative of the structure of the lexicon, one must first understand the mechanisms by which word association occurs.

Various explanations for the word association process have been put forth, the earliest being that words became associated due to their contiguity of occurrence in utterances. Thus, since speakers might tend to say and hear the expression "the Watergate scandal", the word "Watergate" might be expected to elicit as a typical response the word "scandal". Unfortunately for this theory, very few of the actual responses found in word association tests are of the "Watergate--scandal" type. Word associations are typically *Paradigmatic;* that is, the stimulus and the response are members of the same syntactic class of words. And since, in the speech stream, one rarely finds sequences of the form "noun + noun" or "verb + verb", it is unlikely that paradigmatic associations result from being heard in contiguity over and over again.

A theory of word association that accounts for the occurrence of paradigmatic associations has been proposed by Ervin (1961). Ervin suggests that when people hear sentences, they "anticipate" the words that they will hear at the end of the sentence. In the case of many synonyms, it frequently occurs that one word is anticipated when, in fact, the other words occurs. Ervin claims that when this occurs, the words become associated.

While Ervin's model does account for the occurrence of paradigmatic associations, it is still essentially no different from the earlier theories in that it views associations as being the result of stimulus-response associations that build up when words are experienced in temporal contiguity. More recent theories of word association have criticized this approach on the grounds that association theory cannot explain the production of sentences. Clark (1970) summarizes:

> language,...should not be thought of as a consequence of built-up associations; rather, word associations should be thought of as a consequence of linguistic competence (Clark, 1970:272).

Clark proposes a model of word association which is based upon "associating rules" that involve linguistic competence. Clark notes that word association has three stages:

> (1) the player must 'understand' the stimulus; (2) he must 'operate' on the meaning of the stimulus; and (3) he must produce a response. It is the unique second stage that clearly sets this game apart from normal language mechanisms. It contains an 'associating mechanism', which, through its 'associating rules', fixes the response at the third stage (Clark, 1970:273).

Clark's "associating rules" are not unlike phonological rules in their form: generally, what they do is either add, delete, or change some feature of a word to produce another word. The features that are changed by Clark's "associating rules" are semantic features, since it is the semantic associations that he is concerned with explaining. Following this approach, however, it would be possible to use phonological feature or segment changes to describe the rapid "clang" responses that sometimes occur.

To illustrate the "rule" hypothesis, Clark cites the association "man"--"woman" as being the result of the application of a rule that changed the value of the feature [Female]. The association "fruit" from the stimulus "apple" is viewed as the result of the application of a rule which deletes semantic features. And the association "apple" from the stimulus "fruit" is viewed as the result of the application of a rule which adds semantic features. From examples of this sort, Clark concludes,

> any successful explanation of word associations must be formulated in terms of syntactic and semantic features. In such a theory, the explanation will consist of rules that operate on features of a stimulus to produce features of an utterable response (Clark, 1970:285-286).

From this type of an approach to the phenomenon of word association, an understanding of the semantic features of words may be reached. Yet, a deeper investigation into the data of word association may provide further information about the structure of the lexicon. Data as to exactly which features are changed, added, or deleted is needed, along with data as to exactly which features tend not to be changed in word association. This information could, conceivably, provide information about the semantic sub-grouping system existing in the lexicon.

It is felt that this could be done if the assumption were made that word association consists of a speaker's hearing a word, "looking up" that word in his internal lexicon, and responding with a word whose lexical storage is in some sense similar to this stimulus word. This could mean that the stimulus word and the response word are stored *near* each other in the lexicon, or that they have a partially *shared* representation or both. Thus, an examination of the types of responses, and of the actual responses found on word association tests may provide evidence about the format in which words are stored in the mental lexicon.

In this way, if words are lexically grouped according to semantic features, it will be possible to determine which features are involved in the lexical groupings.

The data to be considered here is Kent and Rosanoff's (1910) collection of word association norms. This study involves the multiple responses of 500 subjects to a number of words. Thus, for each word that is used as a stimulus, the most frequent responses from all of the subjects (approximately 1000 responses per word) have been collected. The Kent and Rosanoff data will be analyzed here to determine the semantic features most resistant to change in word association.

The most apparent feature of the Kent and Rosanoff data is that the word association responses tend to be paradigmatic (i.e., of the same grammatical class as the stimulus word) rather than syntagmatic (i.e., involving a change of grammatical class from the stimulus to the response). For each word, approximately 1000 responses were collected. Of these, an average of 80% were of the sa 'part of speech' as the stimulus word. More significantly, for each stimulus word, there was a single most frequently occurring response word; and in 96% of the cases, this word belonged to the same part of speech as the stimulus word. Given the number of different 'parts of speech' from which responses are possible, this is a highly significant finding. The fact that word association responses are (nearly always) of the same 'part of speech' as the stimulus word suggests that the syntactic features of words are significant features by which words are grouped. Thus, the fact that nouns tend to elicit noun responses suggests that there is a major lexical division or grouping that may be labelled "nouns". If a speaker is given a word from that class, it is easiest for him to respond from the class. This finding supports the earlier findings derived from the normal speech error data and the aphasia data. It will be remembered that, both in the word substitutions of normals making a "slip of the tongue" and of aphasia patients, the substituted word tended to be of the same grammatical class as the intended word. Thus, the grammatical class features (or "syntactic features") of words represent major divisions in the lexicon. The strength of this feature is indicated by the fact that this is the one feature that is most apt to remain the same throughout stimulus and response pairs. No other features of words are so consistently (96%) the same.

However, just as with the aphasic substitutions which often remained in the same "semantic field", we find that the word association responses involve features other than the syntactic features which tend to remain unchanged. The semantic feature which is least apt to be changed in word association is the feature [Human]. Five examples of stimuli words which include the feature [+Human] in the Kent and Rosanoff data are: "citizen", "man", "boy", "woman", and "girl". For each of these human stimulus words, the most frequently given response was another [+Human] word.

The five [+Human] stimulus words, along with their most frequent responses are listed in Table 11. It will be noted that the most frequent responses were given, in every case, by over half of the 500 subjects. These figures are revealing, but not so revealing as when all of the paradigmatic responses (not merely the single most frequent responses) for the stimuli words are considered. Table 11 also indicates the total number of [+Human] responses that occurred among all the responses given. [+Human] responses occurred an average of 92% of the time. This figure is almost as high as the figures for responses being in the same grammatical class as stimuli which, as can be recalled, was 96%. This indicates that the semantic feature "human" is a particularly strong feature by which words are grouped--only slightly less strong than the syntactic feature denoting the 'part of speech' of the word. The fact that word association responses are rarely made outside of the grammatical class of the stimulus word suggests that the words of the lexicon are grouped, by syntactic features, into lexical sub-groups that are sufficiently cohesive that it is difficult for speakers to make natural associations outside of them. The fact that word association responses are (almost equally) rarely made outside of the semantic subclass of "human" nouns suggests that words are grouped in the lexicon according to this semantic feature and that this sub-grouping is (almost equally) as significant as the syntactic class grouping. If there is then a hierarchy of semantic features in which some are more significant, or, more likely, in which some represent larger or more "psychologically important" sub-groups, then [Human] is one of the features that would be at the top of such a hierarchy. None of the other word association responses for any of the other types of stimulus words fell so consistently within one semantic category. Nonetheless, there were a few other semantic categories in which a fairly large number of responses were contained and did, thus, appear to be significant features by which words in the lexicon are sub-grouped.

One such feature might be labelled "anatomical parts". It will be remembered that the aphasia data indicated that names of the parts of the body might be a semantic sub-class of words in the lexicon since there were cases of aphasia patients who had selective difficulty with this type of word. The word association data supports this hypothesis. Word association responses to stimulus words which were 'parts of the body' were sufficiently often parts of the body themselves that it appears that this is a lexical sub-class. For the stimulus word "hand", for example, 87% of the paradigmatic responses were parts of the body, including the most frequently occurring response which was "foot", given

TABLE 11

TABULATION OF KENT AND ROSANOFF DATA FOR

[HUMAN] STIMULI

STIMULUS	MOST FREQUENT RESPONSE	NUMBER OF SUBJECTS GIVING MOST FREQUENT RESPONSE	% OF TOTAL (1000) RESPONSES THAT ARE [+HUMAN]
Man	Woman	394/500	89%
Woman	Man	292/500	90%
Citizen	Man	278/500	91%
Boy	Girl	319/500	95%
Girl	Boy	359/500	96%

by 204 of the 500 subjects. For the stimulus word "stomach", 67% of the paradigmatic responses were words denoting parts of the body. For the stimulus word "foot", 67% of the paradigmatic responses were words denoting parts of the body. The most frequently occurring response to "foot" was "hand" which was given by 186 of the 500 subjects.

Another semantic class within which word association responses were consistently kept was the class of "edibles". Evidence of smaller, less significant and less cohesive semantic sub-classes within this class was apparent. The stimulus word "fruit", for example, has 86% of its paradigmatic responses as foodstuffs or "edibles". Of this 86%, 64% represented fruits. The stimulus word "cabbage", on the other hand has a total of 76% edible responses, of which 62% are vegetables. It appears that [+Edible] is a semantic class in which words of the lexicon are grouped, and that "vegetables" and "fruits" may be smaller sub-groups of this group.

As the aphasia data indicated, color words appear to constitute a separate lexical group. The word associations involving color words tended to keep within the class of "color words", although the total number of responses for color words involved fewer paradigmatic responses than was typical of other types of words. Out of approximately 1000 total responses given, for the stimulus "yellow", 609 were color words; for the stimulus "blue" 515 were color words.

The validity of a lexical grouping of "human" nouns is verified by the fact that non-human animate nouns tend to elicit non-human animate responses with as great a frequency as the human nouns elicited human noun responses. The animate non-human responses seemed to be divided however into three sub-classes: roughly, "insects", "birds", and "animals". 72% of the noun responses to "butterfly" were insect words and 63% of the noun responses to "spider" were insect words. 83% of the noun responses to "eagle" were bird words and 67% of the noun responses to "sheep" were animal names.

Thus, the fact that word associations are generally confined within certain classes of words defined by syntactic and semantic features suggests that the lexicon is grouped according to these features. The fact that the consistency of responses to remain within a certain group varies according to different groups suggests that these groups may vary in strength in a hierarchical manner.

6.3 Experimental Evidence

Additional evidence for the existence of semantic sub-sets in the lexicon is provided by the data collected in experiment 2. It will be recalled that in one section of the experiment, participants were asked to list words of a specified part of speech. In this section the responses given often tended to be lists which could be grouped according to semantic sub-classes. Examples are provided in Table 12.

Participant S.R., for example, responded to "yellow" first with a list of color words, then with a list of manner adjectives. Participant S.H. responded to "man" with first animate nouns, then nouns denoting pieces of furniture or equipment, then nouns denoting parts of the body, and finally nouns denoting clothing. Participant C.N. responded to "man" first with animate nouns, then with furniture nouns, and finally with equipment nouns.

The mechanism by which participants switched semantic classes of words in their responses is not completely understood. Sometimes, a semantic association to the preceeding set seems to be responsible; other times a phonological association may be responsible. For example, participant S.H.'s switch from parts of the body to clothing seems to have been motivated by an association of 'wrist' to 'cuff'. Conversely, participant D.K.'s switch from 'location' verbs to 'conversation' verbs may have been the result of a phonological association (due to the rhyming structure) of 'set' and 'regret'.

6.4 Summary and Conclusions

It is clear that the semantic features of words must be represented in the lexicon, and that this representation is in some way structured. In particular:

1. The fact that aphasia independently affects different parts of speech, that word associations tend to be paradigmatic (of the same part of speech), and that speakers can--without hesitation--list words belonging to a certain part of speech suggests that words are grouped in the lexicon according to *syntactic feature classes*.

2. The fact that aphasia affects semantically defined classes of words separately, that word association responses tend to be within certain semantically defined sub-sets, and that continuous associations tend to be in groups of semantic classes of words indicates that there is probably a lexical subgrouping according to *semantic features*. Some of these semantic sub-classes are: Human words Nonhuman-Animate words, Edible things Parts of the Body, Col[illegible]s, Fruits, Vegetables, Insect, Bird, and Animal names.

TABLE 12

"SOME RESPONSES FROM EXPERIMENT 2"

PARTICIPANT	STIMULUS	RESPONSES
S. R.	"yellow"	red, blue, green, sad, poor, docile, active, pathetic, energetic, lazy
S. H.	"man"	dog, woman, girl, sister, chair, desk, paper, pen, pencil, leg, arm, hand, toe, finger, wrist, cuff, shirt, skirt
C. N.	"man"	woman, boy, girl, chair, table, book, shelf, pen, nib, eraser, ruler
B. L.	"toy"	child, tot, tyke, youngster, male, game, ball, wall, furniture, book, paper
R. G.	"toy"	children, pets, dog, cat, car, bike, horse, person, child, boy, girl, woman, man
	"yellow"	orange, red, pink, white, purple, pretty, ugly, attractive, appealing, nice, good helpful
H. R.	"man"	woman, person, thing, boy, girl, place, hill, mountain, car, door, wheels, fender, child, house, grass, window, pen, jacket, blouse, eye, finger, nail
D. K.	"sit"	stand, tell, sell, lay, place, put, store, set, regret, confess, hear, relate, small, perform, require, insist, collect

3. Some of the lexical groupings are more widespread or 'stronger' than others. The syntactic groupings appear to be stronger than the semantic groupings. Of the semantic groupings there appear to be some features that are stronger than others. The class of "human" nouns is one example of a major semantic sub-class.

Chapter 7

Conclusions

7.1 Further Areas of Investigation

Different types of evidence shed light on the structure of the speaker's "mental dictionary". The models proposed thus far (discussed in Chapter 2) have been based on such data as speech errors (including substitutions, spoonerisms, and blends), "tip of the tongue" states, and language games. Experimental evidence, as well as evidence from word association tests and aphasia is discussed in the present work. Still, these collections of lexical data constitute only a beginning. If a truly comprehensive understanding of the structure of the mental lexicon is to be obtained, a great deal of further data must be considered. The areas examined thus far can bear further examination. In addition, a number of other fields and data (unexplored, at least with regard to the problem of lexical structure) are relevant. Below, a few of these other areas of research are mentioned:

One type of data that might provide invaluable information about the structure of the lexicon is language change data. Facts about the manner in which words change through time will provide insights about the various lexical features by which words are represented, as well as about the relative "strength" of these features. An investigation of how the meanings of words change through time will provide insight about the semantic features by which words are represented in the lexicon. If there is a hierarchy of semantic features, it is expected that those features that are high up on the hierarchy will remain stable through time. Information as to the phonological representation of words in the lexicon should also be provided by language change data. Since we know that words are catalogued according to their first consonants, we might expect the first consonants of words to remain more stable during language change than other parts of the word.

Another whole field of data that has not been considered here, but that should provide vital information about the structure of the lexicon is "clustering" data. "Clustering" refers to the phenomenon of structured recall of words. For example, it has been found (see Blousfield, Cohen, and Whitmarsh, 1958) that when a list of words is presented in randomized order, and subjects are asked to recall the list, there is a tendency to recall the words in semantic sets. Names of fruit on the list will be grouped together, as will names of professions, for example. Detailed study into semantic clustering should therefore provide insight into the semantic features by which words are represented and grouped in the lexicon.

A related field of data might be called "phonological clustering". We know that words seem to be divided into sub-groups that are defined by phonological structures as well as by semantic structures. We should therefore expect that recall of words could involve 'phonological clustering' as well as 'semantic clustering'. To test this, a list of words which do not share any semantic features might be presented to subjects to see if recall is structured in terms of such features as initial consonants, etc. Or, a more rigid type of experiment might be conducted in which a list of semantically unrelated words is presented and subjects are asked to recall, for example, words beginning with a certain consonant, words ending with a certain sound, or words having certain other phonological features. It is predicted that subjects would be more adept at clustering words according to the features by which words are stored in the lexicon. Thus, such a clustering experiment could confirm the results obtained in Experiment 2 (Chapter 4) of this work.

Experiments of the type of Experiments 2 and 3 (Chapters 4 and 5) could be conducted to provide still more lexical information. Information that might be asked for could include words having a particular "rhythm", words having a particular final stressed syllable, and words that rhyme with various multisyllabic words. Semantic information might also be asked for: with participants being asked to list as many words as they could think of having a particular semantic feature.

Another means of obtaining relevant data is the dichotic listening experiment. It has already been mentioned that dichotic listening experiments have revealed that "automatic" and "propositional" language are processed (and hence possibly stored) differently. The behavior of other classes of words in dichotic listening experiments could reveal other lexical classes or sub-divisions of words.

Another area of investigation is the field of child language acquisition. The manner and order in which children acquire new words could reveal a great deal about the semantic features by which words are represented.

7.2 Data to be Accounted For

From experimental data, as well as from other types of data (speech rrors, aphasia and word association data) there are a number of facts that must be accounted for in any performance model of the lexicon. These include:

1. The 'generic recall' of "tip of the tongue" phenomenon (discovered by Brown and McNeill) that certain features of words are more apt to be remembered than others during generic recall. According to Brown and McNeill, the features involved are: the number of syllables in a word, the first letter of a word, the stress pattern of a word, the last (three) letters of a word, and the affixes present in a word.

2. The speech error phenomena (noted by Fromkin) that switches always involve words that belong to the same part of speech; and that blends and substitutions always involve words which have similar semantic features.

3. The speech error phenomenon (noted by MacKay) that breaks in words are most apt to occur between an initial consonant and its following vowels; and least apt to occur between the two consonants comprising a consonant cluster.

4. The fact (illustrated by the findings of Experiment 1, Chapter 3) that speakers are more adept at thinking of words when the first part of the word is specified, (rather than when the second part of the word is specified and the first part unspecified).

5. The fact (revealed in Experiment 2, Chapter 4) that speakers are able to retrieve words according to their initial consonant and part of speech; and that speakers are not able to retrieve words according to their number of syllables, final consonants, or final syllables.

6. The fact (revealed in Experiment 3, Chapter 5) that speakers are adept at retrieving words according to their initial consonant clusters and according to their vowel plus last consonants; but not according to their first consonant plus vowels.

7. The fact (revealed in Chapter 6) that aphasia can selectively impair particular 'parts of speech' or semantic classes of words, and that word association typically involves associations made within syntactically defined or semantically defined classes of words.

7.3 A Model of the Lexicon

As has been discussed above (in Chapter 2), there are at least two aspects of the lexicon that must be considered in a performance model of the lexicon. The first is the form of the representation of an individual word in the lexicon; and the second is the form of the storage network of words comprising the total lexicon. Although it is possible that the information represented by these two approaches may in some way be overlapping, an understanding of both of these aspects of the lexicon is necessary for any complete model of the lexicon.

Below, a description of the lexicon from both of these points of view is given. Although the model presented is very tentative and awaits further elaboration and data, an attempt has been made to account for all of the data given to date in this model.

The lexical representation of any given word must include a specification of the phonological, syntactic, and semantic characteristics of the word. Because speakers are able to perform linguistic acts that involve the independent use of these features (i.e., to list words that rhyme--using only the phonological information about words; or to list words having a certain meaning--using only the semantic information about words; or to list words belonging to a particular 'part of speech',--using only syntactic information), it seems likely that these three types of lexical information may be structured separately in the mind in what may be considered to be separate "components" of the word. Figure 7 (below) provides an illustration of how the lexical item "cat" might be thus represented.

The phonological component of the word consists basically of a 'spelling out' of the word in terms of phonemic units. A second spelling, in terms of orthographic units is also needed, but little is known at the present time about the details of this representation. More information is known about the form of the phonological representation. The results of Experiment 1 (Chapter 3) indicate that the phonological 'spelling' of words in the lexicon must be ordered. This ordering allows for the easy retrieval of words according to their first letter or first part. It will be noted that this linear 'spelling' of the word provides a short-hand representation of all of the features of the word that the speaker must know in order to pronounce the word. The number of syllables in the word, the final consonant of the word,the affixes present in the word, the vowel of the word and so on can all be determined from this representation of the word. But, it will be recalled (both from the work of Brown and McNeill and from the experimental findings in Chapters

4 and 5) that some phonological characteristics of words are more 'prominent' than others. These more prominent characteristics include: the initial consonant of a word, the initial consonant cluster of a word, and the vowel plus final consonant of a word. These more prominent features of words may be explained (as discussed in Chapters 4 and 5) by the form of the lexical storage network. Thus, it is possible that lexical listings according to such categories as 'initial consonant', 'initial cluster' and 'vowel and last consonant' exist. However, it is also possible that this information is represented in the stored form of the word itself. The more prominent features may be offset in the lexical representation by means of a boundary feature such as ! The ! boundary would occur between the initial consonant (or cluster) and could act as a marker for sorting and retrieval of words. The presence of such a boundary accounts for the 'hierarchical' data presented by MacKay: notably the fact that words tend to divide at this point for speech errors, language games, and abbreviations. The assumption of a boundary is particularly explanatory in accounting for the finding in Experiment 3 (Chapter 5) that speakers are virtually unable to retrieve words according to the first consonant plus following vowel. The presence of the ! boundary between these two segments may thus act as a deterrent to the speaker's ability to treat these two segments as a unit for the purpose of lexical processing. It may be the case that in words consisting of more than one syllable, another boundary marker will be needed, but further data is needed to determine if this is so. It is possible that the orthographic representation of words may also have special boundary markers in it: the $ boundary between syllables might be one example. The presence of this boundary in the orthographic representation would account for the findings of Brown and McNeill that features such as middle consonant and number of syllables are prominent in generic recall. It will be remembered that Brown and McNeill's findings dealt with the orthographic representation of words (subjects were asked about "letters" instead of "sounds") and did not agree with the phonologically-oriented findings of Experiment 2 (Chapter 3).

The semantic and syntactic "components" of the representation of a word comprise all of the features of words that speakers must know in order to use them correctly in meaningful sentences. The features which describe the meaning of the word are the semantic features. Each semantic feature defines some 'property' of the word, and, since these 'properties' may vary in their generality, it is likely that some ordering is involved in the representation of these features. For example, the features chosen to represent the word 'cat' are [+Animate, -Human, +Animal, and +Feline]. But, the feature [+Feline] obviously entails the features [+Animal] and [+Animate]; as the feature [-Human] is obviously entailed in the feature [+Animal]. Thus, for purposes of simplicity of the model, in order to reduce redundancy and to provide a specification of words in terms of ever-narrowing features, the semantic features listed are ordered. This ordering of semantic features accounts for the fact (noted in Chapter 6) that there is a difference in the scope of strength of semantic features and that, to various degrees depending upon this 'strength', word associations tend to remain within the same feature specifications. It is also noted in Chapter 6 that this information might otherwise be captured in a lexical model in the form of the lexical network. The grouping of lexical items into classes of various 'sizes' or 'strengths' is another way of accounting for the various strengths of features. It must be remembered here that the scope of semantic features is what is being represented, rather than any absolute 'strength'. It is possible that further data (language acquisition and language change data in particular) may establish that there is indeed an absolute hierarchy of semantic features, some of which are stronger--in a number of ways--than others. However, it must be remembered that the evidence to date (again, see Chapter 6) does not support such a claim.

The syntactic "component" of the representation of words is concerned with those features which permit the grammatical use of words in sentences. The only such feature that we have been able to provide data about is the 'part of speech' or grammatical class feature. The importance of this feature in a performance model has been shown by the fact that speech errors are always within the same syntactic class (see the discussion of Fromkin's model, Chapter 2), that word associations are generally within the same part of speech, that aphasia often sharply distinguishes different parts of speech (see Chapter 6), and that speakers are particularly adept at lexical retrieval according to syntactic class (see Experiment 2, Chapter 4).

Each of the phonological, syntactic or semantic features of words give rise to associations that the word can have. That these associations are definite lexical links is suggested by the fact that these associations turn up not only on word association tests, but also as aphasic and speech error substitutions. The word "cat", for example, may be associated (phonologically) to its initial consonant (giving, for example, "castle"), or (semantically) to any of its semantic features. For some of these associations, particularly the semantic ones, it may one day be predictable as to which word will be the primary associate, which word will be the secondary associate and so on. This predictability is suggested by the consistency found across subjects in word association tasks. Figure 7 illustrates the types of 'linkages' or associations that can occur among lexical items. It must be kept in mind that these 'associations' are the result of structural similarity rather than of contiguity in the speech chain. A consideration of the various ways in which words are structurally similar and structurally associated produces an 'index' to the lexical network.

Figure 8 is a rough conceptualization of how the lexical network of words might be represented. The figure is divided into two parts to represent the two types of lexical accessing that can occur. Phonological accessing is of two types: according to initial consonant and according to vowel plus final consonant. Only a few examples of subclasses of words and of their members are provided in Figure 8. Also, the words are written out in spelling for convenience: it is likely, however, that the representation of words in the brain is not in this simple form, but rather is as indicated in Figure 7. Notice that the representation of each word in the brain must occur more than once. It may, in fact, be the case that the word is stored only once in the brain and that the various categories of storage simply refer to this single entry. But, to date, no evidence is known to determine if this is so.

Thus, Figures 7 and 8 provide a schematic model of the lexicon. It will be recalled that the lexicon may be compared to a library in which words, instead of books, are stored. Figure 7 provides a description, then, of the "books" or words. Figure 8 provides a "map" or catalog of the way in which the words are stored.

FIGURE 7 Representation of the word "Cat"

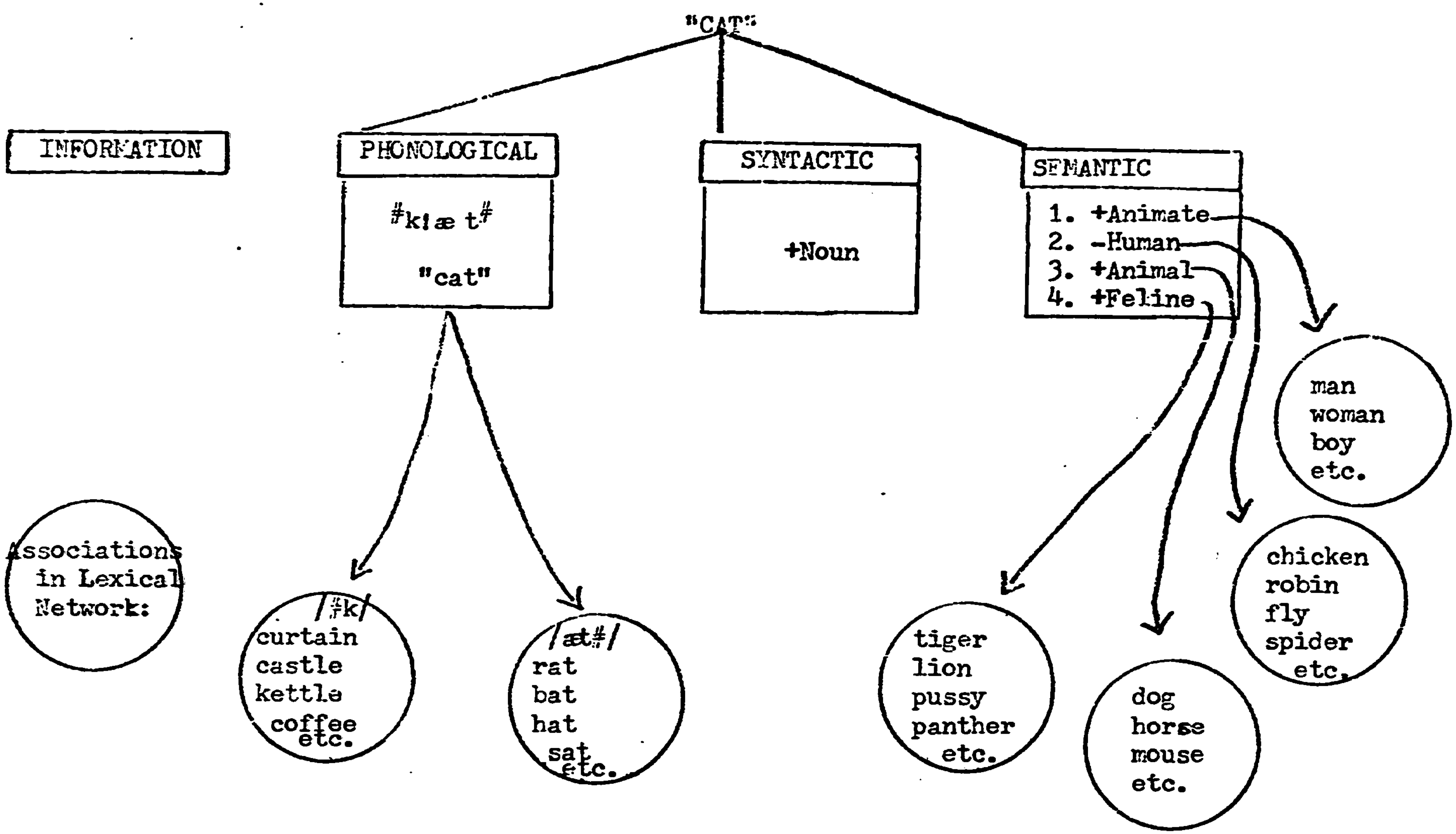
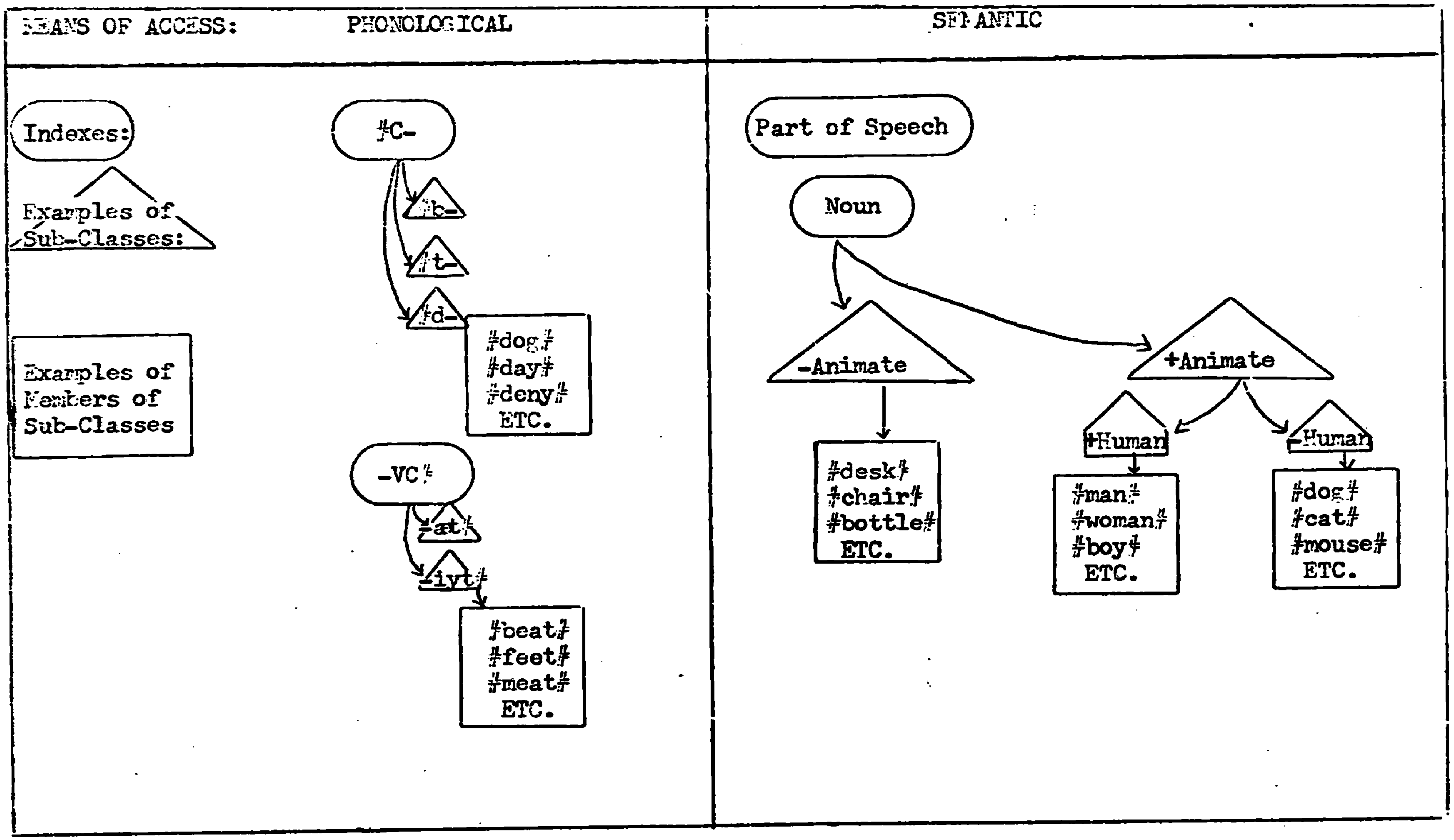


FIGURE 8 The Lexical Network



Bibliography

Binnick, R. (1967) "Semantic and Syntactic Classes of Verbs." Presented at the Chicago Ling. Soc. 3rd Regional Meeting.

Blowsfield, W.A., Cohen, B.H. and Whitmarsh, G.A. (1958) "Associative Clust:ring in the Recall of Words of Different Taxonomic Frequencies of Occurrence." *Psychol. Re.* 4. 39-44.

Brown, R. and D. McNeill. "The Tip of the Tongue Phenomenon." *J. Verb. Lang. and Verb. Behavior.* 5:325-37.

Bruner, J.S. and O'Dowd, D.A. (1958) "A Note on the Informativeness of Words" *Lang. and Speech.* 1:98-101.

Chomsky, N. (1957) *Syntactic Structures.* The Hague, Mouton and Co.

Chomsky, N. (1965) *Aspects of the Theory of Syntax.* M.I.T. Press. Cambridge, Mass.

Chomsky, N. and Halle, M. (1968) *The Sound Pattern of English.* Harper and Row. New York.

Chomsky, N. (1970) "Remarks on Nominalization" in Jacobs R. and Rosenbaum, P. *Readings in English Transformational Grammar.* Ginn and Co. p. 184-221.

Clark, H. (1970) "Word Associations and Linguistic Theory." in *New Horizons in Linguistics.* Lyons (ed) Penguin.

Cramer, P. (1965) "Response Entropy as a Function of the Affective Quality of the Stimulus" *Psychonomic Science.* 3:347-348.

Dingwall, W.O. (1971) *A Survey of Linguistic Science.* University of Maryland.

Epstein, S. and Fenz, W.D. (1962) "Theory and Experiment on the Measurement of Approach - Avoidance Conflict." *J. Abnormal and Social Psyc.* 64:97-112.

Fillmore, C. (1968) Types of Lexical Information, to appear in Steinberg and Jacobovits (eds). *Semantics: An Interdisciplinary Reader in Philosophy, Linguistics Anthropology and Psychology.* Cambridge U. Press.

Fodor, J.A., Garrett, M. and Bever, T.G. (1968) "Some Syntactic Determinants of Sentential Complexity, II: Verb Structure." *Perception and Psychophysics*. 3:453-61.

Fromkin, V.A. (1971) "The Non-Anomalous Nature of Anomalous Utterances." *Language*. 47:1, 27-52.

Fromkin, V.A. (1972a) "On the Reality of Linguistic Constructs: Evidence from Speech Errors." *Working Papers in Phonetics* 22. UCLA. 103-110.

Fromkin, V.A. (1972b) "Discussion Paper on Speech Physiology." *Working Papers in Phonetics* 23. UCLA. 37-60.

Fromkin, V.A. (1972c) "Discussion Paper on Speech Physiology." in J. Gilbert (ed) *Speech and Cortical Functioning*. Academic Press, New York.

Glanzer, M. (1962) "Grammatical Category: A Rote Learning and Word Association Analysis" *J. Verbal Learn. and Verbal Behavior*. 1: 31-41.

Goodglass, H. (1968) "Studies on the Grammar of Aphasics" in S. Rosenberg and J.H. Koplin (eds) *Developments in Applied Psycholinguistic Research*. New York.

Goodglass, H., Klein, B., Carey, P., and Jones, K.J. (1966) "Specific Semantic Word Categories in Aphasia," *Cortex* 2. 74-89.

Goodglass, H., M.R. Hyde, and S. Blumstein. (1969) "Frequency, Picturability and Availability of Nouns in Aphasia." *Cortex* 5. 104-119.

Greene, A. (1969) *Pullet Surprises*. Scott, Foresman and Co. Glenview, Illinois.

Gruber, J. (1967) "Functions of the Lexicon in Formal Descriptive Grammars" System Development Corp. Technical Memorandum.

Halle, M. (1973) "Prolegomena to a Theory of Word Formation." *Linguistic Inquiry* IV.1:3-16.

Hockett, C.F. (1967) "Where the Tongue Slips, There Slip I." *To Honor Roman Jakobson*, vol. II, *Janua Linguarum* series major XXXII, The Hague: Mouton.

Hofmann, T.R. (1966) "Initial Clusters in English" M.I.T. *Quarterly Progress Report* 84. 263-274.

Hotopf, W. (1972) "What Light do Slips of the Tongue and of the Pen Throw on Word Production?" Unpublished paper, London School of Economics.

Jakobson, R. (1968) *Child Language, Aphasia and Phonological Universals.* Mouton: The Hague.

Jensen, A.R. (1962) "Spelling Errors and the Serial-Position Effect." *J. Educ. Psyc.* 53:105-109.

Katz, J. (1972) *Semantic Theory.* Harper and Row. New York.

Katz, J. and Fodor, J. (1963) "The Structure of Semantic Theory" *Language.* 39:170-210.

Kehoe, W.J. and Whitaker, H.A. "Lexical Structure Disruption in Aphasia: A Case Study" in Goodglass and Blumstein (eds) *Psycholinguistics and Aphasia.*

Kent, G. and Rosanoff, A. (1910) "A Study of Association in Insanity," *Amer. J. of Insanity.* 67:37-96.

Kiss, G.R. (1967) "Networks as models of word Storage." in Collins, N.L. and Michie, D. (eds) Machine Intelligence 1:155-67. Oliver and Boyd: Edinburgh.

Kolers, P.A. (1963) "Interlingual Word Associations" *Journ. Verbal Learn. and Verbal Behavior.* 2:291-300.

Kucera, H. and Francis, W. Nelson. (1967) *Computational Analysis of Present-Day American English.* Brown U. Press, Rhode Island.

Ladefoged, P. (1971) "Phonological Features and Their Phonetic Correlates." *Working Papers in Phonetics* 21. UCLA. 3-12.

Ladefoged, P. and Broadbent, D.E. (1957) "Information conveyed by Vowels." *J. Acoust. Soc. Amer.* 29:98-104.

Ladefoged, P. and Fromkin, V. (1968) "Experiments on Competence and Performance." *IEEE Transactions on Audio and Electro Acoustics.* Vol. AU-16.1; 130-136.

Lashley, K.S. (1961) "The Problem of Serial Order in Behavior" in Saporta *Psycholinguistics.* Holt, Rinehart and Winston.

Laycock, D. (1972) "Towards a Typology of Ludlings or Play-Languages." *Linguistic Communications* 6. Monash U. 61-113.

Lees, R.B. (1960) *The Grammar of English Nominalizations*. Mouton: The Hague.

Lightner, T.M. (1971) "Generative Phonology." in Dingwall (ed) *A Survey of Linguistic Science*. U. of Maryland.

Luria and Tsvetkova, (1968) "The Mechanism of Dynamic Aphasia." *Foundations of Lang.* 4: 296-307.

MacKay, D.G. (1966) "To End Ambiguous Sentences." *Perception and Psychophysics*. 1:426-436.

MacKay, D.G. (1970) "Spoonerisms: the Anatomy of Errors in the Serial Order of Speech." *Neuropsychologia* 8. 323-350.

MacKay, D.G. (1972a) "The Structure of Words and Syllables: Evidence from Errors in Speech." *Cognitive Psychology* 3.210-227.

MacKay, D.G. (1972b) "Syllable Structure and Speech Rate." (mimeo).

MacKay, D.G. (1972c) The Hierarchic Specification of Words: Evidence from Paradigmatic Speech Errors. (In press).

MacKay, D.G. (1972d) "Complexity in Output Systems: Evidence from Speech Errors" (In press).

Marshall, J.C. and Newcombe, F. (1966) "Syntactic and Semantic Errors in Paralexia" *Neuropsychologia* 4.

Matthews, W.A. (1965) "The Relation Between Association Norms and Word Frequency." *Brit. J. Psyc.* 56:391-401.

Nooteboom, G.G. (1967) *Some Regularities in Phonemic Speech Errors*. Instituut voor Perceptie Onderzoek. Annual Progress Report 2. Eindhoven.

Palermo, D.S. (1963) "Word-Associations and Children's Verbal Behavior." in L.P. Lipsett and C.C. Spiker (eds) *Advances in Child Development and Behavior*. 1. Academic Press. New York.

Perfetti, C.A., and Goodman, D. (1970) "Semantic Constraint on the Decoding of Ambiguous Words." *J. Exper. Psyc.* 86. 420-427.

Pollio, H.R. and Lore, R.K. (1965) "The Effect of a Semantically Congruent Context on Word-Association Behavior." *J. of Psyc.* 61:17-26.

Sasanuma, S. and Fujimura, O. (1971) "Selective Impairment of Phonetic and Non-phonetic Transcription of Words in Japanese Aphasic Patients: Kana vs. Kanji in Visual Recognition and Writing." *Cortex*. VIII:1-18.

Schachter, P. (1972) "On Post-Transformational Lexical Insertion." UCLA Papers in *Syntax*. 1:161-182.

Schachter, P. (1962) Review: R.B. Lees, *Grammar of English Nominalizations*. *Int. J. of Am. Ling.* 28.134-145.

Schane, S. (1968) "On the NonUniqueness of Phonological Representations." *Language*. 44:709-716.

Schnitzer, M.L. (1971) *Generative Phonology: Evidence from Aphasia*. Ph.D. Dissertation. U. of Rochester.

Schuell, H., Jenkins, J. and Landis, L. (1961) "Relationship Between Auditory Comprehension and Word Frequency in Aphasia." *J. Sp. and Hear. Res.* 4:30-36.

Stockwell, R., and Schachter, P. (1962) "Rules for a Segment of English Syntax." Mimeo, UCLA.

Thomdike, E.L. and Lorge, I. (1952) *The Teacher's Word Book of 30,000 Words*. Columbia U. New York.

Underwood, B.J. (1963) "Stimulus Selection in Verbal Learning." in C.N. Cofer and B.S. Musgrave (eds) *Verbal Behavior and Learning: Problems and Processes*. McGraw-Hill:New York 33-48.

Warren, R.M., Obusek, C.H., Farmer, R.H. and Warren, R.P. (1969) "Auditory Sequence: Confusion of Patterns other than Speech or Music." *Science*.164:586-587.

Webster, N. (1904) *Dictionary of the English Language*. Merriam:Springfield.

Weigl, E. and Bierwisch, M. (1970) "Neurology and Linguistics: To..cs of Common Research." *Found. of Lang.* 6:1-18.

Weigl, E. and Bierwisch, M. (1970) "Neuropsychology and Linguistics: Topics of Common Research." *Found. of Lang.* 6.

Wepman, J.M., Bock,D., Jones, L.V. and Van Pelt, D. (1956) "Psycholinguistic Study of Aphasia: A Revision of the Concept of Anomia." *J. Sp. and Hear. Disorders*. 21:468-477.

Whitaker, H. (1970) "Linguistic Competence: Evidence from Aphasia." *Glossa*. 4:1,46-54.

Whitaker, H.A. (1971) "On the Representation of Language in the Human Brain." *Linguistic Research, Inc.* Edmonton.

Wickelgren, W.A. (1969a) "Context-Sensitive Coding in Speech Recognition, Articulation and Development" in K.N. Leibovic (ed) *Information Processing in the Nervous System.* Springer-Verlag. New York.

Wickelgren, W.A. (1969b) "Context-Sensitive Coding, Associative Memory and Serial Order in (Speech) Behavior." *Psych. Review.* 76:1,1-15.

Wickelgren, W.A. (1969c) "Auditory or Articulatory Coding in Verbal Short-Term Memory." *Psych. Review.* 76:2,232-235.

Wickelgren, W. (1972) "Discussion Paper on Speech Perception." in J. Gilbert (ed) *Speech and Cortical Functioning.* Academic Press. New York.