1 The Biases and Their Manifestations

This book is concerned with twenty words. Specifically, it is a report of several experiments designed to tap the growth of the appreciation of the relations that exist among these words as the individual matures from childhood through adolescence to adulthood. Although most experiments described in this book involve the same twenty words, the hope is that interpolation and extrapolation will be possible, that inferences may be drawn from the experiments and applied to the lexicon as a whole.

Like most experimental programs the one reported here is partly deductive and partly inductive in that it involves a blend of preconception on the one hand and willingness to discover on the other. The preconceptions rest in assumptions about adults: how they understand words, how they appreciate lexical relations, and how they view language as a system. These preconceptions are manifest in the selection of tasks, material, and methods of analysis. The willingness to discover emerges from a question about children: How does the child grow to appreciate the words, their relations, and the language in the way that adults do? The preconceptions and their manifestations are the topic of this chapter; the empirical question will be considered in the next.

Preconceptions

At the most general level there are four biases underlying this work, all of which concern the nature of words. While some of these preconceptions may seem rather obvious, it should be realized that alternative views and

points of emphasis are possible. Moreover, while others may at first appear somewhat gratuitous the motivation for their description may become clearer in later sections of the book.

The Word as a Container of Meaning

The first bias is that spoken and written words are distinguished from random noises and mounds of ink in that the former possess meaning while the latter do not. There is no consensus concerning the concept of meaning (Creelman 1966). The following remarks are intended to indicate what is and is not implied by the term as it will be used below.

We are not here concerned with the affective or attitudinal meaning described by the authors of the semantic differential as connotative (Osgood, Suci, and Tannenbaum 1957). On the other hand we are not concerned solely with the denotative function of words, for interword relations are as important for us as is reference. Although the meaning of a word is thought to be given largely by such intraverbal relations, no heavy emphasis is placed on the relation defined by contiguity which according to Deese (1965) is the notion that has dominated the study of association and of meaning throughout the history of philosophy and psychology.

Words function in organizing the world of experience to make it conceptually manageable. A word is generic in that it denotes not one but a group of referents (Vygotsky 1962). It is thus a category label (Brown 1958). The word *dog* refers to collies, terriers, and poodles. Even proper nouns are generalizations, conceptual integrations over space and time. The words *Julius Hoffman* refer to a whole series of related sensory experiences. Moreover, words describing nonphysical entities, actions, relations, and qualities are also generalizations in this sense (Brown 1958). The words *beauty*, *buy*, *between*, and *big* have more than one referent, just as do *bed*, *bomb*, and *butterfly*.

When we use a word to denote an object in the world of sense we do so by ignoring certain properties and paying attention to others (Locke 1690). It is precisely by virtue of the fact that we ignore certain properties that a word can function generically. When I classify the object that now sits in front of me as a *book*, I ignore its position, its coloring, its texture, its size, and its particular binding, and I pay attention to the fact that it is a solid object with pages that have writing on them. The properties that I ignore are irrelevant, while the properties to which I attend are criterial (Bruner, Goodnow, and Austin 1956) in my use of the word. The word is thus the embodiment of a concept (Vygotsky 1962). Henceforth the criterial properties will be called the *features* of a word.

The set of features associated with a word represents a large part of its meaning. The extent to which two words share meaning is a function of

the intersection of the two corresponding sets of features. Features are roughly similar to what Katz (1966) calls semantic markers. One of the chief differences between Katz's notion and ours is that he emphasizes the distinction between words and semantic markers (Katz 1966, p. 156), while we prefer to emphasize their communality by noting that both words and their features can be expressed by natural language category labels. Thus, partly for reasons of economy, we assume no qualitative difference in the internal representation of words and features.

The Hierarchical Relations among Words

The second bias about words concerns the fact that they are not isolated unrelated entities but rather cohere in a system. A major basis for the organization of words within the lexicon results from the fact that the features of words can often be cast into a hierarchical or nest-like relation (Miller 1969a). A *collie* is a *dog*, a *dog* is an *animal*, an *animal* is a *living thing*, a *living thing* is an *object*, and an *object* is an *entity*. Such class inclusion relations can be represented by tree-like structures with words on twigs and increasingly generic class labels or features on successively higher nodes of the tree (Miller 1967). Such hierarchically organized features are completely redundant; if an entity is a dog it is also necessarily an animal, living, and so on. If two words share a given feature in a nest they will necessarily share all higher-order features within that nest.

Although the hierarchical relation is not the only type of organization that binds words (Miller 1969a) it has been emphasized by both linguists and psychologists. Katz and Postal (1964) recognized the redundant nature of many semantic markers. They suggested that such class inclusion relations be stated at the beginning of their word dictionary for the purpose of simplifying the semantic component of their theory of linguistic descriptions.

Hierarchical structure has probably been stressed even more by psychologists interested in describing the subjective organization of the lexicon than by linguists interested in developing a theory of semantics. Mandler (1967, 1968), Collins and Quillian (1969), and Anderson and Beh (1968) have all stressed the cognitive efficiency that results from such organization. Efficient modes of organizing and remembering material, particularly when it involves the thousands of items of the lexicon, have been emphasized because of the limited span of immediate memory (Miller 1956a, 1956b). Hierarchical organization is attractive as a model since it explicitly and repeatedly involves "grouping or organizing the input sequence into units or chunks," the means proposed by Miller to break "the informational bottle-neck" imposed by that limited memory.

Sentences as a Source of Verbal Concepts

The third bias concerns the source of an individual's appreciation of the features of words. The meaning of a word can be inferred from the utterances and sentences of the language. As Wittgenstein (1953) put it, the language is a word's "original home." While the meaning of a sentence is largely given by the words that make it up, the converse is equally true: the meaning of a word is largely given by the sentences in which it occurs.

There are, of course, other sources from which features can be associated with words. First there is the ostensive definition, which undoubtedly plays a crucial role in a child's appreciation of the first words he comes to understand. Defining by pointing, however, lacks a firm basis by which the word can be fully appreciated as a generalization. There are also many words that will not stand for inspection. Ostensive definitions of *idea*, *some*, *if*, and *during* are impossible. Second, we sometimes learn a word's meaning by resorting to a dictionary. This, however, is not the usual case, and clearly not the most basic. For dictionary construction relies upon the initial extraction of meanings from the language, and dictionary use presupposes the comprehension of the terms making up the definition.

The sentences in which a word occurs are of great importance in the formation of verbal concepts. What is it in the structure of sentences that allows an individual to determine the features of a word? Suppose that one is introduced to a novel word x in the sentence: "The x bought a hat yesterday." Given an acquaintance with the other words in the sentence one can easily infer that x designates a *human*, since nonhumans do not usually buy hats. Other features of the novel word can be inferred from other sentences. Verbal context thus suggests itself as an important factor in the process of meaning acquisition and has been stressed as such by a number of writers (Brown 1958, Deese 1965, Werner and Kaplan 1950).

Similarity of meaning according to this view is systematically related to privileges of occurrence, a notion that has some support from the analysis of the distributional structure of language (Harris 1954). Two words are thought to share meaning to the extent that they share privileges of occurrence. Studies of adult word association support the notion that privileges of occurrence are important in the psychological proximity or, inversely, the distance between two words. Bipolar contrasts or opposites are often the adults' most common responses in the free association task (Deese 1962, 1964, 1965). *Boy* is the most common response to *girl*, *above* to *below*, *laugh* to *cry*, and *rich* to *poor*. Opposites by definition cannot appropriately apply to the same referent at the same time, and they rarely occur in the same sentence. Antonymous responses in the free association task thus seem to violate a Galtonian theory of word association which is based upon the concept of contiguity (McNeill 1966).

Within the system of Katz and Fodor (1963) such responses correlate nicely with the observation that opposites share the same semantic markers except one. For present purposes the point is that opposites can be substituted in many of the same sentence frames. *Boy* can replace *girl* meaningfully in sentences that do not involve reference to sex, the dimension that distinguishes these words.

Consideration of privileges of occurrence in this way "further erases the distinction between grammar and meaning" (Deese 1965). For according to this view the parts of speech — the nouns, the verbs, the adjectives, the prepositions, and so on — which are defined by descriptive linguists in terms of privileges of occurrence (Fries 1952) are actually semantic distinctions as well as syntactic ones. It is not hard to find the semantic correlates of the form classes. Most nouns designate *entities*; most verbs, *processes*; most adjectives, *qualities*; and most prepositions, *relations*. Parts of speech thus appear to correspond to something like Aristotle's semantic categories, the most abstract concepts given in a language. The correlation between syntactic and semantic categories is only rough (Fries 1952) but "though it is less than perfect . . . it would surely be discovered by native speakers if it could be of any use to them" (Brown 1958). The fact that most adult associates are of the same part of speech as the stimulus (Deese 1965) and the fact that confusions in memory tasks tend to be paradigmatic (Anderson and Beh 1968) suggest that the internal lexicon may be organized in terms of form class. Indeed, "lexical markers may be hierarchically organized under form class" (Anderson and Beh 1968).

We have been warned not to be too quick to equate meaning with privileges of occurrence (Miller 1967). But for at least a subset of the sentences of a language the equation has to hold. In 1940 Russell argued that a natural language such as English was, in fact, composed of a hierarchy of languages (Russell 1940). The lowest language in the hierarchy, which he calls the object or primary language, consists only of words that can be defined ostensively and of propositions that refer to specific events constrained by space and time. Higher-order languages include, in addition to the terms of the primary language, what he calls logical words like *some* or *all* that cannot be defined by pointing. The propositions in these languages are statements about words and about languages and hence they are not constrained by space and time. They are generalizations. The difference between the statements "These apples are round" and "Some apples are round" is qualitative.

The point of relevance for this discussion is that if two words can be substituted in sentence frames of higher-order languages, that is, in statements about words rather than about specific referents, then these two words share meaning. If the same predicate can be applied to two words in

such statements, then that predicate describes a feature shared by the words. *Apples* and *oranges* are similar in meaning in part because they are both appropriate in frames such as "Some ___ are round."

The Word as a Social Tool

The last bias relates to the fact that a word is a social phenomenon, a part of the culture, and relatively useless unless it means the same thing to different speakers of the language. It is true that a rather arbitrary relation exists between a word and its referent. The word *dog* signifies a certain class of quadrupeds only for those who speak English. Even within a linguistic community there are bound to be idiosyncratic features associated with words, and idiosyncratic bases for their organization (Tulving 1962). But a word is a tool the function of which is to communicate. Unless the relations between words and referents, and between words and words, are roughly the same for the various speakers of a language, unless words are associated with some of the same features for speaker and listener, writer and reader, communication will be impossible and words will not be serving their function. .

Manifestations

These four biases show up in the studies in three ways. They have influenced the selection of tasks, the construction of the set of twenty words, and the choice of methods of analysis.

The Tasks

Miller's sorting and Bousfield's free recall tasks are the experimental techniques that resulted in the primary empirical findings to be described in this book. Other tasks have been employed in an attempt to clarify these phenomena. But the choice of the later tasks was a result of the earlier findings, and the reasons for their use should become clear after the data from the clustering studies have been described. In this section, therefore, we shall concentrate on the sorting and free recall procedures.

Miller has described his sorting procedure in a series of papers (Miller 1967, 1969a, 1969b). Typically he gives his subjects a deck of cards with a word and a sense-specifying definition on each card. The subject is required to sort the words into piles on the basis of similarity of meaning. He is allowed any number of piles with any number of words per pile. For each subject an $m \times m$ incidence matrix (where m is the number of words) is constructed showing for every pair of words whether or not they were put into the same pile. The unweighted incidence matrices for each of N judges are then added to form one matrix. In each of its cells there is a

number N_{ij} $(0 \leqslant N_{ij} \leqslant N)$ which represents the number of judges who put words i and j together. A measure of the psychological similarity between the two words is given by N_{ij}; reciprocally, a measure of the psychological distance between the two words is given by $N - N_{ij}$. The matrix is then subjected to various kinds of analyses including Johnson's (1968) hierarchical clustering program.

The results of sorting data on 48 common nouns suggested to Miller (1969a) that adult subjects group words by ignoring the features that differentiate the words and by attending to those that the words share. Presumably, some subjects chose to ignore many features and thus grouped many words together; others ignored only a few features and produced small clusters. The sorting task's sensitivity to hierarchical relations is dependent upon such intersubject variability.

By and large the results appeared consistent with a hierarchical model of subjective lexical organization, although paradigmatic and linear organizations may have been operative in some subsets of words. Such features as *object-nonobject*, *living-nonliving*, and *human-nonhuman* appeared to emerge from an intuitive analysis of the data (Miller 1967).

The ease with which the sorting task can be administered to children, its apparent sensitivity to relations among words chosen from diverse sections of the lexicon, and the possibility of interpreting its results in terms of shared features were all factors which argued for its use. However, for reasons that will become clear it was necessary to replicate the major experimental findings with a different task that employs different instructions. For this the free recall technique was chosen.

Bousfield was the first to use the free recall procedure in order to examine clustering (Bousfield 1953). In the original experiment he presented subjects with a randomized list of 60 words made up of 15 animals, 15 names, 15 professions, and 15 vegetables. Immediately following the presentation, subjects were required to recall as many words as possible with no constraints as to order. The major finding was that subjects tended to group their output in clusters that conformed to the four conceptual categories that Bousfield had built into the set of words.

The interpretation of free recall results differs from that of some other verbal learning experiments in that little reliance is placed upon the concepts of contiguity, of reinforcement, or of stimuli and responses, mediated or otherwise (Deese 1965). The subject is often viewed as an active participant in the experiment who deliberately organizes the input (Mandler 1968, Miller 1956) and who makes use of his knowledge of the many relations that exist among the words in his language (Tulving 1968).

In some respects the free recall task can be viewed as the immediate

ancestor of the sorting task. In both, subjects are presented with an array of words, and in both, subjects produce word-clusters. Some of the free recall results might well be interpreted in terms of shared features. Bousfield originally interpreted his findings in terms of the activation of superordinates. Thus the occurrence of *dog* and *cat* both activated the superordinate *animal*, with the result that these words were clustered in recall. The point for us is that such superordinates are important features shared by words.

The necessity of such a principle as Bousfield's superordination (and therefore our shared features) in the interpretation of free recall results has been a subject of debate. The question is whether these results might not all be explained in terms of the "relatively simple associative connections" that exist among words (Bousfield, Steward, and Cohen 1964, Cofer 1965, 1966, Postman 1964). While it is clear that some free recall results can be predicted from free association norms (Jenkins and Russell 1952, Rothkopf and Coke 1961), the question as posed, is misleading for two reasons. First, what has been meant by *explanation* in this context has never been clear (Mandler 1968, Tulving, 1968). No adequate theory of free association exists and a correlation between free association and free recall data does not erase the need for an explanation of either. Second, there are clearly instances of clustering in free recall that would not be predicted by free association norms, at least those computed in the usual way (Tulving 1962a, 1962b) some of which appear to be instances of what Bousfield called superordinates, and what we are calling shared features (Marshall 1963).

A variant of the free recall technique has been employed by Bower et al. (1969) to examine the appreciation of the structural relations among words in adults. To one group of subjects they presented a hierarchically organized set of nested categories on a sheet of paper so that the spatial display reflected the structure implicit in the set of words. Superordinates hovered over subordinates which in turn hovered over still lower level categories. To a control group of subjects they presented the same words arranged in the same tree-like formations but in this case the words were scrambled so that the spatial display did not conform to the class inclusion relations that existed among the words. They found that recall was two to three times better for the structured than for the scrambled material. They also found that this effect could not be predicted by associative "guessing." Their interpretation of this phenomenon in terms of the discovery of the rules or principles that relate the words clearly implies the participation of an active subject who brings his preacquired knowledge of the language as a system to bear upon the task at hand.

The Set of Words

For reasons that will become clear, a crucial concept in this work is the degree of abstractness of the equivalence relation between words. Equivalence is said to exist between any two words when they share a feature or a set of features. The term has been borrowed from Bruner and Olver (1963, and Greenfield 1966). *Dog* and *cat* are equivalent because they are both *animals*, *living*, and so on. *Hot* and *wet* are equivalent because they are both *properties of physical objects.*

The relation of equivalence can vary in what we shall call, with a certain degree of trepidation, abstractness. *Abstractness* is a term that has a wide variety of rather vague uses in English, and hence our trepidation. Brown (1958, p. 266) states that the clearest sense of the "concrete-abstract" distinction is given in terms of subordinates and superordinates. According to this definition the superordinate is more abstract than the subordinate, while the latter is more concrete. Thus abstractness is a completely relative term. Within a set theoretic nest of natural language category labels, a particular label can be abstract in relation to some labels and concrete in relation to others. *Dog* is abstract compared to *collie* and concrete compared to *animal*, for the category *dog* includes and extends beyond the category *collie* while the reverse is true for *dog* relative to *animal.*

There are two problems with such a definition of abstractness. The first is that the notion becomes extremely limited; it is defined only for terms that can be arranged in a nest. Thus no statement can be made about the abstractness of a term like *animal* relative to *petunia* in spite of our intuitions. The second problem with such a notion is peculiar to our use of equivalence relations. Again the relation for one word-pair may be compared to the relation for another word-pair only if the two sets of shared features can be arranged in a nest. The problem here is that it is difficult to say a priori what features a word possesses for the "average" speaker of the language. An individual does have strong intuitions about the features he associates with words. But, although he can safely assume that many of his intuitions will be shared by others (Bias 4), he cannot be certain in all cases. These problems necessitate ultimate reliance upon empirical support for a definition of abstractness that is originally based on intuition. Such support will be developed in Chapter 3.

The original selection of words, however, was determined by the writer's intuitions about word-relations and his desire to construct a set of words such that the shared features could be arranged in a nest. The construction of material based on intuition is certainly not unique (e.g., Bousfield 1953, Bower et al. 1969, Marshall 1963). The chosen words are shown in Figure 1.1. There are 6 nouns, 4 prepositions, 5 verbs, and 5 adjectives. These
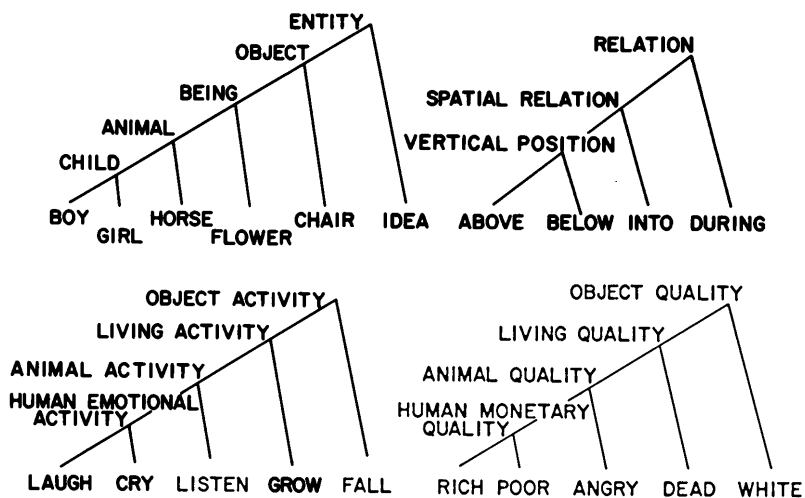
Figure 1.1. Schematic representation of relations among words used in developmental studies.

appear at the ends of the branches of the trees. The hierarchies of concepts that were thought to relate the words have been written in at the nodes.

Consider the nouns. *Boy* and *girl* are both human children. (Of course, *boy* and *girl* are equivalent in that they are both *animals*, *living*, and so on, for, as we have seen, certain features carry with them a host of super-ordinate features. But it is necessary to state only the most concrete feature of a nest since the rest are implied by definition. This most con-crete feature will henceforth be called the *presumed minimal feature*. It is presumed because it has been selected entirely on the basis of intuition. It is minimal because it is thought to be represented by the most concrete category label that applies to both words.) *Boy* and *horse* (as well as *girl* and *horse*) are both animals. *Boy* and *flower* (as well as *girl* and *flower*, *horse* and *flower*) are both living organisms or beings. *Boy* and *chair* (as well as *girl* and *chair*, *horse* and *chair*, *flower* and *chair*) are both physical objects. Finally, *boy* and *idea* (as well as *girl* and *idea*, *horse* and *idea*, *flower* and *idea*, *chair* and *idea*) are both entities.

The relations presumed to characterize the prepositions are as follows: *above* and *below* both denote vertical position. *Above*, *below*, and *into* all describe spatial relations. *Above*, *below*, *into*, and *during* all refer to rela-tions, be they spatial or temporal.

Previous attempts by Miller (1969b) to use the sorting technique with verbs and adjectives suggested that subjects tend to group these on the

basis of the nouns that accompany such words. Thus the verbs and adjectives are arranged primarily in terms of the nouns that go with them. The five intransitive verbs vary in the type of agent that is capable of performing the action depicted by the verb. *Laugh* and *cry* are both human emotional activities. *Laugh*, *cry*, and *listen* are all animal activities. *Laugh*, *cry*, *listen*, and *grow* are all activities of living things. *Laugh*, *cry*, *listen*, *grow*, and *fall* are all activities of objects, organic or inorganic.

The five adjectives vary in the type of noun they can describe. *Rich* and *poor* are both human monetary qualities. *Rich*, *poor*, and *angry* are all animal qualities. *Rich*, *poor*, *angry*, and *dead* are all properties of things that are living (or have lived). *Rich*, *poor*, *angry*, *dead*, and *white* are all properties of objects.[1]

Figure 1.1 gives only the skeleton of the equivalence relations that exist among these words. Each superordinate or "superset relation" is associated with a host of derivative or "property relations" which constitute the flesh (Collins and Quillian 1969). For example, animals breathe, eat, and move. Thus, *respiration*, *nutrition*, and *motion* all denote relations which make *boy*, *girl*, and *horse* equivalent.

Methods of Analysis

The chosen methods of analysis mirror each of the four biases. Since these reflections will become evident in Chapters 3 to 5 they will be only mentioned here. First, the meaning shared by two words is estimated in terms of the proximity, the major concept of analysis in this work. The proximity for a word-pair is defined by the number of judges who put the two words into the same pile in the sorting task, by the number of subjects who cluster the two words in the free recall task, by the number of responses shared by the two words in the free association task, by the number of individuals who put the two words into the same slot in sentence frames, by the amount of memory facilitation produced by presenting the two words contiguously in a spatial display, or by the number of judges who are able to verbalize a relation that makes the two words equivalent. Second, Johnson's hierarchical clustering program (1967) has been used to depict the appreciation of the class inclusion relations among words. Third, special treatment has been given to clusters comprising opposites and to clusters comprising words of the same part of speech since

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[1] The features have been chosen to have the property that they are general enough to include every instance of the words over which they hover. If we consider a feature (F) and the words to which it applies $(W_1, W_2, \cdots, W_n)$ to be sets then the words have been chosen so that

$$W_1 \cup W_2 \cup \cdots \cup W_n \subseteq F$$

these represent the extremes along the continuum defined by privileges of occurrence. Fourth, multidimensional scaling techniques devised by Kruskal (1964), Shepard (1962), and Carroll and Chang (1969) have been used to estimate the extent to which individuals agree in their responses to tasks involving use of the semantic relations among words.

The work is clearly fraught with implicit assumptions that have become explicit as manifestations in three important phases of the experimental program. While empirical confirmation of such assumptions has been an interest, it has not been the only one or even the primary one. The purpose of the next chapter is to describe the nature of the genuinely empirical question at hand, and to suggest that we have got out more than we have put in.