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## THE DEVELOPMENT OF LANGUAGE

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This chapter, to be included in "Carmichael's Manual of Child Psychology," edited by P.A. Mussen, deals with the connection between the acquisition of language and the growth of intellect, and the connection between both of these and the process of maturation. The author feels that various theories of development cannot account for the child's acquisition of grammar in a relatively short time, and he discusses the reasons as well as the lines which the explanation must follow. The bulk of the chapter is a survey of language acquisition itself. It is organized under three major headings, one for each of the three main components of a grammar: syntax, phonology, and semantics. A description of the methods typically used in studying the development of each component is given. The emergence of the components themselves is traced (insofar as it is known), and a discussion of various theoretical issues in the light of the empirical findings is presented. Wherever possible, mention is made of children exposed to languages other than English, with the chief contrast languages being Russian and Japanese. (See related document ED 017 921.) (D0)

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THE DEVELOPMENT OF LANGUAGE\*

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The Development of Language

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## The Development of Language

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Like the humors of the mind, the development of a child may conveniently be divided into four parts.

One part is physical maturation; another is personality development, including the process of socialization; a third is intellectual development; and a fourth is language development. The division is artificial but useful, tolerated because of its advantages for orderly inquiry. However, it should not be allowed to obscure the fact that the four parts intertwine in complex ways to make up the process -- absolutely unique in the animal kingdom -- of human growth.

It is clear, for example, that socialization depends on the acquisition of language. Yet it is equally clear that language bears the marks of socialization, as the linguistic differences among social classes attest. The development of personality both acts on and reacts to the development of intellect, as evidenced by the cases where both fail as in schizophrenia (Inhelder, 1967). Indeed, although the interaction is rarely examined, the network of characteristics we call personality could not develop at all were it not for a child's capacity to represent his world in the particular way that forms the subject matter of cognitive psychology. Yet there are also differences in cognitive style, in the characteristic modes of thought that accompany particular types of personality (Kagan, et. al., 1963).

This chapter is concerned with two such interactions. One is the connection between the acquisition of language and the growth of intellect. The other is the connection between both of these and the process of maturation. The parts so intertwined may strike the reader as an arbitrary selection.

However, the selection is a sensible one; and the interaction among them provides considerable insight into the process whereby a child grows to become an adult. But this is the substance of the chapter.

#### PLAN OF THE CHAPTER

In order to understand the acquisition of language, it is essential first to understand something of what is acquired. There is, therefore, a Linguistic Appendix. Readers unfamiliar with developments in modern linguistics are urged to begin with it; others may want only to refer to the Appendix as the occasion requires.

The phenomenon of language poses a challenge for psychologists. A grammar is a system of knowledge. It is everywhere complex and at many points abstract. Yet very young children acquire grammars and they do so in a surprisingly short period of time. For reasons to be discussed in the first section of the chapter, various theories of development cannot account for this achievement. Explanation must follow other lines. One view is that the acquisition of language rests on certain cognitive capacities (the presence of which are reflected in language as linguistic universals). These capacities may be innate and may mature with time.

The bulk of the chapter is a survey of language acquisition itself. It is organized under three major headings, one for each of the three main components of a grammar: syntax, phonology, and semantics. A description will be given of the methods typically used in studying the development of each component; then the emergence of the components themselves will be traced, insofar as this is known; and finally, there will be a discussion of various theoretical issues in the light of the empirical findings presented. Wherever possible, mention will be made of children exposed to languages other than English, with the chief contrast languages being Russian and Japanese.



A caveat. There has been no serious attempt to survey the literature on language acquisition in a comprehensive way. The chapter is organized on principles other than inclusion. For one thing, most of the references are recent, since 1954, when McCarthy's chapter on language development appeared in the second edition of The manual of child psychology. Her review should be consulted for the earlier work. For another thing, recent developments in linguistics pose crucial issues for psychology, and examination of them takes priority within the limits of space over comprehensive citation. The criteria for including studies in this chapter, therefore, have been two: that they have not been covered by earlier editions of this Manual, or that they contribute in some way to the clarification, definition, or resolution of theoretical questions raised by the process of linguistic development.

#### SYNTAX

One large issue can be stated immediately. Normal children, not impaired by deafness, brain damage, or other physical or psychic disorders, begin to babble at about six months, utter a first "word" at 10 to 12 months, combine words at 18 to 20 months, and acquire syntax completely at 48 to 60 months. All children pass such a sequence of "milestones," always at these same ages (Lenneberg, 1967). They do so regardless of the language they acquire, or of the circumstances under which they acquire it. Such massive regularities of development remind one more of the maturation of a physical process, say walking, than of a process of education, say in reading. One might even say that children cannot help learning a language, whereas they can easily avoid learning how to read.

The acquisition of language thus shows some of the characteristics of physical maturation. Yet, at the same time, it is obvious that language is learned. Without certain linguistic experiences children acquire no language at all -- as is the case of congenitally deaf or criminally neglected children.

One psychological issue, then, deals with the explanation of this peculiar combination of facts. The regular development of language strongly suggests the operation of a maturational process, as Lenneberg (1967) has recently argued. The complete absence of language in children deprived of all linguistic experience equally suggests a process of learning. Both learning and maturation are necessary conditions for the development of language, but neither is sufficient. To understand such a problem, clearly we must consider both the innate and acquired aspects of linguistic competence, as well as the way in which they combine.

Nativism and empiricism in developmental psycholinguistics. The question of what is innate and what is acquired in behavior and language is often posed in the same terms one would use in describing the selection of a wife. Except for polygamous societies, a person can have only one mate -- either potential wife A or potential wife B must be chosen. Similarly, many wonder if language is innate or acquired. These questions are raised on the assumption that there is some reason to choose between the two alternatives, as if the truth about language acquisition were to lie in advancing one view at the expense of the other. In fact such questions are of marginal interest and the promotion of one of these views over the other merely serves the cause of obfuscation, not of truth.

The dichotomy between nature and nurture has been a pernicious one for psychology. It is pernicious because it has mainly polemical value and obscures a far more basic question of describing the interaction of innate abilities with experience. One must suppose that there is a correct view of

The latter, although it may not yet be discovered. Whatever this view is, however, it is logically independent of the argument over whether language is largely innate or acquired. The two questions are quite distinct. It is misleading to state what children learn in acquiring a language without understanding what is inborn; and conversely it is misleading to state what is innate in language without understanding how it interacts with experience. Only one hypothesis is reasonable, not a pair of rival hypotheses. However, as we shall see, nearly all the debate over the existence of an innate endowment for language acquisition has rested on the dichotomy of innate and acquired aspects of language.

The problem of "cognition and language." Given that the basic problem in explaining language acquisition is to understand how the innate abilities of children interact with their linguistic experience, there remains a need to consider such theories of learning and cognitive development as are currently available, and whether or not they can account for this interaction.

For reasons considered at various points both in the Linguistic Appendix and in this section on syntax, theories of learning based on S-R principles are inappropriate to the task. The acquisition of language requires the development of abstract linguistic knowledge, and there appears to be no way without question-begging to apply a theory couched in terms of "S" and "R" to a linguistic phenomenon where neither "S" nor "R" can be defined. For a number of strong arguments on this point, see Chomsky (1959); for a defense of S-λ theory, see Palermo (in press) and Staats (in press).

Theories of cognitive development, such as Piaget's, cannot be dismissed so easily. There are no a priori reasons to doubt the appropriateness of these theories to language acquisition; the problem instead is an empirical one. We must ask for each such theory, whether or not the facts of linguistic development can be understood in the terms offered by the theory.

Such an inquiry, when it succeeds, would contribute a fundamental insight, for it would explain some aspect of the universal form of human language on the basis of general psychological principles. Let us call this enterprise "cognition and language" to distinguish it from the exactly opposite question of language influencing thought, which historically has been called the problem of "language and cognition."

The problem of cognition and language has not been widely recognized. There is little or nothing written of it. Moreover, the impression of this reviewer is that little or nothing could be written of it. The most comprehensive theories of cognitive development take the general form of language for granted; they do not regard it as a phenomenon to be explained. Vygotsky (1962) and Bruner (1966), for example, have concentrated on the opposite problem of language and cognition; Piaget (1926; also, Sinclair-de Zwart, 1967) has dealt with the expression of thought in language -- which again is not the problem of "cognition and language."

Although occasional aspects of Piaget's theory may help explain fragments of language acquisition (such as the fusion of early speech with action, which seems to reflect the operation of sensory-motor intelligence), successes are rare and always leave one wondering if a reformulation of the cognitive theory would not lead to a stronger grip on language.

The immediate prospects of explaining the acquisition of language are bleak. However, they are not hopeless. One can reverse the direction of exploration. Can the aspects of linguistic development that lie beyond psychological explanation be construed as matters of cognitive development? And if they can, then how might our theories of cognitive development be enriched to include the new cognitive phenomena? We shall encounter two outstanding examples of such a possibility below. One is predication and the other is the set of transformational relations that universally exist between

the deep and surface structures of sentences in all languages. Both are prominent in the acquisition of language; neither can be explained in terms of any cognitive theory; and yet both appear to be purely cognitive rather than strictly linguistic effects.

The problem of cognition and language cannot be pursued in this chapter. Nonetheless, the reader is invited to bear it in mind as he follows the development of language, as it is set forth in the following pages.

We now turn to the development of syntax.

#### METHODOLOGY AND METHODOLOGICAL ISSUES

There is little in the study of language acquisition that can be called Methodology, with a capital "M." The very speed of linguistic development constrains the methods used in studying it. Massive changes in the grammatical status of children take place between one-and-a-half and three years. The age at which studies can be conducted is thereby fixed, and it is no one's fault that this age falls at a time for which there is, in general, no well developed methodology. In such circumstances, the simplest methods -- e.g., turning on a tape recorder -- are as good as any, and the bulk of recent observations has been collected in this way.

Recent studies of the development of syntax can be organized in terms of three contrasting strategies. 1) Observers have examined either the production or comprehension of speech. 2) They have attempted either to trace general linguistic advancement or the emergence of particular grammatical systems. 3) They have conducted either experimental studies or made observations of spontaneous linguistic behavior.

Of the eight possible categories of methods formed in this way, only four have been used at all, and most studies have used just two. There have been no studies, for example, of general comprehension. Most have worked with

spontaneous linguistic production, following either the development of general linguistic competence or of particular linguistic systems. Certain strategies naturally go with others -- comprehension, for example, has almost always been studied experimentally. There have been no studies seriously attempting to relate linguistic development to intellectual development -- which is, perhaps, a fourth strategy, as well as a substantive issue.

Rather than make a list of the extant categories of research methods, a list that may change tomorrow, it seems more profitable to discuss the broader categories of research strategies that present certain methodological issues. Of these, there are two.

Distributional vs. particular analyses. The richest details and the deepest insights have so far come from longitudinal collections of observations. Such studies have followed general linguistic development as well as the emergence of particular grammatical systems. Very often the same project lends itself to both strategies, so their proper relationship must be understood. But first a word on the studies themselves.

Almost without exception, observational studies have been engaged with the production and not the comprehension of speech. All are descendants of the early diary studies long conducted by newly parental linguists (Stern and Stern, 1907; Leopold, 1939; 1947; 1949a; 1949b), and differ from the earlier work mainly in the use of other people's children and in the collection of tape recorded protocols. Braine (1963a) Weir (1962), Brown and Bellugi (1964), Miller and Ervin (1964), McNeill (1966b), and Gruber, (1967) have all contributed in varying amounts to this literature.

Typically, a small group of children is visited, at home, once or twice a month, where everything the child says, and everything said to him, is tape recorded. The recordings are usually supplemented by running commentaries, made on the spot, on the general situation in which the speech was uttered.

The ultimate step in such extra-linguistic record-keeping is placing everything on film or TV tape, a step recently taken by Bullowa, Jones, and Bever (1964). Longer intervals between visits are possible, and for most purposes, are as useful as the two to four week intervals more customarily used. The sole reason for these visitations is to acquire a corpus of spontaneous utterances from a child. The significant part of the study lies in the analyses made of the corpus so collected, and up until now it has mattered little if a child's speech is accumulated in small amounts over three months and then combined into a large corpus, or if a large corpus is collected in one stroke every three months.

It is in the treatment of the corpus that the two strategies -- distributional analysis of general linguistic development and the analysis of particular grammatical systems -- differ; the decision to conduct one analysis or the other rests on certain methodological issues.

One strategy is to write a grammar that describes a child's complete corpus. The hope in this case is to capture his total linguistic system at the time the corpus was collected, without distortion from adult grammar. It is often done by performing a distributional analysis of the child's speech. The procedure followed is clearly described in Brown and Fraser (1964); Braine (1963) also provides some helpful comments. Essentially, an investigator searches for words that appear in the same contexts, the assumption being that such words are members of the same grammatical class in the child's grammatical system. Words with different privileges of occurrence are assumed to belong to different grammatical classes.

Suppose, for example, that a corpus collected from a two-year old contains the following utterances:

My cap  
that cap  
a shoe  
that horsie

other dog  
a daddy  
big shoe  
red sweater

One could conclude that the words on the left all belong to a single grammatical class; that the words on the right all belong to a different grammatical class; and that the child's grammar at this point considers a "sentence" to be any word from the first class followed by any word from the second class.

Words are placed into the same categories in a distributional analysis when there are no systematic differences in their usage relative to other words -- they then have identical privileges of occurrence. My and that belong together because they both appear with cap. Horsie and cap go together because they both follow that. Cap and shoe are semantically similar, or so one assumes, so words that they can follow -- my, that, a, and big -- are placed together in the first class, and words that can in turn follow these words -- cap, shoe, horsie, and daddy -- fall together into the second class. Finally, sweater, cap, and shoe are semantically alike, which justifies adding red to the first class.

As these examples make clear, the independence of distributional analysis from the analyst's own knowledge of language is limited. A distributional analysis does not insist on the co-occurrence of words in strictly identical contexts, but counts appearance in the context of meaningfully related words as co-occurrence also. Moreover, one assumes that non-occurring combinations -- for example, that sweater or big daddy -- are allowed by the child's grammar but are not observed because of sampling limitations.

Having established what seem to be a child's grammatical classes, the rules of his grammar are written so as to state the manner in which classes are combined -- in this case, Class 1 + Class 2. More complex categories demand more complex rules, but in every case the rules merely summarize the patterns



of categories observed in a child's corpus. Studies that have prepared distributional analyses in this manner are Braine (1963a), Brown and Fraser (1964), and Miller and Ervin (1964).

An important methodological question is left open in such investigations. An investigator combines individual utterances (my cap, a shoe, etc.) into categories through the application of certain principles of combination (shared privileges of occurrence), and then states the regularities observed among the categories so formed (Class 1 + Class 2 is a sentence). But none of this necessarily comprises a statement of a child's linguistic competence, his knowledge of language. It is a summary of his performance, whereas a statement of competence is a theory about what a child knows.

Moreover, there is serious question whether or not a theory of competence can ever be developed from manipulations of a corpus. Contemporary linguists deny that it can be done (cf., Chomsky, 1964, Lees, 1964 for a discussion in the context of investigations of child language). A corpus is incomplete, un-systematic, and (in the case of adults, at least) insensitive to a number of important grammatical distinctions. Insofar as utterances from children are limited in the same way, a distributional analysis will not lead to a correct description of competence, however neatly it may summarize performance; and there is no way, of course, to tell when a corpus is so limited. A distributional analysis is a summary of performance, which at best provides a description of a child's grammatical classes, plus some hints as to his grammatical rules. A theory of competence that explains these classes and rules may well take an entirely different form, a phenomenon that we shall see repeatedly in the pages that follow. The most elaborate general analyses of child grammar go far beyond the distributional evidence of a corpus (e.g., Brown, Cazden and Bellugi, in press).

As a description of performance, distributional analysis is but one source of information among many. Other observations, dealing with other aspects of performance, are often of equal importance; and, in some cases, they are more easily justified.

Among other such sources of information are observations made under the second strategy mentioned above. Rather than attempt to describe the total corpus collected from a child at some point in time, one examines the emergence of a particular grammatical system as it is manifested at different times. Thus, one might study the development of negation (Bellugi, 1964), or questions (Klima and Bellugi, 1966), or a host of other grammatical systems. The advantage of this strategy lies in the demands it places on observation, and arises from the very fact that it does what a distributional analysis typically strives to avoid -- it exploits the fact that adult grammar is the end-point of linguistic development. A distributional analysis attempts to discover parts of a grammar from a corpus. The second strategy begins with a part of adult grammar and judges if there is sufficient evidence in the corpus to justify ascribing it to a child. The demands on the second strategy are weaker than the demands on the first, for it must only recognize the applicability of a known theory; it does not have to discover an unknown theory.

When an adult analysis cannot be ascribed to a child, one can still describe the sequence of events followed in reaching the adult system. Thus, for example, children first negate by saying not want, then don't want some, then don't want none, and finally, don't want any (Bellugi, 1964). At each point, one can say what a child lacks with respect to the adult system -- he does not have auxiliary verbs, he does not have negative pronouns, and he does not have indeterminate pronouns, respectively. But one does not attempt to discover from these observations the child's grammatical system. That is a separate step -- a matter of the investigator's invention, ingenuity,

imagination, and good fortune. It is everything except a matter of discovery.

The following quotation from Brown, Cazden, and Bellugi (in press) summarizes many of the dangers and opportunities of following either strategy when interpreting a corpus of utterances collected from a child:

"We operate on the general assumption that the child's terminal state of knowledge is of the sort represented by current transformational grammars. However, we do not simply attribute to each sentence that the child produces the analysis that would be appropriate to that sentence if it were produced by an adult; if we were to do that the inquiry would be largely vacuous. Insofar as the child's particular sentence -- and all related sentences -- depart from adult forms the grammar is tailored to the departures. The most informative departures are analogical errors of commission such as goed...Harder to interpret, but still important, are errors of omission such as the absence of auxiliary did...Omissions in a sentence are at least easy to detect but omissions in the distributional range of a form are harder to detect and harder to interpret since it is necessary to weigh the probability that an omission is simply a consequence of the size of the sample that has been taken. Finally all the errors that occur must be considered in comparison with conceivable errors that do not occur. Even this full procedure will not render the construction completely determinate in all respects. The indeterminacies are tentatively resolved by assigning the usual adult representation insofar as that representation does not depend on forms that have never appeared in the child's speech. (pp. 4-5)"

It is possible to carry the second strategy to the level of true experimentation. Instead of observing the spontaneous occurrences of particular grammatical features, one tries to evoke them. For example, Ervin (1964), working with W. Miller, tested children's knowledge of English plurals by presenting free-form figures made of clay, each named with a nonsense syllable. A child is first shown one such figure, perhaps shaped like a salt cellar and called a bunge, and then is presented with a second figure exactly like the first. What does he call the two figures together -- bunge or bunges? The latter would indicate mastery of the rule for the pluralization of English nouns ending in sibilants. The age at which a child demonstrates such mastery can be compared to the age at which he correctly uses such genuine plurals as oranges.

A similar method can be used to elicit the past-tense inflection of verbs. However, the procedure suffers some uncertainty in this case, inasmuch as past time is difficult to exemplify perceptually. A failure to elicit a past-tense inflection may result from a failure of the experimenter to present the appropriate conditions, as well as from a failure of the child to add past-tense inflections when the conditions are right. Nonetheless, one can at least approach the problem by demonstrating a novel gesture, saying at the same time I'll sib it, and then asking a child what had been done.

Bellugi (1967) has described a number of tests of negation, some for comprehension, others for production. All are suitable for use with young children. Since the variety of syntactic forms covered is quite large, only a sampling will be given here.

To test a child's comprehension of negatives affixed to auxiliary verbs, a child can be shown a doll with movable arms, one arm up and the other down. The child is told to make the doll fit either of the sentences, "the boy can put his arms down" or "the boy can't put his arms down."

To test a child's comprehension of negation used in Wh-questions, a child can be shown an array of objects -- a boy doll, an orange, an apple, a ball, a toy, a tomato, and an ashtray -- and be asked "what can the little boy eat?" or "what can't the little boy eat?"

To test a child's comprehension of indeterminate pronouns (such as some) and negative pronouns (such as none), a child can be shown a doll and a few blocks, and be told to make the doll fit either of the sentences, "The doll can push some of the blocks," or "The doll can push none of the blocks."

To elicit negative indefinite forms, i.e., pronouns based on any, a child can first be shown a doll with a hat on its head, being told "Here is John. He has something on his head," and then be shown a second, hatless, doll, being told "Here is Bill. What does he have on his head? He doesn't have \_\_\_\_\_."

A child can be given systematically distorted forms, the distortions being designed to bear on points of syntactic interest, and be asked to correct them. For example "he not touching it," which violates a rule in English that negatives must be attached to auxiliaries.

The reader can exercise his own ingenuity in devising other tests. It would be well, however, to bear in mind Bellugi's admonition that such techniques serve only to supplement the findings obtained from children's spontaneous speech. Tests of linguistic competence can never be rich enough, subtle enough, or sensible enough to stand on their own.

Perhaps the best known test of children's productive abilities is the test devised by Berko (1958). A comparable test has been independently developed by Bogoyavlensky (1957) for use with Russian children (cf. Slobin, in press). Berko investigated the development of the morphological inflections of English: plural marking of nouns, past-tense marking of verbs, comparative marking of adjectives, plus some others.

The test uses a set of drawings of exotic creatures doing ordinary things, or ordinary creatures doing exotic things. Berko used it with children four to six years old, although it has been used with children as young as two (Lovell, in press). One drawing, for example, shows a shmoo-like creature. It is introduced as a wug. -- "Here is a wug." Then two more are shown, the experimenter saying, "Here are two others, there are two....," his voice trailing off, hoping to elicit a plural inflection. The test includes items presenting each of the conditioning phonemic environments of the plural and past-tense inflections of English, so by the end, one has collected a complete sample of a child's morphological inflections.

Studies of comprehension. A second methodological issue involves the comprehension of grammatical forms -- how it is to be investigated, and why. Unlike the first methodological issue, which involves the clarification of the proper role of an existing method, this methodological issue involves the clarification of the requirements of a method that does not yet exist.

There are several reasons for studying comprehension. As one of the linguists at The Fourth Conference on Intellectual Processes (Bellugi and Brown, 1964) pointed out, in comprehension the investigator knows what the input to the process is -- it is the sentence comprehended. Thus, when comprehension fails, the source of trouble can be located. The same cannot be said for production. What is the input for, say, what I can do mommy?

Moreover, even though the results of production are easy to observe, it is not always obvious what the observations mean. Does the fact that a child systematically excludes auxiliary verbs from his speech signify the absence of Aux from his grammar, or does it, on the contrary, indicate censorship of Aux from his speech in order to meet the constraints of an abbreviated memory span? Although these are matters of production, it is only through the testing of comprehension that such questions can be settled.

In what follows, the few studies that have attempted to investigate comprehension are described, their limitations pointed out, and some promising new techniques presented.

Brown (1957) demonstrated that certain of the major grammatical classes have semantic correlates for children. He used an ingenious test of comprehension, which apparently has not since been employed. A child is shown a drawing of someone performing a strange action with a peculiar substance contained in an odd bowl. The picture thus presents an action, a mass, and a container -- three states that would be described in English by a verb, a mass noun, and a count noun, respectively. As the picture is shown, the experimenter says what it is: it shows how to wug, or some wug, or a wug. Whichever the child is told, he is next shown three drawings -- one of the action alone, one of the mass alone, and one of the container alone -- and is asked to select the one that portrays what was labeled in the first picture. To the degree that a child is sensitive to the referential implications of verbs, mass-nouns, and count-nouns, he will be able to make appropriate choices (but see Braine, in press, for a different interpretation). Brown used this test with nursery-school children, finding them to be sensitive to the implications of each grammatical class. In view of the claim sometimes made (e.g., Slobin, 1966a), that children first construct grammatical classes on a semantic basis, it would be useful to repeat the experiment with younger children, say two-year-olds.

A second test of the comprehension (as well as the production) of speech appears in an experiment by Fraser, Bellugi, and Brown (1963). Their method has come to be called the ICP Test, for Imitation, Comprehension, and Production. Again, a set of drawings is shown to a child, this time in pairs. Each pair presents a referential correlate of some syntactic contrast -- e.g., subject versus direct object (a boy pushing a girl and a girl pushing a boy). In all, 10 different contrasts are represented. Comprehension is tested by saying to

a child, "Here are two pictures, one of a boy pushing a girl, and the other of a girl pushing a boy," care is being / not to show which picture goes with which sentence. The child is then asked to point to the picture that illustrates one of the sentences -- "Show me the picture of the girl pushing the boy." The test of production begins in the same way, but instead of asking the child to point to the picture for a sentence, he is asked to give a sentence for a picture. Fraser, et al. conducted their study with three-year-olds. and Dixon Lovell (1965) have done it with two-year olds, with much the same results.

Such studies of comprehension, clever though they are, suffer a common limitation. All use picturable correlates of various grammatical contrasts and classes. But not every aspect of syntax has a picturable correlate; indeed, most of syntax cannot be so represented, as the reader can persuade himself by a glance at the Appendix. It is always possible, of course, that further ingenuity will discover more grammatical forms that can be tested in this way. However, this is of little significance for as the method is extended further, it must use more and more dubious connections between language and portrayable events. The methodological problem, then, is to devise tests of comprehension that make use of the linguistic materials themselves, not the fortuitious correlations between language and the external world.

Two studies that point in this direction are Bellugi's (1965) and Brown's (1966). They searched their longitudinal records for spontaneous dialogues between children and adults, looking at the children's answers to the adults' questions. The aptness of the answer was used as an index of comprehension. If an adult asks, for example, what did you hit? and a child answers, arm, we can assume that the question was understood. But if the answer is hit, we can conclude that the child does not yet know the transformation relating Wh-forms to the underlying object of sentences. Some caution must be exercised in accepting appropriate answers at face value, as it



is always possible that extra-linguistic factors evoke an utterance that happens to be appropriate. Nonetheless, the method applies to any Wh-question, and has the virtue of involving spontaneous linguistic performance. But only Wh-questions are within its reach, so it is hardly general, even though it is not limited by language-environment correlations. A third study escapes some of these shortcomings.

Slobin and Welsh (1967) have used the simplest of methods for studying linguistic development -- imitation. For reasons discussed below (pp. ), it is evident that children usually reformulate sentences given to them for imitation. Adult sentences too long to be retained in immediate memory are invariably altered so as to fit the child's grammar of the moment. For example, suppose that a child who is not yet inflecting verbs for the progressive aspect is asked to repeat Adam's nose is dripping this morning. If the entire sentence is beyond the child's capacity for immediate recall, the relevant part will be imitated nose drip, not nose dripping. The model is reduced to the child's current grammar. Beyond the limits of immediate memory, a child produces in imitation only what he produces in spontaneous speech -- which means that imitation can be used to study children's productive capacities, a fact known and utilized for some time (Menyuk, 1963 ; Lenneberg, Nichols, and Rosenberger, 1964 ; Slobin, <sup>^</sup> and press)

However, Slobin and Welsh have used imitation to study comprehension as well. They have exploited the fact that reformulation in imitation depends on comprehension. In contrast to the use of imitation to study production, where the focus is on verbatim repetition, the focus in comprehension is on non-verbatim repetition combined with the preservation of meaning. When children reformulate a sentence in imitation, they express parts of the underlying structure of the model in a surface structure consistent with their own grammars. But when children fail to comprehend the model, they are unable to

recover its deep structure. The imitation will then inevitably express a different meaning, or, more likely, no meaning at all. In this way -- by noting whether or not reformulated imitation preserves meaning -- comprehension can be studied.

The method can be (and has been) used with very young children, and can be applied to any aspect of the structure of sentences. Children can be induced to repeat what adults say, particularly if they are familiar with the investigator; and the sentences to be imitated are entirely a matter of the investigator's choice, so the method can be used selectively.

The following are a few of the examples given by Slobin and Welsh (1967). All are imitations by Welsh's two-and-a-half-year old daughter. The first two are meaning-preserving, the last two are meaning-changing:

Adult: HERE IS A BROWN BRUSH AND HERE IS A COMB

Child: Here's a brown brush an' a comb

Adult: JOHN WHO CRIED CAME TO MY PARTY

Child: John cried and he came to my party

Adult: THE BATMAN GOT BURNED AND THE BIG SHOE IS THERE

Child: Big shoe is here and big shoe is here

Adult: THE BOY THE BOOK HIT WAS CRYING

Child: Boy the book was crying

The first two imitations indicate an ability to comprehend but not produce certain grammatical forms, whereas the last two indicate a failure of comprehension. The method deserves exploration, for it appears to have the virtues of generality and naturalness that the other methods for testing comprehension lack.

The Berkeley Cross-Cultural Project. Although not a method itself, except insofar as a program for investigating language acquisition in other

cultures may be called a method, a group at the University of California (Berkeley) has compiled a manual of procedures (Slobin, 1967) for use in the field studies of children and their language. In addition to the manual, the Project sends workers into remote places, pith helmet in hand, to observe children exposed to exotic languages.

#### THEORIES OF LANGUAGE ACQUISITION AND EARLY SPEECH

Perhaps the most striking recent development in the study of language acquisition is a resurgence of interest in theory. In an earlier period the explanation of linguistic development was a major goal. Entire books were devoted to the problem -- for example, Stern and Stern (1907) and de Laguna (1927). But that was 40 or more years ago. The years since then have been a time of relentless description, noteworthy as much for an indifference toward theory as for a sturdy accumulation of facts and figures. The entire literature has been excellently summarized in preceding editions of this Manual, and will not be much touched on here. We shall, instead, concentrate on the recent developments in theory and the empirical work associated with them. The issues posed, both by theory and observation, are significant enough to warrant the devotion of space and attention.

Let us begin with a description of the speech of a two-year-old. Not everyone has had the privilege of attempting to converse with such a person, at least not recently. The following speech, taken from records collected by Brown and Bellugi (1964), will set the tone. The first sample is from a 27-month old child, the second from the same child at 35 months, and the third at 38 months. Vivid changes take place from sample to sample, a number of which will be discussed below.

Child (28 months)

Adult

What dat...somebody pencil

Whose pencils are they?

Floor

Floor?

Where birdie go?

Birdie

Birdie up dere

Birdie

Read dat?

Will you read it to me?

Read dat?

Is that a hammer, Adam?

What inere?

Hammer

Hit hammer, mommy

No Cromer \_\_\_\_\_, mommy?

Hurt

Poor Adam. Did you hurt yourself? What happened, Adam?

Screw (did) happen

Screw happened' You didn't even have a screw.

have screw

\_\_\_\_\_no down there...

table...get broom

Does that one fit?

Yep, it fit

Yep, it fit

Does it fit?

No...fit

Put suitcase...for?

What did you put it in the suitcase for?

What dat?

That's tape. We'll use that one tomorrow.

All right 'morrow

Shall we use it tomorrow?

Yep

Use morrow, yep

Sure, use morrow

Child (35 months)

Adult

What his name?

His name

His name, Ursula?

I know his name

No...I don't know his name  
I don't know  
Can't come up, fellah (to a yo-yo)  
Going pick pick up  
Lemme do again  
Don't...don't hold with me  
Turning round

It's stop

What dat...feeled...like?  
What dat feeled like?

I...going...drop my books (drops one book)  
An' what happens?  
I going drop it...inne dump truck

No...please cry, cracker

Cracker

Please cry, cracker.

Yes

Why not...cracker can't talk?  
Romper domper tell me boo  
Romper domper tell me beo  
I got someping show you  
What's dat...you have?  
Why me go?  
Why me going?  
D'you want brush him?  
D'you want he walk?  
Where's it?  
Why you rolling up?  
Hey, why...why you waking me up?  
What you doing...taking out?  
Why you knocking me off?

Why not?  
I can't...couldn't...show it...to her

No  
I too big  
Dose are mines  
Dat's mines

Yes, it is turning around

It stopped?

It feels like rubber, I  
guess.

What?

Please what?

Please cry?

How can a cracker cry?  
Crackers can't talk.

I'm not knocking you  
off

You're going to show it  
to her?

Child (38 months)

Adult

I like a racing car  
D'you like some?  
I broke my racing car

Oh, did you used to have one?

Yes  
Look at dat one

What part broke?

Like dis part broke  
Dis part broke, like that  
It's got a flat tire  
What is dat?  
It's a what?  
He...his mouth is open  
What shall we shall have?  
Why he going to have some seeds?  
Why it's not working?

You got some beads?

Yes

Just like me?  
I got bead 'round myself  
Hit my knee

Hit my knee

Hit your knee  
What dat teacher will do?

Why you pull out?

Dust in your hair

Who put my dust on my hair?

Can you tell Ursula what  
the lesson is...on the  
blackboard?

On the black which board?  
We going see another one  
We can read 'bout dis  
You wanto read?  
What is dat?  
What is dat got?  
It's got a flat tire  
When it's got flat tire, it's needs to  
go to the ...to the station.  
The station will fix it.  
Tank come out through what?  
Really...tank come out through...here  
Mommy don't let me buy some  
What is dis?

That's a marble bag

A marble bag for what?

For marbles  
It would be good to  
carry tiny cars.

What is dat?  
Can I keep dem?  
Why I can keep dem?  
Now can I keep dem?  
We don' do some games  
It's broked?

At 28 months, a child's speech may often seem random; some may uncharitably claim that it is not much improved at 38 months. Words appear to be thrown together haphazardly. The meanings often seem bizarre. But not so. Even the earliest word combinations are organized on definite principles; and the content is not bizarre, but banal. In the following sections, we shall review the evidence for these claims and some possible explanations of them.

Telegraphic speech. Brown and Fraser (1963) have called the patterned speech of very young children "telegraphic." The expression aptly captures one characteristic feature of children's first multiple-word utterances: both in telegrams and in child speech, certain words are systematically eliminated. Looking at the sample collected at 28 months, we can see that articles, auxiliary verbs, copular verbs, and inflections of every sort are all missing -- put suitcase...for? where birdie go? what innere? and yep, it fit.

The telegraphic analogy is provocative and worth considering. Perhaps child speech is telegraphic for the same reason that real telegrams are -- to save on costs. Just as a telegram-writer, in order to save currency, may delete the least informative words of a message while retaining the content words and their order, a child may do the same to save space in memory. The fact that identical words, by and large, are eliminated in both situations adds some credence to the argument. But there are two difficulties with this account -- one conceptual and one factual.

The factual problem is that children learning Russian also omit

inflections from their early speech (Slobin, 1966b). Russian is a case-inflected language, and so conveys a great deal of information through certain inflections. Indeed, some of the information conveyed by word order in English is conveyed by inflections in Russian -- the subject of a sentence, for example. Thus, in terms of informational importance, Russian children eliminate what American children retain, though both eliminate inflections. Clearly, it is not informativeness that counts.

The conceptual difficulty is that, although the least informative words of English tend not to appear in child speech, a lack of informativeness is itself a highly implausible explanation of this fact (Weksel, 1965). The only way a child could know whether or not a word is informative without knowing its syntactic role in advance (a possibility excluded in this case) is by keeping records of the speech he has heard from his parents. Equipped with such records, he could discover which words are used with low frequency, and so are informative. But this is a vast actuarial undertaking -- so vast that psychologists who want such records turn to computers for assistance, and implausibly vast for the unaided mind of a two-year-old.

Telegraphic speech is the outcome of the process of language acquisition. It is not the process itself. To understand it, we must penetrate more deeply into what children do.

Holophrastic speech. It is convenient to begin even before the period of telegraphic speech. "Holophrastic speech" refers to the possibility that the first single-word utterances of young children express complex ideas -- that ball means not simply a spherical object of appropriate size, but that a child wants such an object, or that a child believes he has created such an object, or that someone is expected to look at such an object.

Many investigators of children's language (e.g., de Laguna, 1927; Stern and Stern, 1907; Leopold, 1949; McCarthy, 1954) have said that the



single words of holophrastic speech are equivalent to the full sentences of adult grammar. It is true, of course, that adults typically require a full sentence to express the content of children's holophrastic speech. But this is not what is meant by the term "holophrastic." Rather, holophrastic speech means that children are limited phonologically to uttering single words at the beginning of language acquisition even though they are capable of conceiving of something like full sentences. Let us look into this claim, for it is central to understanding the course of events in later stages of language acquisition.

In what sense do children have in mind the content of a full sentence while uttering a single word? No one believes that children have detailed and differentiated ideas in the adult manner. On the contrary, everyone who has written on the earliest stages of language acquisition agrees that the conceptual side of holophrastic speech is undifferentiated and global. As Leopold (1949a) puts it, "...the word has at first an ill-defined meaning and an ill-defined value: it refers to a nebulous complex, factually and emotionally; only gradually do its factual and emotional components become clearer, resulting in lexical and syntactic discriminations (p. 5)."

A degree of semantic imprecision in holophrastic speech is therefore taken for granted. There remains, however, a question of what it is that children are imprecise about. Several factors seem to be important. Often children's single-word utterances are closely linked with action, sometimes so closely linked that action and speech appear fused. A child speaks both when he acts and when he wants action from others. Leopold's daughter, for example, said walk as she got out of a cart to walk, away as she pushed something away, and blow as she blew her nose (all at 20 months). Leopold (1949) calls these utterances self-imperatives to distinguish them from true imperatives -- utterances apparently directed toward someone else. Of the latter, mit from komm mit, ma from come on, and away from put it away are examples (also at 20

months). (Leopold's daughters grew up as German-English bilinguals.)

Besides such imperatives and self-imperatives, children's early speech often seems imbued with emotion. Indeed, Leopold believes that the first step in linguistic development occurs when a child attaches emotional significance to sounds produced accidentally while babbling. Meumann (1894) holds a similar view, believing that a child's first words express his "emotional relation" toward the objects and events referred to. This expressive aspect of children's speech maintains its dominating role for some time. According to Stern and Stern (1907); summarized briefly in English by Blumenthal, in press), the first word combinations of children consist of one part interjection and one part statement, the former continuing from the earliest stages of development six to 12 months before.

There is some consensus, then, that holophrastic speech is expressive of children's emotional state, as well as fused with action. There is yet a third characteristic. Holophrastic speech apparently rests on an ability to name things. A child expresses his feelings about whatever is indicated in his utterance. The utterance [mam:a], for example, seems to have meant for Leopold's daughter both "delicious!" and "food." The utterance had both an expressive and referential component. (It did not mean "mama" until six months later.)

Not every occurrence of holophrastic speech is limited to naming, however. Some utterances are purely expressive. Leopold's daughter said [dididi] in a loud voice to indicate disapproval and in a soft voice to indicate comfort. [dididi] was in fact an exclamatory call, much like the calls of apes, and was graded as these calls often are from loud to soft; [dididi] was an articulated grunt. (cf. Marler, 1965, for examples of grading in The calls of rhesus monkeys.)

Examples of all these characteristics of holophrastic speech are included in Table I, which is a list of the first seven "words" observed in the develop-

ment of Leopold's daughter. Utterances marked with an asterisk were originally babbled sounds; the rest have recognizable sources in adult speech. The "words" of Table are typical of the early one-word utterances recorded by others (Stern and Stern, 1907).

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Insert Table I here

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Holophrastic speech has three intertwined functions. It is fused with action; it expresses a child's emotional and motivational condition; and it names things. The expressive aspect of holophrastic speech sometimes appears in pure form, as in [dididi]. Holophrastic utterances may become fused with actions as in the case of walk. They may refer to objects when the objects evoke certain feelings as in the case of [mam:a]. These are the attested functions of holophrastic speech.

It is also possible that holophrastic speech is sometimes purely nominal in function -- a pure labeling of an object or event, without any emotional or enactive elaboration. Indeed, various psychologists have at one time or another assumed that all primitive utterances from children serve this purpose: a child learns the name of an object and says the name when the object appears before him. However, the fact is that no one has ever observed such nominal speech. When a one-year old says daddy, he does not simply refer to that personage, however amorously conceived, but to something about daddy. We have here a fundamental fact of language acquisition.

Holophrastic speech as predication. The expressive and enactive aspects of holophrastic speech are best understood on non-linguistic grounds; expressiveness is an example of the exclamatory function of primate communication in general (cf. Marler and Hamilton, 1966); the fusion of speech with action is probably a consequence of the sensory-motor period in general cognitive develop-

ment (Piaget, 1952). Here we consider a more special question, that holophrastic speech is never purely nominal, but that it is usually uttered about something. It is in this way that holophrastic speech corresponds to full sentences in adult speech.

de Laguna (1927) viewed the single-word utterances of children as predicates, comments made by a child on the situation in which he finds himself. The holophrastic word is the comment. Together with the extra-linguistic context, which is the topic of the comment, it forms a rudimentary kind of proposition, and thus amounts to a full sentence conceptually.

It is worth quoting de Laguna's peroration in full:

"It is precisely because the words of the child are so indefinite in meaning, that they can serve such a variety of uses; and it is also -- although this sounds paradoxical -- for the same reason, that they are fit to function as complete rudimentary sentences. A child's word does not ... designate an object or a property or an act; rather it signifies loosely and vaguely the object together with its interesting properties and the acts with which it is commonly associated in the life of the child. The emphasis may be now on one, now on another, of these aspects, according to the exigencies of the occasion on which it is used. Just because the terms of the child's language are in themselves so indefinite, it is left to the particular setting and context to determine the specific meaning for each occasion. In order to understand what the baby is saying you must see what the baby is doing." (1927, pp. 90-91, italics in original).

In Table I [mam:a] is listed as meaning both "food" and "delicious!" But this is only its apparent meaning if we accept de Laguna's interpretation of early speech. With that interpretation, Leopold's daughter said [mam:a] as a comment (delicious) on an extra-linguistic topic (food). Several other "words" in Table I can be interpreted in the same way -- [ʔʔ] and [dɛ:], and possibly [pIti], [nenene], and [t t!]. On the other hand, [dididi] was not a comment at all, and [nenene] and [pIti] may not have been either.

If we accept de Laguna's interpretation of holophrastic speech, we can see why purely nominal utterances never occur. Except for those occasions when children's speech is purely expressive, it is invariably predicative. Children

cry, or comment, and sometimes both. But they never utter mere labels. This is a remarkable fact of human communication, and we shall see its effects at every stage of linguistic development. One such stage is the following.

Pivot and Open classes. The terms, "Pivot" and "Open," are taken from Braine (1963a) and refer to the outcome of a distributional analysis of child speech. When such analyses are conducted on speech collected from children of 18 months or so, at least two classes of words emerge. One class contains a small number of words, each of them frequently used -- the "Pivot" class. Words from the Pivot class always appear in combination with words from the open class, and the class itself is slow to take in new members. The position of Pivot-words in two-word sentences is fixed, first for some children, and second for others, but never both. The "Open" class contains the words not in the Pivot class. There is typically a large number of Open-words, which are therefore used infrequently in two-word sentences. The Open class is quick to take in new members, and may stand alone in a child's speech. Given a two-word sentence the position of Open-words is fixed with respect to the position of Pivot-words. Open-words also appear in combination with each other, although not necessarily in fixed relative positions. Some children have a second Pivot class as well, which shares no members with the first. The two Pivot classes sometimes occupy complementary sentences positions, but when they do, they never appear in combination with each other.

Such are the characteristics of the Pivot-Open distinction. The distinction can be summarized by setting down the combinations in which Pivot- and Open-words appear -- the basic fact supporting the distinction in the first place. Using "P" and "O" for "Pivot" and "Open," and assuming a child with a full complement of both classes, the following occur:

$P_1 + 0$

$P_1 + 0$

$0 + P_2$

$0 + P_2$

$0 + 0$

0

The only possibilities that never appear are Pivot-words uttered alone or in combination with each other. Everything else is possible.

Table 2 shows the Pivot and Open classes of three children studied by Brown and Bellugi (1964), Braine (1963a), and Miller and Ervin (1964), respectively. The table itself is from McNeill (1966a). For want of space, only a portion of each Open class is represented, but the Pivot classes are included in their entirety.

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Table 2 here

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For the children in Table 2, sentences all consisted of a word from the list on the left followed by a word from the list on the right -- that is,  $P + O$ . Thus, byebye fan, wet sock and that doed all occurred. Not every combination allowed by Table was actually observed, of course. But there are no evident differences between the combinations that did occur and those that did not, so it is assumed that the gaps arise from sampling, not grammatical, restrictions.

What is to be made of the Pivot-Open distinction? Perhaps nothing at all. It is possible that the speech of young children arises through rote memory, as a simplified imitation of adult speech. If so, it would be a mistake to ascribe grammatical significance to what, in this case, would be an artifact

of a distributional analysis. Before proceeding, therefore, we must first consider the possibility that the Pivot and Open classes do not mark the beginning of grammar in children.

There are several reasons for rejecting such a possibility. For one thing, if the sentences recorded from children are not produced but reproduced, the fact would reflect an astonishing ability to memorize verbal material. The number of different combinations recorded from one of Braine's (1963a) children in successive months was: 14, 24, 54, 89, 350, 1400, 2500+. It is unlikely that the child was echoing 2500+ different combinations already heard.

There is a second reason for accepting Pivot-Open distinction as a genuine grammatical innovation. Not only is it implausible that a great variety of forms in the speech of children could result from imitation, but in some cases it is impossible that their speech could be so derived. Take Braine's subject in Table 2, for example. He said such things as allgone shoe, allgone vitamins, and allgone lettuce -- all apparently inversions of the corresponding adult models: the shoe is allgone, the vitamins are allgone, the lettuce is allgone. Similar observations can be made of other children. Ervin's subject said that doed, and Brown's, big a truck. Children do not hear English even remotely like this from their parents, but these examples correspond to the Pivot-Open pattern, and their occurrence reinforces a belief that the distinction reflects a genuine division of children's vocabulary into two classes.

The most compelling argument in behalf of the Pivot-Open distinction is the fact that Pivot words never occur alone or in combination with each other. Beginning approximately with the first birthday and continuing until 18 months, children utter only single words. Some of these words later become Pivot words, and so appear only in combination, whereas others become Open words and appear both in combination and in isolation. It is impossible to think of such a development as not reflecting a restriction on the use of words

-- i.e., as not reflecting a grammatical system of some kind. In fact, the Pivot-Open distinction is a reflection of children's most primitive grammar. It is to a description of that grammar that we now turn.

Early grammatical rules. The present section relies heavily on the work of Brown and his colleagues (Brown and Fraser, 1963; Bellugi and Brown, 1964; Brown, Cazden, and Bellugi, in press). They have followed the linguistic development of three children, two girls and a boy, the study beginning in each case at roughly two years and continuing, for one child, until age five. The goal of the research of Brown and his colleagues has been to describe the linguistic competence of children at different points in development and to express these descriptions in the form of generative grammars. We shall first consider the results of their descriptive efforts, and then turn to a theoretical interpretation of them.

Not amazingly, grammars written for the earliest stages of development are simple in the extreme. The following rules summarize the performance of one child in Brown's study, Adam, at 28 months (after McNeill, 1966a):

- (1)  $S \longrightarrow (P) \quad NP$
- (2)  $NP \longrightarrow \left\{ \begin{array}{l} (P) \quad N \\ N \quad N \end{array} \right\}$
- (3)  $S \longrightarrow \text{Pred P}$   
 $\text{Pred P} \longrightarrow V (NP)$

Rules (1), (2), and (3) describe one, two, and three-word sentences, the length of a sentence depending on the options adopted in each rule. As usual, optional elements are enclosed within parentheses. Rules (1) and (2) apply to such sentences as ball, that ball, and Adam ball -- i.e., N, PN, and NN. Rules (2) and (3) apply to such sentences as want ball, want that ball,



and want Adam ball -- i.e., VN, VPN, and VNN. In addition, rules (1) and (3) sometimes apply together, always in such a manner that the result of (1) precedes the result of (3), as in Adam want ball and Adam ball table -- i.e., NVN and NNN.

The combinations allowed by Rules (1), (2), and (3) did not occur in Adam's speech with equal frequency. For example, Rule (3) was employed more often than was Rule (1); the option of including P in Rule (2) was never taken; and the joint application of Rules (1) and (3) occurred only 15% of the time.

All these characteristics and more are set forth in Table 3 which lists every combination of P, V, and N observed to occur in Adam's speech at the earliest stage for which observations exist, along with the frequency of occurrence of each combination. It is of course possible that a larger sample of Adam's speech would contain examples of other combinations; there is no way to judge such a possibility. However, as will be discussed below (pp.     ), the combinations that did occur in Adam's speech possess a certain consistency, which the combinations that did not occur lack.

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Insert Table 3 here

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Rules (1), (2), and (3) adhere closely to the superficial details of Adam's speech. The rules summarize the patterns in Table 3, but they do not exhaustively describe Adam's linguistic competence, and they may not represent it at all. It appears, for example, that the phrases described by Rule (2) can have two different implications when a P is chosen for the first position. Sentences of this type strike an adult as being sometimes demonstrative (that ball) and sometimes modificational

(little ball). If Adam were actually honoring such a distinction, but not marking it in overt speech, Rule (1) would fail to reflect it. Adam in this case would treat as different constructions the Rule treats as the same. We shall return to this general matter below; there are a number of issues involved and it is convenient to discuss them in one place.

Rule (2) defines a particular grammatical constituent: it says that Adam possessed NP's at 28 months and that these consisted of a N, a PN combination, or a NN combination. Rules (1) and (3) in turn contain NP as a sub-part. What justification is there for ascribing such a superordinate constituent as NP to Adam? Could we not instead write several separate rules -- one for N, one for PN, and one for NN? Doing so would account for the same combinations of grammatical classes in Table 3, but would avoid claiming that Adam was acquainted with the abstract sentence constituent, NP. However, there are several lines of evidence pointing toward the "reality" of NP in Adam's grammar, and hence supporting such definitions of NP as Rule (2).

Consider, first of all, some distributional facts. One is that single nouns and developed noun phrases appear in the same environments in children's speech (Brown and Bellugi, 1964). For example,

Positions for Single N

that (flower)

where (ball) go?

Adam write (penguin)

(horsie) stop

put (hat) on

Positions for NP

that (a blue flower)

where (the puzzle) go?

doggie eat (the breakfast

(a horsie) crying

put (the red hat) on

Apparently, wherever N can go NP can go, presumably because individual N's are actually NP's.

Another bit of evidence is that pauses in children's speech usually bracket NP's, not N's. "Put...the red hat...on" is a likely occurrence, whereas "put the red...hat...on" is not. Insofar as pauses reflect points of decision in speech (Goldman-Eisler, 1961), such sentences indicate that decisions are made in terms of NP and not N.

Finally, consider the fact that the pronoun it is really a pro-noun phrase, since it replaces NP and not N. This is the case in the English of adults, and it is also the case in the English of children, as the following pairs reveal:

Mommy get ladder

Mommy get it

Mommy get my ladder

Mommy get it

Adam sometimes combined both the pronoun and the NP the pronoun should have replaced in a single utterance, as in Mommy get it ladder and Mommy get it my ladder. That the NP and N are treated alike, even in this case of deviation from the rules of adult English, is further evidence that NP is a genuine constituent.

There are, in short, grounds for assuming that NP is a superordinate constituent in children's early grammars. Except for sentences like ...get it my ladder, which was peculiar to Adam, all children provide evidence of the sort summarized above; NP's appear in the life of a child even before measles do.

Rules (1), (2), and (3) describe Adam's sentences when he was 28 months old. At this point, his sentences were less than two morphemes long on the average. Nine months later Adam's sentences have increased only slightly in length -- to nearly three morphemes on the average -- but his grammar has been much elaborated. Instead of three phrase-structural rules, the grammar now contains 14; instead of there being no transformational rules, the

grammar now has two dozen. Table 4 presents the entire phrase-structural component, and two rules from the transformational component, of the grammar written for Adam's speech at 36 months. The sentences generated by this grammar are of the type on pp. , all of which are taken from Adam's protocols at 35 and 38 months.

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Insert Table 4 here

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The easiest way to convey an idea of the sentences described by the grammar in Table 4 is to provide a few examples; this is done in Figs. 1 - 4 . Before considering them, it is necessary to explain the following notational conventions.

Imp and WH are grammatical markers, representing in the first case imperative sentences and in the second case such questions as what, where, and who. Neg stands for negation, MV for main verb, and Cop for copula (e.g. is in the dog is an animal). V<sup>c</sup> is a "catenative" verb -- wanna, gonna, and hafta. Adverb is a sentence constituent, like NP, whereas Adv is the grammatical category of adverbs proper. Because Adam sometimes produced sentences of the form, that my book, and sometimes of the form, that's my book, a distinction is drawn between be and B; the former is a variant of the auxiliary verb, to be; the latter represents the same syntactic function but is never expressed in the surface structure of a sentence. Det stands for "determiner," a category including such words as the, a, that, this, these, and those. Prt stands for "particle" -- e.g. the up in look up, and the down in put down. The symbol some  $\Delta$  in the first transformational rule covers both somewhere (from phrase-structure rule 11) and something (from phrase-structure rule 13), both of which are grammatical markers, not words. The remaining symbols are defined by the grammar itself.

With these symbols in mind, we can consider some of the sentences the grammar yields. The particular examples are where those dogs goed, don't throw that ball, who jumping on me, and Susan is in the bath. Four sentence types, of course, do not exhaust the variety of grammatical forms that Adam produced, but together they illustrate the workings of most of the parts of the grammar in Table .

Fig. 1 shows the deep structure of where those dogs goed, a well-formed question for Adam (from Brown, et al., in press). Ten of the 14 phrase-structure rules in Table 4 are used to generate this phrase marker (rules 1, 2, 3, 4, 5, 6, 10, 11, 13, and 14); the two transformations listed at the bottom of the table relate the phrase marker to the surface structure of the sentence.

---

Insert Fig. 1 here

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Fig. 2 shows the deep structure of an imperative sentence, don't throw that ball. Seven phrase-structure rules are involved, plus two transformations (not included in Table 4 ), one of which has the effect of deleting the subject of the sentence, you, and the other of introducing do and affixing it to Neg. The phrase-structure rules are 1, 2, 3, 4, 6, 13, and 14.

---

Insert Fig. 2 here

---

Who jumping on me, is a WH-question, like the first sentence, but contains in addition a prepositional phrase and a verb in the progressive aspect; the auxiliary verb, is, has been omitted. Fig. 3 is the deep structure generated by the grammar; a transformation parallel to T2 in Table 4 reverses the order of ing and jump, and a morphological rule changes WH-someone to who. Because B and not be is the form of the auxiliary verb, the

surface structure omits an auxiliary.

---

Insert Fig. 3 here

---

A final example is diagrammed in Fig. 4 -- the deep structure of Susan is in the bath. In this case, be is part of a copular not an auxiliary verb, so the affix-verb transformation required for who jumping on me does not apply. Phrase-structural rules 1, 2, 7, 8, 9, 10, 11, 12, 13, and 14 are used to generate this deep structure.

---

Insert Fig. 4 here

---

The grammar in Table 4 is not complete for Adam at 36 months, and its omissions create two distortions the reader should be warned against. One distortion arises from the fact that only two of Adam's transformations are included in Table 4. Much of the complexity in the phrase-structural component, particularly in the development of the predicate, exists to support the transformations not in the Table; omitting them naturally leaves a number of phrase-structural features undemonstrated.

A second distortion exists in the manner of introducing words into the deep structure. In Figs. 1 - 4 words -- such as Susan, on, jump, etc. -- are simply appended to the bottom of the phrase marker. Their relation to the remaining structure of the sentence is left unanalyzed. However, the grammar developed for Adam by Brown, et al., goes farther. Each word in Adam's lexicon is represented as a set of syntactic features. The features state, in effect, the contexts each word can occupy, plus the characteristics of each word as a context for other words. This can be done quite compactly. Take dog, for example. For Adam at 36 months, dog was a count noun, it could

be pluralized, and it could follow determiners. The last feature states a context for dog, whereas the first two features state characteristics of dog when it is the context of something else. In formal notation, these properties of dog can be collected in the form of a lexical entry as follows:

+ N
[+Det ____]
+ ct
+ no

dog

The +N at the top signifies that dog belongs to the category of nouns. The +ct indicates that dog belongs to the subcategory of count nouns -- that it is a word like table, man, and idea, and unlike sand, mush, and justice. The +no indicates that dog belongs to the subcategory of nouns that can be either singular or plural, and so is unlike such words as pants, justice, and John. Finally the [+Det \_\_\_\_] means that dog can follow determiners.

A rule of the grammar governs the insertion of words into phrase markers by requiring that all such phrase markers present the features specified in the word's lexical entry. Fig. 1, for example, can receive dog -- there is a slot of the right kind. So also with Figs. 2 and 4. But Fig. 3 has no place for dog or any other noun, for it accepts only pronouns in the two "nominal" positions.

When a lexicon is completely specified, it is possible to play items off against each other when inserting words into phrase markers. In this way the grammar can avoid describing bizarre combinations -- such non-sentences as Where is in the dog.

We have sketched briefly the development of the phrase-structural component of child grammar. We have seen that only a few rules are needed in the early stages to summarize the sentences children produce -- in the case of

Adam, only three. A relatively short time later -- nine months for Adam -- many more such rules are needed, a number of them possessing greater complexity than the few original rules.

Besides these changes, a child's grammar becomes elaborated through the introduction of transformations. None are included in the earliest grammars for children's speech; but six to 12 months later, 24 are used in the grammar written for the speech of the three children studied by Brown, et al.

What do such developments tell us? The point has arrived where we must try to understand them. First to be discussed will be the rules of the phrase-structural component; then the transformational component. Many issues connected with the innate endowment of children for language arise with the first, and equally many issues connected with the linguistic experience of children arise with the second. All these matters will become clear as the discussion proceeds.

Contextual generalization. Braine (1963a) was the first to point out the distinction between Pivot and Open classes, and we shall begin with his account of the distinction and the view of language acquisition it entails.

Pivot words are so called because to Braine they are the only words for which a child knows the proper temporal location in a sentence -- that they occur first, last, etc. Open words are used wherever Pivot words are not, which means that in two-word sentences the positions of both Pivot and Open words are locked in place.

Various characteristics of the Pivot-Open distinction neatly follow from this simple account. . . Because at first a child knows the location of only a few words, pivot words are used with high frequency, and the class itself has few members. . . The Pivot class increases membership more slowly than the Open class, presumably because it is more difficult to learn the positions of words than it is to learn new vocabulary regardless of position.



The main characteristic of the Pivot-Open distinction not accounted for by Braine's theory is the restriction on the use of Pivot words -- that they rarely appear alone or with other Pivots. This restriction should not exist if children learn only the positions of words in sentences. It is one thing to learn where to put a word in a sentence; it is something very different to learn to put it nowhere else or only with Open words. But the restriction on the use of Pivot words carries most of the weight in justifying the grammatical relevance of the Pivot-Open distinction; an inability to account for it poses a fairly crucial problem.

Other objections have been leveled against Braine's hypothesis as well, but to present these issues we must first go into his argument in somewhat greater detail.

The actual mechanism of learning the position of words in sentences is left unspecified, although Braine has conducted a number of experiments purporting to demonstrate the existence of such a phenomenon (Braine, 1963b; but also see Bever, Fodor, and Weksel, 1965a). Whatever the mechanism, it applies when children hear sentences and causes them to classify words according to the relative position the words occupy. For example, upon hearing will you read it to me? a child could observe that you is in the first half of the sentence, and that read is in the second half. Both words can then be so classified. Contextual generalization -- the process by which this theory is generally known -- carries you and read into new, analogous contexts.

Contextual generalization is not essentially different from ordinary stimulus or response generalization, except that it takes place over temporal positions. Its merit in the present context is that it serves to explain linguistic productivity. Having learned that you comes first in some sentences, contextual generalization places it first in other sentences. From you read, a child can produce you come, you want, you sit, you bad, and, even, you all.

In short, you has become a Pivot.

Two-word sentences grow to three-word sentences and beyond because a child observes the relative position of words. Having learned that you appears in the first half of sentences, a child can later discover that you also appears in the first half of phrases. A child might learn, for example, that you is first in the phrase you should, and that this phrase is first in the sentence you should come. Contextual generalization again provides flexibility and the child can produce you can come, you should read, etc.

More important than the increase in length gained in this way, is the increase in the complexity of the structure. By learning that a word is first in a phrase, and that a phrase is in turn first in a sentence, a child learns that sentences are hierarchically organized. It is ((you should) come). Thus, positional learning, extended through contextual generalization, leads to the kind of sentence structure conventionally represented by a phrase-structural grammar. It is on this point that a rather loud dispute over Braine's theory has arisen.

The difficulty is that the order of words in the surface structure of sentences is not necessarily the same as the order of elements in the underlying structure (Bever, Fodor, and Weksel, 1965a, 1965b). Although it is only the underlying structure that contains information represented as a phrase-structure grammar, it is only the surface structure that is available for positional learning.

There is a dilemma here. The solution adopted by Braine (1965) is to restrict positional learning to simple declarative sentences, where the order of elements in the underlying and superficial structure is more or less the same. But this is to beg the question of syntactic learning. The cases where underlying and superficial structure are the same are among the things that a child must learn in acquiring language. The only way to avoid this

difficulty, also adopted by Braine, is to change the syntactic analysis of sentences, by construing them all as having the same underlying and superficial structures. But this is to avoid the problem of language acquisition altogether. It is instead to do a novel kind of linguistics, answering the question: what kind of language could be acquired through positional learning (McNeill 1968a)? Thus, the two horns of the dilemma. Faced with the alternatives of either begging the question of syntactic learning or being irrelevant to it, it is evident that Braine's theory fails in a fundamental way.

There are some auxiliary difficulties, also. Braine (1963; 1965) considers transformations to be "sublanguages," each deforming simple declarative sentences in some specific way. Passive sentences, negative sentences, and the like, are the result. However, the resemblance of a sublanguage to a grammatical transformation is entirely superficial, dealing only with the manifest form of sentences. Whereas a transformation in linguistic theory is a relation between a deep and surface structure, a sublanguage is a relation between two surface structures. The difference between these views is discussed by Braine (1965) and Bever, et al. (1965a, 1965b). See also McNeill 1968a and Weksel (1965).

If positional learning is not the way children develop knowledge of syntax, what then are we to make of the Pivot-Open distinction? Is it learned positionally, as Braine argues, only to lead nowhere -- a syntactic cul de sac, fallen into by virtually all children (according to Slobin, in press, a Pivot-Open distinction appears in the early speech of children exposed to Russian, Bulgarian, Croatian, French, German, as well as English)? A cul de sac is a possibility. But there is another fact about these early grammatical classes, which suggests they are directly related to later syntactic development, at least for some children.

Differentiation and generic classification. Adam, one of Brown and Bellugi's (1964) subjects, developed the grammatical classes of adult English through differentiation. The class differentiated was a Pivot class, the same one reproduced in Table 2, and the classes developed from it were articles, demonstrative pronouns, possessive pronouns, adjectives, and determiners. The entire process took place in five months, and followed the sequence diagrammed in Fig. 5.

---

Fig. 5 here

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Each step in Fig. 5 is the result of differentiating the Pivot class then existing into one or more adult classes plus a new residual Pivot class. The essential aspect of such differentiation is that entire adult classes are removed from the ancestral Pivot class in one step -- separate words do not straggle out at different times.

Zhenya, the son of the Russian linguist Gvozdev (1961), developed a Pivot class exactly like Adam's and formed adult grammatical categories through a comparable process of differentiation.

It is the phenomenon of differentiation that suggests a direct relation between the Pivot-Open distinction and later syntactic developments. For differentiation can take place only if the classes differentiated -- the Pivot class in Adam's case -- are generically appropriate (McNeill, 1966a).

A generically appropriate Pivot (or Open) class is one that ignores but potentially admits all the relevant distinctions of the adult grammar. Adam, for example, had the two articles in his Pivot class at Time 1; he did not have one in the Pivot class and one in the Open class. Similarly, every adjective then in Adam's vocabulary was in the Pivot class; there were none in the Open class. In fact, Adam's Pivot class contained every available member of

several adult grammatical classes, even though none of these classes were themselves recognized in Adam's grammar.

Differentiation always presupposes generic classification -- a fact not usually recognized. But generic classification is puzzling. For it means that children classify words (as Pivot and Open) in a way consistent with more subtle distinctions they are yet to draw, when differentiation takes place in the future. What guides children in such apparent teleology? The answer is by no means obvious or settled. Even to consider it, we must cover many of the recent observations made of children learning language.

Linguistic capacities, linguistic universals, and the problem of abstraction. According to one traditional view, language is a systematic relation between expression and content (see Appendix, p. ). In a transformational grammar such a view is embodied in the distinction between deep and surface structure: the deep structure of a sentence is associated with meaning, and the surface structure is associated with sound; deep and surface structures are in general different from each other, but stand in a specific relation, which is explicitly described for every possible sentence by the transformations of the language.

One inherent aspect of each sentence, therefore, is the existence of an abstract deep structure. It is the phenomenon of abstraction, which all children face and overcome, that eliminates Stimulus-Response theory as a possible explanation of language acquisition. The difficulties with Braine's theory, discussed above, derive from its commitment to this more general difficulty. The issues have been discussed in many places (Chomsky, 1959; 1965; Katz, 1966; Bever, et al., 1965a, 1965b; McNeill 1966, 1968a ), as well as in the Appendix of this Chapter, and need not be repeated here.

The phenomenon of linguistic abstraction presents a major theoretical challenge in the explanation of language acquisition. Fluent speakers somehow gain knowledge of the deep structure of sentences. They do so even though they never encounter such information in the form of examples, stimuli, or anything else.

Moreover, children make use of information organized as deep structure very early in the acquisition of language. From the first moment of speech, indeed, children have the ability to communicate meaning, and do so in a manner understandable to adults. It is easy to overlook what an astonishing fact this is. But it means that the most abstract part of language, its propositional content, is the first to appear in development. Children present evidence of employing something like the deep structure of sentences before grammar is acquired.

Let us put the problem in a semi-formal way. Doing so will help clarify some of the issues involved. Consider the "Language Acquisition Device" discussed by Chomsky (1957, 1965), which we can call LAD for short (alternatively, a Language Acquisition System, or LAS -- the feminine form). LAD receives a certain corpus of utterances. Some of these utterances are grammatical sentences in the language to which LAD is exposed; but besides grammatical speech, the corpus also contains blunders, false starts, interruptions, and a certain amount of nonsense. The corpus may be large, but it is not unlimited in size. Assume that it contains the number of utterances overheard by a typical two-year-old child.

Given such a corpus, LAD is so constructed that it can develop a theory of the regularities that underlie the speech to which it has been exposed. It can exclude the non-grammaticality in the corpus by constructing a theory about the regularities it contains. This theory is LAD's grammatical competence, its knowledge of the language behind the corpus. Having developed such a grammatical theory, LAD becomes able to go far beyond the corpus with

which it began. LAD can distinguish the infinitely many grammatical sentences in its language from the infinitely many non-grammatical alternatives, and it can judge how far from full grammaticality each of the latter deviates.

The situation may be diagrammed as follows:



Clearly, the problem of understanding how LAD develops grammatical competence given a corpus requires understanding the internal structure of the box labeled LAD.

It seems useful to distinguish two major components of LAD. One is a set of procedures for operating on a corpus -- for example, conducting a distributional analysis, or looking for transformations of certain kinds. The other is a <sup>body</sup> <sub>^</sub> of linguistic information -- for example, that all sentences include noun and verb phrases, or, for that matter, that there are sentences. It is conceivable that LAD is limited to just one of these components. LAD might contain a set of procedures for discovering a grammar or it might contain a set of assumptions about the form of grammar (McNeill, 1966b); or, of course, it might contain both (Fodor, 1966).

Whatever LAD contains, however, must be universally applicable. For LAD must be able to acquire any language; it cannot be biased toward some languages and away from others for reasons of internal structure. Thus LAD may contain information and procedures bearing on the general form of language, but presumably contains nothing bearing on the form of any particular language. The following remarks are directed to the possibility that LAD contains universal linguistic information; almost nothing has been written on the possibility that LAD contains universal procedures of analysis.

The description of linguistic universals has already been alluded to. The theory of grammar -- as opposed to the grammar of a single language -- is

a description of the general form of natural language (Chomsky, 1965; Katz, 1966). Its purpose is to state the conditions that grammars describing individual languages must meet. For example, grammars must all be transformational, and the base component must include rules stating the relations that hold among such syntactic categories as NP and N. When the grammar of a particular language represents the linguistic knowledge of the speakers of the language, and also conforms to the theory of grammar, one can claim to have explained the grammar of the language (Chomsky, 1965).

The argument becomes clear if we carry it a step further. Let us take the theory of grammar to be a description of LAD's internal structure. Whatever comprises the structure of LAD, is (or will be) described in the theory of grammar. The output of LAD -- competence in a language -- would then be explained by reference to the theory of grammar. A language has the particular grammar it does because the universal principles embodied in LAD constrain the grammar that accounts for the corpus of sentences LAD has received.

We thus have a hypothesis about the internal structure of LAD: it is described in the theory of grammar. It is an empirical question whether or not LAD can be so described.

LAD, of course, is a fiction. Our purpose in considering it is not to design an actual machine. On the contrary, our purpose is to isolate crucial aspects in the acquisition of language by real children, not by abstract ones. The purpose is served because LAD and children present the same problem.

LAD is faced with a corpus of utterances, some of them grammatical sentences and some not. So are children. From such a corpus, LAD develops a grammar on the basis of some kind of internal structure. So do children. Since children and LAD arrive at precisely the same grammar from precisely the same corpus, children and LAD must have precisely the same internal



structure, at least within the limits that different children may be said to have the same structure. Accordingly, a hypothesis about LAD is ipso facto a hypothesis about children.

The proposed relation between the theory of grammar and children's innate linguistic capacities is simple and straightforward (McNeill, 1966b). Languages have all necessarily evolved so as to correspond to children's capacities. No language can evolve to be unlearnable. Because children automatically impose those features of language that reflect their capacities, such features appear universally. The theory of grammar thus becomes possible.

What are the universals mentioned in the theory of grammar, which we now presume to be a reflection of children's innate capacities? Some are phonological. Every language, for example, employs consonant and vowel types, syllabic structure, and not more than 15 distinctive features (Jakobson and Halle, 1956; Halle, 1964a). Other universals may be semantic -- universals that are essentially constraints on possible concepts, on what is thinkable (Katz, 1966) -- a fascinating possibility that unfortunately cannot be discussed in these pages.

In the case of syntax, most universals describe characteristics of the deep structure of sentences (Chomsky, 1965). Every language utilizes the same basic syntactic categories, arranged in the same way -- such categories as sentences, noun phrases, verb phrases, etc. Every language utilizes the same basic grammatical relations among these categories -- such relations as subject and predicate of a sentence, verb and object of a verb phrase, etc. And every language distinguishes deep and surface structure, and so is transformational.

The transformations of a language are mostly, though not exclusively, idiosyncratic. However, the types of relation that exist between deep and surface structure are universal. For example, English relates the underlying and surface structure of auxiliary verbs by permuting the order of verbs and affixes (cf. Appendix pp. ). This transformation appears in English and

French (Ruwet, 1966), and possibly elsewhere, but is not universal. However, the relation of permutation is universal. The transformational idiosyncrasy of each language arises from the way in which a few universal transformational types, such as permutation, are exploited.

We can put these several considerations from linguistic theory together into a hypothesis about language acquisition (McNeill, 1966b). Most syntactic universals describe the deep structure of sentences; most transformations are idiosyncractic uses of universal types of relation. Making the assumption that certain linguistic universals exist because of innate abilities, we can say that the abstractions of the deep structure are those universal categories and relations that reflect children's innate capacities, and they are made abstract when children discover the transformations of their language.

A language is thus acquired through discovering the relations that exist between the surface structure of its sentences and the universal aspects of the deep structure, the latter being a manifestation of children's own capacities.

The interaction between children's innate capacities and their linguistic experience occurs at this point, in the acquisition of transformations -- and it is here that parental speech must make its contribution.

Not every aspect of the deep structure of sentences can be explained in this way. The order of categories in the deep structure, for example, apparently is variable among languages, and so must (on the current hypothesis) be acquired from evidence in a corpus. Nonetheless, the bulk of linguistic abstraction is subsumed under the hypothesis that what must be acquired in the acquisition of a language are its transformations.

Predication and the basic grammatical relations. If a language is acquired through discovering the transformations that relate surface structures to the universal aspects of the deep structure of sentences, then the latter

must be present in children's earliest speech. Only differences in rate of maturation could affect this expectation. An aspect of children's capacities will not appear until it has "matured," but everything in earliest speech that is not transformational should reflect an aspect of children's capacities. The early linguistic constructions of children should therefore be the universal parts of the deep structure of sentences, but in effect pronounced directly. It is for this reason that children are able to express meaning from the onset of language acquisition.

Recall the phenomenon of holophrastic speech. Such speech consists of single-word utterances that have the conceptual content of full sentences. de Laguna (1927) argued that holophrastic utterances have such content because they are comments on the situation in which the speech occurs. If we accept de Laguna's argument, the phenomenon of holophrastic speech can be seen as the most primitive manifestation of a basic grammatical relation, namely, predication, and therefore as a very early appearance of what ultimately becomes part of the deep structure of sentences. Children' speech is understandable by adults even in its most primitive form because it makes use of predication, and predication is a fundamental aspect of the deep structure of sentences.

de Laguna believed that two-word sentences emerge when children label the topics of their comments. She was interested in this step because it liberates the interpretability of child speech from an extreme dependence on non-linguistic context. She was little concerned with the extension of grammar beyond that. Nonetheless it is clear that her views encompass the early phases of patterned speech in general.

The basic grammatical relations correspond to the traditional grammatical functions of subject, predicate, verb, object, modifier, and head. Such relations hold among the syntactic categories of the deep structure; they are universal; and they are honored in the early speech of children.

Table 3 presented in the last section, contained every combination of Adam's grammatical classes observed in his speech at 28 months. It was remarked at that point that the combinations of grammatical classes observed in Adam's speech possess a certain consistency that the combinations not observed in his speech lack. We can now see what the consistency is.

The combinations in Table 3 are the patterns of Adam's grammatical classes that result from a mechanical application of the definitions of the basic grammatical relations as contained in linguistic theory (McNeill, 1966a). A predicate, for example, is defined in linguistic theory as a VP directly dominated by S. For Adam, the following combinations are consistent with this definition: VN, NV, VNN, VPN, NVN, NNV and NPN (the last assuming an absent V -- the sentence was Adam two boot.) Similarly for the other relations. Opposite each combination in Table 3 are listed the basic grammatical relations with which it could be consistent. As the reader can see, every combination of Adam's grammatical classes is consistent with at least one basic grammatical relation. More significantly, the combinations Adam did not produce are not consistent with any basic grammatical relation. With three grammatical classes, there are  $(3)^2 = 9$  different patterns two-words long and  $(3)^3 = 27$  different patterns three-words long. Five of the two-word patterns and 19 of the three-word patterns do not correspond to the basic grammatical relations; none of them occurred in the sample of utterances collected from Adam at 28 months.

One explanation of Table 3 therefore, is that Adam organized all his utterances in terms of the basic grammatical relations, but had not yet acquired any of the transformations in English that combine structures or add elements -- for example, conjunctions or embeddings. It is for this reason that patterns such as VVN did not occur in his speech, even though such sentences correspond to common surface structures in the speech of adults -- for example,

come and eat lunch. Indeed, many of the patterns excluded from Adam's speech correspond to patterns available in the surface structure of adult sentences.

We can relate Table 3 to de Laguna's argument about predication. If we search Table 3 for patterns that could express predication, we find that in one way or another every pattern except PN (another ball) and PNN (big Daddy book) could do so (and even some of these sentences probably are predicative -- that Becky, for example, or that Becky ball). In terms of frequency of occurrence, between 70% and 90% of Adam's utterances express predication (the lower figure excludes all potential modificational combinations, the higher figure includes them all). If predication is a primitive form of semantic organization, as de Laguna claimed, most early utterances of children should express it, and such is the case with Adam. In contrast, only three patterns (PN, NN and PNN in Table 3) could be subjects without predicates. All other instances of NP occur in the context of the object or predicate relations.

If now we look in Table 3 for patterns that could be predicates with subjects and patterns that could be predicates without subjects, we find a preponderance of the latter. The patterns that correspond to predicates without subjects are VN (change diaper), VPN (hit my ball), and VNN (read Cromer paper) -- none of which were judged to be imperatives; there were 194 such utterances at 28 months. The patterns that correspond to predicates with subjects are NN (Joshua home -- meaning "Joshua is at home"), NV (daddy go?), NPN (Adam two boot),

PNV (another doggie run), NNV (Adam mommy stand), NVN (Adam change diaper), and NNN (Adam mommy pencil); there were 178 such utterances, at 28 months.

Even though there is a greater variety of patterns with subjects, there is more frequent use of patterns without subjects. The divergence becomes more pronounced when we look for the single most frequent two- and three-word patterns. In both cases they are predicates without subjects -- VN and VNN --

and they are more frequent in Adam's speech by a large margin (Table 3). Such a relation with the frequency of using patterns would result if the sentences with subjects were all recent acquisitions and the sentences without subjects had existed in Adam's repertoire for some time. Gruber (1967) draws a similar conclusion for the speech of another child. There is, therefore, some support for de Laguna's contention that children at first produce isolated predicates and later add subjects.

Predication, however, is not the only relation evident in the speech of children at this early stage. In addition, <sup>children</sup>  $\wedge$  express direct and indirect objects, modification, and possibly other <sup>relations.</sup>  $\wedge$  Among Adam's utterances, for example, were see truck, write paper, and dirty paper -- a direct object, an indirect object, and a modificational construction, respectively. He also uttered apparent possessives -- for example, Adam hat -- which is a variety of modification according to recent views (Chomsky, 1967).

All these examples manifest different grammatical relations, and a question arises concerning their origin. It is impossible to say from Adam's evidence whether or not these relations had equal tenure in his grammar at 28 months. All four conceivably existed at the holophrastic stage. But it is equally possible that originally Adam's utterances expressed only predication, to which was first added modification (including possessives), then direct objects of verbs, and finally indirect objects -- this being the order of the frequency of these relations in Adam's speech at 28 months.

Whatever the order of emergence of such relations, however, it is difficult to imagine that they were, in any sense, discovered by Adam. For example, Adam apparently expressed the object of a preposition before he included prepositions in his speech, as in write paper and several other examples. It is difficult to see how he could have discovered such a relation from surface structures without also discovering the preposition. It seems rather that

Adam used the different basic grammatical relations, as they became available, to organize his other linguistic experiences -- for example, the classification of vocabulary, or the ultimate acquisition of such prepositional phrases as write on the paper.

Other children also manifest these relations. A child studied by Gruber (1967) has already been mentioned. The two other children followed by Brown and his collaborators give parallel evidence. Perhaps more striking is the appearance of these relations in the speech of children exposed to other languages. Evidence for Japanese children has been discussed by McNeill (1966b). Slobin (in press) has reviewed a number of diary studies and found evidence of the early emergence of the basic grammatical relations in Russian, Croatian, French, German, Georgian, Italian, and Bulgarian.

Intrinsic and extrinsic predication.<sup>2</sup> Adam's sentences without subjects at 28 months usually made reference to himself as the omitted but implied subject. Change diaper meant that Adam wanted to change his diaper; hit my ball meant that Adam was appropriating this act to himself; and read Cromer paper described something that Adam was doing. His sentences with subjects, on the other hand, almost always had an NP other than Adam or I as the subject -- Joshua, daddy, another doggie, etc.

The pattern of omitting Adam and I from the subject position of sentences reflects a distinction between two types of predicative relation available to children, between what we may call intrinsic and extrinsic predication. The distinction is widespread. It appears as a conditioning factor for the presence of subjects in children's sentences; it comprises the difference between be and is in Adam's grammar at 36 months (Table 4); it appears as a permanent

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2.

The discussion in this section has been developed jointly with Nobuko B. McNeill. Without her collaboration neither the data nor the observations reported below could have been obtained.

distinction in the Negro dialect of English (as between he working and he be working, Labov, Cohen, and Robins, 1965); and it controls two transformations in Japanese.

Adult speakers tend to omit the subjects of sentences when it is clear that the subject will be understood by a listener. To use Vygotsky's (1962) example, one would not say "the bus for which we have been waiting so long is here at last;" one would simply say "at last." Adam apparently believed that sentences involving himself as the subject were clear in this sense, whereas sentences containing other NP's were not.

How did he arrive at such a conclusion? The egocentrism of young children comes to mind as a possible explanation, but in fact it does not provide an answer. For if Adam was egocentric in the sense of Piaget (1926), we must wonder why he ever included subjects in sentences; all subjects would appear to be "understood" to an egocentric mind. Egocentrism plays a role in Adam's speech, but it is secondary to the more fundamental role of intrinsic and extrinsic predication.

Let us turn to the acquisition of Japanese. It is here that the distinction between extrinsic and intrinsic predication is most clearly revealed; then we can return to the acquisition of English.

Japanese, like many languages, uses postpositions. Two of them are reserved for marking the superficial manifestation of the subject of a sentence. The two postpositions have identical distributions in the surface structure of sentences, in that they replace one another, but they have different implications for the underlying structure. One postposition, wa, is used when the relation between the subject and predicate of a sentence is of an intrinsic type; the other, ga, is used when this relation is of an extrinsic type.

The distinction between intrinsic and extrinsic predication probably is cognitive in origin (and thus falls in the domain of "cognition and language,"



p. ) and all languages exploit it, although in different ways.

In Japanese the two types of predication resolve themselves into a distinction between the subject (ga) and topic (wa) of sentences; however, this distinction is a special syntactic point and need not concern us here.

Sentences requiring the postposition wa in Japanese have predicates that state an intrinsic property of the subject. It is felt intrinsicness that counts; no difficult ontological insights are required to be a Japanese speaker. Habitual activities, for example, are regarded as intrinsic -- daddy works in an office. So is attribution -- government architecture is grotesque; membership in a hierarchy -- a collie is a dog; definition -- that is a collie; and various truisms such as all men are mortal.

Sentences with ga have predicates that state extrinsic properties of the subject. Such sentences often take the form of momentary description -- there is a dog in the yard (when this is not customary). As with an intrinsic predicate, the information contained in an extrinsic predicate is asserted about a subject; but unlike an intrinsic predicate such information is not felt to be an inherent part of the subject.

How are wa and ga acquired? Both postpositions are introduced into the surface structure of sentences by transformations (Kuroda, 1965), and at first do not appear in the speech of children. At 28 months or so (in the children studied by McNeill, 1966b), ga first comes to be used, though not frequently. When used, however, it is used appropriately -- i.e., always with extrinsic predicates. About six months later wa first appears, and it too is always used appropriately -- i.e., with intrinsic predicates. Thus, extrinsic predication appears to develop before intrinsic predication.

However, we have only half the story, and the second half reverses the interpretation of the first. It is possible for a native speaker of Japanese to classify utterances containing neither wa nor ga according to the postposition

required. McNeill (1968b) found that approximately 90% of Japanese children's sentences are sufficiently clear to be so classified. The results of the procedure are clear; the great majority of children's early sentences consist of intrinsic predicates. Although ga is the first postposition to be included in child speech, wa is the postposition most often called for.

We have what appears to be a paradox. On the evidence of the postposition first acquired, extrinsic predication is dominant; but on the evidence provided by direct judgments of children's predicates, intrinsic predication is dominant.

The paradox is resolved when we observe the effect of the two types of predication on the inclusion of subject-NP's in sentences. If one looks at whether a child utters an isolated predicate or a predicate with a subject, one finds that subjects are usually included with extrinsic predicates and are usually omitted with intrinsic predicates. The transformation for wa accordingly cannot be formulated, since in most sentences there is no superficial NP to which the postposition can be attached. The situation is the opposite with extrinsic predication. Subjects are usually included with such predicates, so the transformation that introduces ga can be, and is, formulated early. Indeed, wa can not appear in child speech until subject-NP's are regularly included with intrinsic predicates.

The same tendency exists in the speech of English-speaking children. English-speaking children, of course, also do not include wa or ga in their early speech. They therefore present a situation comparable to the speech of young Japanese children, and a native (but bilingual) speaker of Japanese can also classify their sentences according to whether they "require" wa or ga. The procedure leads to the same outcome (McNeill, 1968b). There is a strong tendency for the children studied by Brown and his colleagues to include subjects with extrinsic predicates and to omit subjects with intrinsic predicates.

The following are examples of the two types of predication from four children -- two English-speaking and two Japanese-speaking:

Eve

- (extrinsic) Mommy sit bottom  
Fraser read Lassie
- (intrinsic) on Wednesday (in answer to "When's Cromer coming?")  
on my head (said of a hairband)

Adam

- (extrinsic) Bunny rabbit running  
Cromer right dere
- (intrinsic) pretty, Mommy?  
go dere, Mommy? (said of a puzzle piece)

Izanami

- (extrinsic) Reiko said "no"  
tape goes round and round
- (intrinsic) the same (said of two dresses)  
office (said of her father)

Murasaki

- (extrinsic) the lion's mommy is seated  
a griaffe is eating grass
- (intrinsic) can't eat the rind (said of an orange)  
delicious (said of a cracker)

We can now see why Adam tended to omit mentioning himself as the subject of sentences. The predicates of such sentences were intrinsic. An intrinsic predicate is one that entails its subject; the information contained in the predicate is felt to be inherent in the subject, which therefore need not be mentioned. Possibly Adam egocentrically felt that anything predicated about himself was intrinsically true. But this egocentric view was completely

conditioned by the distinction between intrinsic and extrinsic predication. Other NP's, when serving as the subjects of sentences, were included precisely because the predicate was felt not to be intrinsically true of these NP's.

It is possible that holophrastic utterances consist largely if not exclusively of intrinsic predicates. That would be one reason for a limitation and for a dependence of holophrastic speech on context. of such utterances to single words ^ Children would add subjects to predicates, as de Laguna believed, when the predicates become extrinsic. Such an event appears to happen first when children are 18 to 24 months old. It is as if one suddenly realized that he was talking to a blind man when he said "at last" as a bus appeared around a distant corner.

The differentiation of grammatical categories. Fig. 5 traced the history of the Pivot class of one child, Adam. According to Slobin (in press), Gvodzev's son Zhenya had a Pivot class almost identical to Adam's -- both children included demonstrative and personal pronouns, various adjectives, and such determiners as other. Presumably the two children passed through a similar series of steps in reaching the grammatical classes of their languages.

The interpretation made before of Adam's Pivot class can also be made of Zhenya's Pivot class: although exposed to a different language, Zhenya as well as Adam arrived at<sup>a</sup> generically appropriate classification of the words in his vocabulary. Indeed, Adam and Zhenya arrived at the same classification. Having reviewed evidence for the existence of children's innate linguistic abilities, in particular the ability to organize sentences according to the basic grammatical relations, we can now return to the problem of generic classification.

The reader will recall from p. what the problem is. A generically appropriate Pivot class honors distinctions in adult grammar that children have not yet drawn. Both Adam and Zhenya, for example, placed all adjectives

into a Pivot class even though adjectives themselves were not yet recognized as a grammatical class. The problem is to explain such apparent teleology.

Two accounts come to mind. Each corresponds to a different conception of grammatical classes in linguistic theory. In the end, we shall find a way to put the two explanations together; but to begin with we shall present them as if they were alternative accounts.

One explanation was proposed by McNeill (1966a). The argument in this case relates the telegraphic sentences of young children to the semi-grammatical sentences of adults. A speaker of English will recognize John plays golf, for example, as being well-formed. He will also recognize golf plays John as being semi-grammatical, a deviation from the grammar of English, and golf plays symmetrical as being even less grammatical than golf plays John. Moreover, speakers of English can interpret semi-grammatical sentences: Golf plays John is a devastating remark in part because of its analogies with the well-formed John plays golf.

There are two salient facts in connection with the phenomenon of semi-grammaticality. One is that semi-grammatical sentences are ordered according to how far they depart from being well-formed. The other is an ability to interpret semi-grammatical sentences, even though they are not well-formed.

Chomsky (1961) dealt with this problem and gave an explanation in terms of a postulated hierarchy of grammatical categories. Such a hierarchy has never actually been established, but one can imagine what some of its properties would be. Every level of the hierarchy, for example, would encompass the total lexicon of English, but successively higher levels would classify words less finely than would lower levels. The lowest level would comprise all the grammatical classes of English; the next level would include the same words except that certain distinctions are lost; the level

above this would include again the same words except that even more distinctions are lost; and so on until the top-most level, which would consist of a single gigantic class.

A semi-grammatical sentence is one that can be represented by the rules of the grammar only at some intermediate level in the hierarchy of categories. Of two semi-grammatical sentences, the one that deviates most from being completely well-formed is the one that is represented at a higher level in the hierarchy of categories. John plays golf is represented by the rules of the grammar at all levels of the hierarchy, including the most differentiated level at the bottom. However, golf plays John can be represented only down to the level where the distinction between animate and inanimate nouns is lost, and golf plays symmetrical cannot be represented below the level where the distinction between nouns and adjectives -- two major grammatical categories -- is lost.

Understanding a semi-grammatical sentence depends on noting an analogy with well-formed sentences represented in the same way as the semi-grammatical sentence at the appropriate level in the hierarchy. Thus, golf plays John is perceived as analogous to John plays golf because both receive the same representation when the distinction between animate and inanimate nouns is abolished.

McNeill's (1966a) suggestion was that children's sentences are semi-grammatical in this technical sense. Like golf plays John and golf plays symmetrical, the telegraphic sentences of children omit certain grammatical distinctions. Moreover, it was claimed the differentiation of the grammatical classes shown in Fig. 5 is in fact a record of Adam's progress down the hierarchy of categories Chomsky discussed. Thus early sentences from children honor fewer distinctions than later sentences do, just as semi-grammatical sentences honor fewer distinctions than well-formed sentences do, and the

distinctions children draw at any time are generically related to the distinctions they draw at later times, just as the category of nouns (for example) is generically related to the categories of animate and inanimate nouns.

Children's sentences are therefore understood by adults as semi-grammatical sentences. Since the information is the same, adults understand such infantile utterances as that a Adam ball through the same mechanisms they use to understand such semi-grammatical sentences as golf plays John. In both cases, grammatical distinctions of English are violated, thus placing the sentences on an intermediate level in the hierarchy of categories and the sentences are understood on the basis of analogies with well-formed sentences.

An experiment reported by McNeill (1966a) lends support to this identification of child sentences with semi-grammatical sentences. Pairs of sentences recorded from children at different ages were given (in written form) to adults, who had to decide which member of each pair had been uttered by a younger child. Vocabulary and length were matched within pairs; every sentence was grammatically deviant; only the age of recording and, presumably, the degree of grammaticality differed. The judgments of adults were accurate 81 per cent of the time (chance being 50 per cent); earlier sentences tend to be more deviant when judged against the standards available to adults. It seems clear that there is a basic similarity between the phenomenon of semi-grammaticality in adults and the linguistic development of children.

The suggestion in McNeill (1966a) was that the upper levels of the hierarchy of categories are universal among languages, and a reflection of one aspect of children's innate linguistic abilities. It is certainly difficult to imagine that children learn such generically appropriate categories. There is no class of "modifiers" in English or Russian that corresponds to

Adam's and Zhenya's Pivot class. However, children may be equipped to notice a general function of modification when it exists in the speech of adults, and to place words together when they serve this function. At some (fairly high) level in Chomsky's hierarchy, articles, demonstrative and personal pronouns, adjectives, and such determiners as other are all alike. Adam and Zhenya, if they had available such a level in the hierarchy, would treat these different adult classes as the same, that is, as Pivots. Discovery of the adult categories could then proceed, as it did, by differentiation.

Such is one account of children's early syntactic organization. It makes a strong prediction, which can easily be examined. If children initially classify words according to a universal hierarchy of categories, then all primitive grammatical classes must be generically appropriate. Children must never place words from the same adult class into different grammatical classes of their own. Doing this would mean either that words in the same adult class do not necessarily belong to a single superordinate class, or that children do not always follow a hierarchy of categories in forming grammatical classes. The first possibility would reflect a shortcoming in Chomsky's theory and the second possibility a shortcoming in the extension of the theory to children.

In fact some children do not arrive at a generically appropriate classification of words. One of Miller and Ervin's (1964) subjects, for example, placed adult adjectives in both the Pivot and Open classes. Izanami, one of McNeill's (1966c) subjects, did the same. Different adjectives appeared as Pivot and Open words in the speech of these children, but this does not affect the conclusion that their early grammatical classes were not generically appropriate and could not possibly be refined through differentiation.



There is a difficulty then. The problem appears to lie with the analysis of adult syntactic classification, and not with the extension of such an analysis to the syntactic classification of children. On independent grounds, Chomsky (1965) rejected the notion of grammatical categories, replacing it with the concept of syntactic features. The change in theory was made to take into account the cross-classification of words. Consider, for example, the four nouns, John, elephant, ocean, and Egypt. Two are proper nouns (John and Egypt) and two are common nouns (elephant and ocean). One might suppose that English contains these two grammatical categories. But the four words present a second distinction, which cuts across the first. John and elephant also are animate nouns, and Egypt and ocean are inanimate nouns. Logically no way exists to make one of these distinctions hierarchically superior to the other. Inanimate nouns, for example, are not all proper nouns, nor are they all common nouns. They may be either; nouns are cross-classified.

A consideration of such facts led Chomsky to do away with the idea of a grammatical category, and to replace it with the idea of a syntactic feature. Thus Egypt has the features [inanimate] and [proper]; John has the features [animate] and [proper]; elephant has the features [animate] and [common]; and ocean has the features [inanimate] and [common]. There is no hierarchical arrangement in this analysis; there is cross-classification instead.

It is not surprising therefore to find that children also cross-classify grammatical classes. Words in the same adult "class" can have in part different features. Depending on which features a child uses, words from the same "class" may find their way into different categories in the child's grammar. Suppose, for example, that at an early point in development a child classifies words encountered in adult speech according to whether they are [animate] or [inanimate], but in no other way. Then elephant and ocean, two nouns, would appear in different syntactic categories, as would Egypt

and John. Miller and Ervin's and McNeill's subjects apparently cross-classified adjectives in a way comparable to such cross-classification of nouns.

If we accept the possibility that children classify words according to features, then how can we explain such generically appropriate classification as does occur? What led Adam and Zhenya to treat demonstrative and personal pronouns, articles, determiners, and adjectives alike?

On the view sketched above, generic classification can mean only one thing. At the time Adam's and Zhenya's speech was observed, they were classifying words according to a single feature. The feature must have been one shared by the various words classified together as Pivots; these words, as they were encountered in adult speech, were then placed into the Pivot "class."

The function played by Adam's and Zhenya's Pivot words was modification; indeed, Brown and Bellugi (1964) referred to Adam's Pivot class as a Modifier class. We therefore might suspect that the Pivot class and the feature on which it is based are associated in some way with the basic grammatical relation of modification. The reader will recall that a relation of modification holds between a determiner and a noun when both belong to the same NP (p. ). In order for this definition to hold, any word understood to modify a noun must be classified [+Det] and [+ N]; similarly, any word understood to be modified by a determiner must be classified [+N] and [+Det    ]. That is, the grammatical relation of modification automatically imposes two grammatical categories, Det and N, and establishes a contextual relation between them --    N and    Det    , respectively.

Evidence has already been presented (p. ) that the basic grammatical relations reflect an aspect of children's inborn linguistic abilities.

The argument can now be extended to account for the appearance of certain syntactic features in child grammar (McNeill, 1966b; in press; a similar argument is given, independently, by Schlesinger, in press). A child

able to recognize that two words are related as modifier and modified must also be able to classify one as [+Det, +\_\_N] and the other as [+N, +Det\_\_]. Doing so is a result of understanding the basic grammatical relation. The second set of features would designate a class of nouns (cf. p. ); the first set would exactly designate the Pivot class of Adam and Zhenya.

The argument can be generalized to cover each of the basic grammatical relations. If the reader will visualize a tree-diagram representing the deep structure of a simple declarative sentence (or look at Fig. 12 in the Appendix), he will see that each of the six following sets of features can be derived (parentheses indicating optional features):

predicate	[+VP, +NP__]
subject	[+NP, +__VP]
main verb	[+V, (+__NP)]
object	[+NP, +V__]
modifier	[+Det, +__N]
head	[+N, +Det__]

The basic grammatical relations from which each set arises is indicated on the left. (The use of +NP and +VP as features has been proposed for adult grammar by Chomsky, 1967.)

A word classified with just one set of features can be used only in the corresponding relation. Eventually all words are classified in several ways, thus enlarging the distributional range of each word. However, additional features sometimes lead to restrictions instead. Two of Brown's subjects, for example, used for a time only animate nouns as the subjects of sentences and only inanimate nouns as the objects of verbs (unpublished materials). Nouns had been tagged in the lexicon as [+NP, +\_\_VP, +animate] and [+NP, +V\_\_, +inanimate]; an enlargement of the feature roster produced a restriction in distributional range.

The question is sometimes raised whether or not children rely on semantic considerations in classifying words syntactically (e.g., Slobin, 1966a). Doing so would be a feat of considerable abstraction (Chomsky, 1965), but children may use general semantic consistencies in this way: words alike on a certain semantic feature (say, activity) may all be given the same syntactic feature (say, + V). Brown (1958) found evidence that children of three or four are alert to the semantic implications of nonsense words used as mass nouns, count nouns, or verbs. Braine (in press), using a technique like Brown's, concluded that whereas the classification of verbs might be assisted by semantic implications, nouns probably are not. His observations are worth reporting in some detail.

Braine taught his two-year-old daughter two new words, one the name of a kitchen appliance (niss) and the other the name of the act of walking with the fingers (seb). Neither word was used by an adult in grammatical context. However, the child used both words appropriately -- niss as a noun and seb as a verb, as in more niss and seb Teddy. She also used seb as a noun, but never used niss as a verb. There were sentences like more seb and this seb, but none like niss the vegetables. Evidently there is no requirement that nouns be associated with things, although there is a requirement that verbs be associated with actions.

The observation shows that although semantic information is helpful in syntactically classifying words, such information is not identical with syntactic classification: seb was used as a noun, regardless of its association with action.

The child's productive use of both seb and niss in sentences, even though the words had been introduced out of context, reflects the degree of freedom of child speech from the circumstances in which examples are encountered -- a matter we return to below (pp.     ).

If children develop lexical features from the basic grammatical relations, what then becomes of the Pivot class? The answer is simple. It has been replaced by [+Det, + \_\_N], and there is no Pivot class, just as there are no syntactic categories in any grammar. The recent work of Brown and his colleagues (Brown, et al., in press) recognizes this fact in the form given to lexical entries (cf., p. ).

It is unclear why children usually select the modification relation among all the basic grammatical relations as an initial source of features. But so they do. At least, such is the impression one receives from the Pivot classes that have been published (Braine, 1963; Brown and Bellugi, 1964; Miller and Ervin, 1964; McNeill, 1966c). However, Braine (in press) claims that children's first sentences consist of the higher-level nodes, NP and VP, and Slobin (in press) has found some exceptions to the rule that Pivots express modification. But in a majority of cases the relation expressed in Pivot-Open sentences appears to be modification. The reviewer knows of no data that contradict this interpretation. Kelley (1967) has built a modification feature into a computer program that successfully acquires certain aspects of English syntax.

It is because Pivot words express modification that they rarely occur alone or in combination with each other in child speech. Pivot words cannot occur alone because they have the obligatory feature [+ \_\_N]; they cannot occur with each other because they do not have the feature [+ Det\_\_]. These restrictions in turn correspond to the definition of modification contained in linguistic theory -- and by hypothesis to the inborn expectations of children concerning the form of language.

Summary. The basic grammatical relations penetrate deeply into the linguistic powers of children. It is well to summarize what has been said of them so as to expose clearly the line of argument we have followed.

One basic grammatical relation -- predication -- is present from the earliest moments of holophrastic speech. Later developments depend on an elaboration of this relation as well as an introduction of the remaining grammatical relations -- verb and object, and modification. All such developments produce forms that eventually become the deep structure of sentences.

There are two lines of change. One is that subjects come to be included with predicates in children's speech; another is the construction of a lexicon where words are classified according to syntactic features.

It is important to observe that the basic grammatical relations, combined with the definition of grammatical categories in terms of syntactic features, give children's grammar a certain necessary form. Without exception, children construe everything understood in adult speech according to the basic grammatical relations; equally without exception, therefore, they identify words encountered in parental speech as possessing such features as [+N], [+Det\_\_], [+ \_\_VP], etc. Children may or may not record such information (a lexicon is not developed instantly), but merely to understand adult speech its vocabulary must be classified according to the features imposed by the basic grammatical relations. Children's own speech then is also constructed according to the basic grammatical relations and to the syntactic features these relations yield -- for children presumably understand most of what they say.

There is no guarantee that children correctly understand adult speech; there is only a guarantee that the understanding of children is organized by the basic grammatical relations (McNeill, 1968a). It is thus possible for a child to misconstrue the meaning of an adult sentence and to record the results of this misconstrual in his lexicon. Suppose, for example, that an

adult sentence, the boy hit the ball, is understood (in an ambiguous extra-linguistic situation) to mean "the ball hit the boy." If this is a child's understanding, then syntactic features must be assigned at least momentarily in such a way that boy is the object of the verb hit, and ball is the subject of the entire sentence.

If such features are recorded in a child's lexicon, a child would utter sentences backwards for a time. Some children apparently do just this. One of Braine's (1963) subjects said allgone shoe, allgone lettuce, and allgone daddy -- all inversions of the adult equivalents, the shoe is allgone, the lettuce is allgone, and daddy is allgone. Other children utter sentences both forwards and backwards, the two directions expressing the same grammatical relation, as if some nouns (for example) were tagged [+VP\_\_] and others [+\_\_VP]. Thus we hear both ball hit and read mommy as expressions of the subject and predicate relations (cf., Braine, in press, for more examples). It is not necessarily the case, as sometimes has been thought (e.g., Slobin, 1966b) that children adhere to a fixed order of words when expressing the basic grammatical relations.

Insofar as the basic grammatical relations reflect the innate abilities of children, the type of grammar outlined above will be developed regardless of the language to which a child is exposed. It is a universal child grammar. Other aspects of language also may be universal and a reflection of children's innate abilities. Syntactic features derived from the basic grammatical relations, such as [+\_\_VP] and [+N], are what Chomsky (1965) called categorical features, and they make such strings as golf plays symmetrical grammatically deviant. However, categorical features do not exhaust the information contained in the deep structure of sentences. In addition there are features called sub-classificational by Chomsky, which serve to eliminate such strings as golf plays John. Features of the first type specify where a word can appear in a deep structure -- e.g., in NP but not in V. Features of the second type

specify how words co-exist in deep structures -- e.g., plays takes only animate subjects. Sub-classificational features cannot be developed from the basic grammatical relations.

It is impossible to guess what could be the source of sub-classificational features. Children may have to discover them from a corpus of utterances. However, the differentiation of Adam's Pivot "class" (Fig. 5 ) results in the emergence of a family of sub-classificational features. It may be that there is a universal hierarchy of features, much like the hierarchy of categories described in Chomsky (1961), responsible for this development. If this is the case, the arguments developed on p.        would again apply. Sentences that violate a sub-classificational feature would be understood by reference to a higher level in the hierarchy; and children's linguistic advancement would be understood as progressing from such higher levels to lower levels in the same hierarchy.

#### THE ACQUISITION OF TRANSFORMATIONS

The deep structures of sentences are largely a reflection of children's innate linguistic abilities. It is for this reason that such information can be totally abstract in sentences. Deep structures become abstract when children learn the transformation of their language. The interaction between linguistic experience and innate linguistic ability thus occurs here -- in the acquisition of transformations -- and <sup>here</sup>  $\wedge$  is the appropriate place to examine the role of parental speech.

The present section reviews what is known of this interaction. It can be viewed as a history of the way that children beginning with a universal child grammar diverge in the direction of the grammar of their local language. We shall have occasion to trace the emergence of several transformations of English, and to examine the suitability of several psychological proposals -- both traditional and otherwise -- for the acquisition of language.



The emergence of inflections. We may begin with the acquisition of certain morphological details. Although inflections are usually not introduced via major transformations, they are easily traced features of the surface structure of sentences, and clearly illustrate some aspects of the way children learn to relate deep and surface structures.

Table 5 lists the order of emergence of several nouns and verb inflections in English (Bellugi, 1964). The data are based on observations of two children. Also shown is the relative frequency of the same inflections in the speech of the children's mothers.

There are several matters worth noting. One is that the order of emergence is the same for the two children. Order is the same even though the children's rate of development is radically different, one child requiring twice as much time to acquire the six inflections of Table 5 as the other.

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Insert Table 5 here

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A second point is that forms employing the same phonetic variants do not necessarily appear at the same time. Three inflections have the same phonemic realization, -s. These are plural marking of nouns, nouns marked for possession, and third person verbs; the last appears anywhere from two to eight months later than the first. Clearly it is not phonemic development that regulates the acquisition of inflections. Finally, the order in which inflections emerge in the speech of children is weakly correlated with the frequency of the forms in the speech of adults. The most glaring discrepancy involves third-person marking on verbs, which is the third most frequent inflection in maternal speech, but the last inflection to emerge in child speech.

Now consider the equivalent phenomenon in the acquisition of Russian. Here matters are more complex. The language is highly inflected, but for

this very reason more informative. Slobin (in press), after examining a number of reports in the Russian literature, has reconstructed the following chronology: The first inflections to appear are the plural and diminutive marking of nouns, and the imperative marking of verbs. This happens at 22 months or so. Next to appear are various case, tense, and person markings on verbs -- a complex story to which we shortly return. Then appears the conditional marking of verbs, much later than the inflections of case, tense, and person, even though the conditional is structurally simple in Russian. After this, nouns come to be marked for various abstract categories of quality and action, and finally, last by a large margin, appears gender marking of nouns and adjectives.

Slobin argues that three major factors influence the point at which inflections appear in linguistic development. One is the frequency of occurrence of an inflection in adult speech; we see the effects of this factor in Table 5. A second is the superficial complexity of an inflection (e.g., the accusative emerges late in German, where it is relatively complex, and early in Hungarian, where it is simple). The third is something Slobin calls the semantic content of an inflection. Semantic content probably refers to the deep structure of sentences. The relatively late appearance of the Russian conditional, for example, is explained by its difficult semantic content.

Gender in Russian is an ambiguous case. It is by far the most difficult aspect of Russian syntax for children to master, and errors typically continue until seven or eight years. Slobin attributes the confusion over gender to its difficult semantic content: most nouns are arbitrarily marked; some nouns with real implications of gender are marked in the wrong way; etc. However, gender in Russian may have no semantic content at all. If this is correct, then the trouble children experience in acquiring gender-marking is not a matter of deep complexity, but of superficial complexity. A Russian child must learn a large number of localized rules -- a requirement that

opposes the tendency in children to formulate a small number of generalized rules (cf., below, p. ).

It is interesting to note in passing that public education in a society seems not to begin until children have mastered the morphology of their language. English, which poses relatively few problems, is largely mastered by four or five. Schooling begins at five or six. Russian, which poses many more problems, is not mastered until seven or eight. Schooling begins at seven. The intellectual readiness of children apparently has historically been judged according to their mastery of the most peripheral part of language.

In keeping with the visibility of morphology, it is not surprising that when inflections are overgeneralized, the phenomenon attracts a good deal of attention. All parents are aware that children regularize strong verbs (runned, goed, sitted, etc.) and nouns (foots, mouses, tooths, etc.). However, the actual development of such forms is more complex than usually realized, and tracing their history is instructive on a number of points.

Overgeneralization, simplification, and the question of overt practice.

English has a number of strong verbs, the past tenses of which are irregularly formed. There is also a number of nouns with irregular plurals. Although children long regularize these forms -- adding -ed to the verbs and -s to the nouns -- this is not the way they begin (Ervin, 1964). Initially, strong verbs appear in child speech in the correct irregular form -- came instead of comed, ran instead of runned, and did instead of doed. The development of irregular plurals shows the equivalent phenomenon -- feet, mice, and teeth occur in child speech before foots, mouses, and tooths. Regularization, when it occurs, is a step forward.

The explanation of the early appearance of such correct irregular verbs and nouns has to do with the frequency of these forms in adult speech. Strong

verbs are by far the most frequent verbs, and strong nouns occur commonly also. Children are thus given many opportunities to discover the association of the underlying morphemes (Past) and (Plural) to these words, and they make such discoveries early.

But each irregular verb and noun is a case unto itself; no rule covers more than one. Because of this fact, the weak, or regular, forms remain untouched by developments in the strong forms. A child who only knows how to say feet may have in mind plurality when he says two box, but he cannot express this underlying idea. Should it be baex, bikes, or, possibly, boxen? Obviously, it is box.

It is general rules that children seek; indeed, they seek the simplest such rules possible. The evidence here is dramatic. Ervin (1964) searched her records of child speech for the first examples of the regular past-tense and plural inflections. Correct usage of irregular forms was already present. For verbs she first found -ed on these same irregular forms! Overgeneralizations apparently occurred before anything existed in the children's speech to generalize from. Plural inflections on nouns first appeared with weak forms, but very shortly thereafter with strong forms as well.

The finding with verbs, of course, is an illusion. Strong verbs are frequent in child speech, just as in adult speech. Accordingly, Ervin had a better chance of observing -ed on strong than on weak forms. However, such superior frequency of strong verbs does not influence the force of Ervin's observation. The point is that children treat strong and weak verbs alike, and for this reason, strong verbs are encompassed by the regular past-tense rule as soon as it is formulated. The same is true of plural inflection on nouns. The gap between the first appearance of -s and its overgeneralization to irregular forms is brief, usually only a matter of weeks.

Slobin (in press) refers to such encroachments of regularity as "inflectional imperialism." There are no political connotations in the fact that inflectional imperialism is a major factor in the acquisition of Russian; it rather has to do with the language. To quote Slobin:

"Overregularizations are rampant in the child's learning of Russian morphology -- small wonder, what with the great variety of forms within each category, determined on the bases of both phonological and grammatical relations. For example, not only must the child learn an instrumental case ending for masculine, feminine, and neuter nouns and adjectives in singular and plural, but within each of these sub-categories there are several different phonologically conditioned suffixes (not to mention zero-endings, morphologically conditioned suffixes, and other complications). The child's solution is to seize upon one suffix at first and use it for every instance of that particular grammatical category.

In the case of the instrumental inflection, Gvozdev's son Zhenya first employed -om, the suffix for masculine and neuter nouns in the singular. However, Zhenya used -om on all nouns, including the feminine nouns that were at that time most abundant in his speech. The corresponding feminine form, -oy appears only some time later; but when it does appear, it immediately dominates the original inflection, -om. Much later, -om reappears in Zhenya's speech, this time to be used appropriately. An experiment by Zakharova (1958) found the same sequence of events in a sample of 200 children. Such is inflectional imperialism.

However, inflectional imperialism in Russian and English do not seem to be the same. The English regular verbs invade a domain where no rule exists at all; the Russian suffix -oy invades where a rule is already in force. One appears to fill a vacuum, whereas the other seems truly aggressive. The difference, however, is more apparent than real, and on closer examination we can see that the two cases demonstrate the same phenomenon.

The phenomenon is that children always strive to formulate the most general rule possible. That is what English-speaking children do in extending regular inflections to irregular forms. Instead of having several ways of

expressing (Past) or (Plural), they have only one for each. Russian children do the same. Both -om and -oy have multiple uses in adult Russian, but -om has fewer (two) than -oy (five). Russian children thus first select the suffix with the fewest uses, as Slobin points out.

One reason for making such a choice is that a rule formulated for -om has fewer exceptions than has a rule formulated for -oy. A rule for -om must be restricted from only one non-instrumental context, whereas a rule for -oy must be restricted from four. The -om suffix is therefore the more general.

Later, when a child discovers that gender is a grammatical category, the balance between the two inflections changes. To mark gender as well as to mark the instrumental case, -oy is the inflection with greater generality, for it applies to many more words. The imperialism of -oy thus results from children doing what they did with -om, which is to follow the rule of larger scope.

English- and Russian-speaking children approach morphology in the same consistent way. Within the limits posed by their language, both seek at all times the most general rule possible. Gvozdev remarked that the development of grammar precedes the development of morphology. The remark, as Slobin observed, refers to inflectional imperialism -- children master the grammatical category of the instrumental case, for example, before they master the morphological details of expressing the category. In turn, imperialism is a result of children seeking rules of maximum generality.

Russian- and English-speaking children are alike in yet another respect. Inflectional imperialism in the acquisition of morphology clearly shows that overt practice has little influence on linguistic development. When we observe one form imperialistically driving out another, we observe a form that has received little or no overt practice displacing another that has received a great deal of overt practice.

The regular past-tense inflection in English was so rare in the speech of Ervin's children that it first appeared on the frequent strong verbs. These verbs, in contrast, had been used with their correct irregular inflections for months and in large numbers. Such extensive practice offered no protection against the tendency to express the past tense in a single rule. Since correct irregular forms are replaced by incorrect regularizations, it is clear that children actually expressed past time in the correct forms. The same situation exists in the development of Russian morphology. The masculine suffix -om is well practiced but easily and immediately displaced by the feminine suffix -oy.

The impotence of practice in the acquisition of morphology is not surprising when account is taken of what such learning consists. Inflections express details of the underlying structure of sentence. Each inflection is related to the underlying structure in a way described by a particular transformation; discovery of the transformation controls the use of the inflection. Practice is possibly useful in the formation of associations (whatever they are); but when a transformation and an association conflict, as when digged competes with dug in the grammar of a three-year old, the association is simply irrelevant to the child's effort to formulate a rule. There is no competition in such cases.

We therefore can draw at least a negative conclusion concerning the role of parental speech in language acquisition. Its role is not to provide children with <sup>opportunities</sup> ^ to practice. As we shall see below (p. ) the acquisition of morphology is not different in this respect from the acquisition of any transformation. The negative conclusion just drawn has the widest possible scope.

Imitation. One traditional view of language acquisition holds that the process is advanced through imitation. However, there are several reasons to doubt that imitation plays a role in language acquisition, and it is appropriate to consider the question at this point.

But first we must clear up an ambiguity. The word "imitation" is used in two quite different senses, and only one of them can be applied to language acquisition. In one sense, "imitation" refers to a process whereby one organism comes to resemble more and more closely another. The trait on which the resemblance develops must necessarily be within broad limits arbitrarily variable -- resemblance in height, for example, is not the result of imitation. However, all sorts of other things develop through imitation in this sense; etiquette, driving a car on the left side of the road in England, typing, writing prose in the style of Faulkner -- all are included. In this sense, it is also true that children acquire language through imitation.

There is a second, more technical use of the word "imitation:" details of behavior -- for example, plural inflections on English nouns -- are first acquired by copying the behavior of a model. Such a view of language acquisition was presented by Allport (1924) and it has appeared in psychology texts ever since; but it is the technical sense of "imitation" that is inappropriate for language acquisition.

There is no question that children imitate the speech of adults a good deal. In the records collected by Brown, fully 10% of children's speech at 28-35 months is imitative, as, for example, in such exchanges as the following:

<u>Adult</u>	<u>Child</u>
Oh, that's a big one	big one
But he was much bigger than Perro	big a Perro
Salad dressing	salad dressing



That's not a screw

dat not a screw

Are they all there?

all dere?

However, the fact that children imitate the speech of adults does not mean that the process of acquisition is imitation. It is clear from examples given in previous sections that not everything in child grammar originates in such a fashion. It runned, allgone shoe, a that man, for instance, have no models in adult speech, but are grammatical within a child's system. The system clearly could not have been derived from imitation in these cases.

Nonetheless, it is possible that forms are first introduced into a child's speech through imitation. So long as grammar is not fully developed, a child might produce such utterances as a that man, and yet still enrich his grammar through the imitation of well-formed examples. In this case, imitations will be "advanced" grammatically relative to spontaneous speech.

Ervin (1964) looked into this possibility by comparing children's naturally occurring imitations to their free speech, and found that the grammatical organization of the former was identical to the organization of the latter. Only one child in Ervin's sample of five was an exception, and her imitations were more primitive than her spontaneous speech. For all these children, therefore, imitations were not "grammatically progressive," as Ervin put it.

The result reflects a general characteristic of child speech. There is a strong tendency among children to include nothing in the surface structures of sentences that cannot be related to deep structures -- i.e., nothing for which there is no transformational derivation. The principle encompasses imitation as well as spontaneous speech. If a child does not yet include the progressive inflection -ing in his speech, he also will not imitate -ing in the speech of adults, particularly if the adult model is long relative to his

memory span. Adam's nose is dripping might be imitated Adam nose drip but probably not Adam nose dripping. It is for this reason that imitation can be used as a test of children's productive capacities (cf. p.       ), and it is for this reason<sup>also</sup> that children's early utterances are patterned as deep structures. In both cases, children exclude superficial forms when they cannot be related to deep forms.

The resistance of children to new forms sometimes goes to extravagant lengths. Consider, for example, the following exchange between one mother and her child (from McNeill, 1966a):

Child:                               Nobody don't like me.  
Mother:                              No, say "nobody likesme."  
Child:                               Nobody don't like me.

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. .  
. .  
. .  
. .

(eight repetitions of this dialogue)

.  
. .  
. .  
. .

Mother:                              No, now listen carefully; say  
  "nobody likes me."  
Child:                                Oh! Nobody don't likesme.

Although children do not ordinarily behave differently when imitating and speaking, it is possible to instruct children to imitate, as Slobin<sup>and Welsh</sup> (1967) and Fraser, Brown and Bellugi (1963) have done. Under these circumstances, a child's imitations may depart from his grammar. But instructed imitation is not typical of the ordinary circumstances of child speech, and phenomena observed here cannot be extended to the actual acquisition of grammatical structure.

Rather than serve didactic purposes, imitation often seems to be carried out in play. It therefore is the opposite of instruction, if indeed it has any effect at all: a child manipulates the grammatical system already at his disposal, often in fantastic ways, but he does not correct it. Take as an example one of Brown's subjects, who, starting from an ordinary imitation, elaborated on it in an almost fugue-like manner (mentioned by Slobin, 1964; also McNeill, 1966a):

Adult: That's the tattooed man

Child: Tooman. Tattoo man. Find too tattoo man.

Tattoo man. Who dat? Tattoo. Too man go,  
mommy? Too man. Tattoo man go? Who dat?

Read dat. Tractor dere. Tattoo man.

Weir (1962) found many examples of similar grammatical play in the pre-sleep soliloquies of her two-and-a-half year old son. The child selected a particular paradigm -- sometimes grammatical, sometimes phonological -- and then elaborated a stream of examples. The following uses a syntactic paradigm; it might be considered the linguistic equivalent of repeatedly building up and knocking down a tower of blocks.

go for glasses

go for them

go to the top

go throw

go for blouse

pants

go for shoes

We thus arrive at the same negative conclusion as before: the role of parental speech in language acquisition is not to supply <sup>opportunities</sup> for

children to practice. The practice of forms already in a child's grammar (e.g., dug) contributes nothing to the viability of the forms when they come into conflict with a child's changing system; such is the case in inflectional imperialism. The practice of forms not yet in a child's grammar simply does not occur; such is the case with imitation. The dominating factor is a child's own system of rules. The contributions of parental speech are always most severely filtered through this system.

What, then, of adult speech? To see even the beginning of an answer to this question, we must examine more closely the acquisition of transformations. It is here, as noted before, that the interaction of a child's linguistic abilities with his linguistic experience takes place.

Negation in the acquisition of English. The study of how children acquire the transformational systems of language has barely begun. One would like to have detailed observations on a wide range of transformational relations, as it is only through investigations of such scope that our views on the process of acquisition can be evaluated. However, few transformations have been investigated from a developmental point of view, and even here the investigations are incomplete.

Menyuk (1964a, 1964b, 1964c, in press (a), in press (b)) has pursued a number of surveys of linguistic development. They possess the desired degree of scope -- a large variety of sentence types being examined -- but the results are presented in terms of a kind of contrastive analysis, and little can be discovered from it about the actual acquisition of transformations.

More direct analyses of transformations are presented by Klima and Bellugi (1966), Brown, Cazden, and Bellugi (in press), and Bellugi (1967). These studies are so far confined to the acquisition of two transformational systems -- negation and questions -- by the three Biblically named children in Brown's study, Adam, Eve, and Sarah. We shall first consider the emergence

of negation and then of questions.

Brown and his colleagues have organized their longitudinal records into a series of "stages." The stages are not intended to have linguistic or psychological significance, although some of them in fact coincide with true junctures in development. The stages are defined in terms of average utterance length, measured in morphemes, and merely provide a way of comparing children whose rates of development are different. Fig. 6, taken from Brown, et al. (in press) shows the relation between chronological age and mean utterance length for the three children of Brown's study. Roman numerals indicate the stages into which the analysis has been divided; the following discussion focuses on the first three of these.

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Insert Fig. 6 here

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At the first stage, coinciding with the first appearance of Pivot constructions, children utter such negative sentences as the following (Klima and Bellugi, 1966):

No...wipe finger

More...no

No a boy bed

Not...fit

No singing song

No the sun shining

No play that

Wear mitten no

Not a teddy bear

No fall!

The form of these sentences is fixed, simple, and universal. They all consist of a negative operator (no or not) plus an otherwise affirmative sentence. The internal structure of the sentence, if any, remains undisturbed by the negation -- the sun shining, play that, and a teddy bear, for example, are all possible affirmative sentences.

The earliest schema for negation, then, is Neg + S. Since a negative operator (no) sometimes appears after sentences instead of before them, there also is the alternative form, S + no.

According to Slobin (1966), Gvozdev's son Zhenya also produced negative sentences in accordance with these schemas. Whereas an adult would say nyet nikavo (literally, "not no-one"), Zhenya said nyet kavo, reducing the well-formed double negative to the single negative required by the schema, Neg + S. French children use non or pas in an analogous fashion (Grégoire, 1937), and Japanese children do essentially the same <sup>thing</sup> with nai (McNeill and McNeill, 1966).

Some two to four months later, depending on the child, Klima and Bellugi found a flowering of negative forms. Compared to the two simple forms of negation of the first period, there are now seven distinct types:

I can't catch you

We can't talk

I don't sit on Cromer coffee

I don't like him

No pinch me

No...Rusty hat

Touch the snow no

This a radiator no

Don't bite me yet

Don't leave me

That not "0," that blue

There no squirrels

He no bite you

I no want envelope

Certain of the sentences are well-formed in English -- I can't catch you, for example. Others are identical to the negative sentences of the first stage -- no pinch me, for example. The rest are intermediate, more complex than the primitive negatives of the first stage but not yet well-formed -- he no bite you, for example.

Although some of the sentences of the second period are apparently well-formed, the grammar yielding them is not yet the grammar of adult English. In fact, I can't catch you and he no bite you have the same basic structure for children at this point in development.

In adult English, sentences such as I can't catch you possess a deep structure of roughly the form Neg + NP + Aux + VP (Klima, 1964). A transformation relates the deep structure to the surface structure of I can't catch you by removing Neg from its location at the beginning of the sentence to a position behind the modal verb can. The process is called "Neg-transportation." In other sentences, for example, I don't like you, there is no modal verb in the underlying structure, but a second transformation introduces the modal do into the surface structure as support for negation. Thus the meaning of I don't like you is really the meaning of I n't like you, since do serves merely to support the negation of the sentence. This process is called "do-support."

The only well-formed sentences listed among the child examples given above were sentences of these two types. If children indeed utter well-formed sentences in such cases, transformations for Neg-transportation and do-support must be involved. However, there is no indication in the second stage of development that do-support exists, although a precursor of Neg-transportation might already be established.

The auxiliaries can and do appear only in the context of Neg at this stage. There are no affirmative sentences such as I can do it, can I have it? or do you think so? Children instead say I do it, I have it?, and you think so?, all without the modal verbs do and can. Klima and Bellugi represent the fact that do and can are restricted to negation by including in the children's grammar a constituent they call the negative auxiliary (Aux<sup>neg</sup>). Aux<sup>neg</sup> in turn eventually leads to don't and can't as two lexical items. Aux<sup>neg</sup> can be regarded as an undifferentiated amalgam of negation and "auxiliary verbness," and its two components will not be distinguished until some months later.

Klima and Bellugi set down the following rules:

$$\begin{aligned} \text{Aux}^{\text{neg}} &\longrightarrow \left\{ \begin{array}{l} \text{Neg} \\ \text{v}^{\text{neg}} \end{array} \right\} \\ \text{v}^{\text{neg}} &\longrightarrow \left\{ \begin{array}{l} \text{can't} \\ \text{don't} \end{array} \right\} \\ \text{Neg} &\longrightarrow \left\{ \begin{array}{l} \text{no} \\ \text{not} \end{array} \right\} \end{aligned}$$

The constituent Neg appears in that no fish school, he no bite you, and other sentences of this type.

Since Aux<sup>neg</sup> appears immediately after the subject NP of a sentence and immediately before the main verb, negation is already positioned appropriately, and Neg-transportation is not necessary to produce surface structures of the type observed. Moreover, since there is no evidence for modal verbs existing independently of negation, a transformation for do-support is likewise not necessary to obtain the surface structures of the second stage. On Klima and Bellugi's analysis, then, such sentences as I don't like you and he no bite you are fundamentally alike. Neither includes a modal verb, both include the constituent Aux<sup>neg</sup>, and the transformations for Neg-transportation and



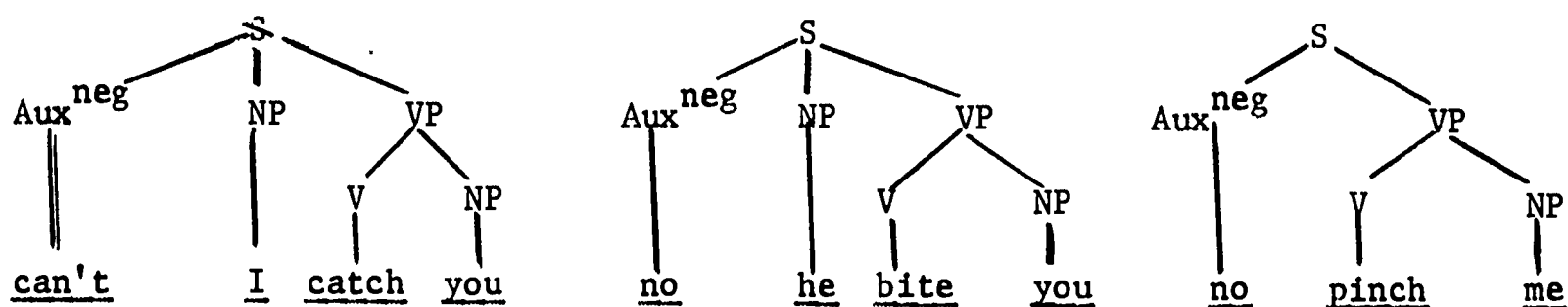
do-support are not involved. Clearly, therefore, the well-formedness of I don't like you and I can't catch you is illusory, as both have at root the same structure as he no bite you.

There is another interpretation of sentences of the last type. He no bite you includes negation internal to the sentence, and in this respect differs from the more primitive specimens observed in the first stage of development, e.g., no the sun shining. One innovation occurring between the first and second stages of development may therefore be the appearance of Neg-transportation.

If we accept this interpretation the consequence for Klima and Bellugi's grammar is merely to reverse the order of elements assumed to underly negative sentences. Instead of NP + Aux<sup>neg</sup> + V, as in Klima and Bellugi, it becomes Aux<sup>neg</sup> + NP + VP, with the constituent Aux<sup>neg</sup> being developed as before.

Neg-transportation now applies to every sentence, including I can't catch you. One advantage of this interpretation is that it leaves room for the negatives -- such as no pinch me and no...Rusty hat -- that appeared in the second stage but seem to be relics of the first. In Klima and Bellugi's analysis, they are truly relics, coming from an earlier and unintegrated system. In the alternative analysis they are identical to the underlying form of all negative sentences in the second stage, with the exception that they have no subjects -- still a common fact in children's sentences at this time.

Consider, as examples, the three phrase markers below. The first is the deep structure of I can't catch you, the second of he no bite you, and the third of no pinch me.



The transformation for Neg-transportation at the second stage is,

$$\underline{\text{Aux}}^{\text{neg}} + \underline{\text{NP}} \Rightarrow \underline{\text{NP}} + \underline{\text{Aux}}^{\text{neg}}.$$

This transformation must apply to the first two phrase markers above, as they meet the condition of the transformation; I can't catch you and he no bite you result.

However, the transformation cannot apply to the third phrase marker, since it has no NP after Aux<sup>neg</sup>; the sentence remains no pinch me. According to the alternative interpretation, therefore, such sentences as no pinch me are untransformed deep structures. We shall return to this possibility below (p. ).

Notice that the well-formedness of I don't like you and I can't catch you is illusory in the alternative analysis as well as in Klima and Bellugi's analysis. The basic kinship of these sentences to he no bite you remains undisturbed by assuming the existence of a transformation; the kinship is merely explained in a different way.

Two to six months later, again depending on the child, sentences of the following types occur:

Paul can't have one

This can't stick

I didn't did it.

You don't want some supper

Donna won't let go

No, it isn't

I am not a doctor

This not ice cream

They not hot

I not crying

He not taking the walls down

Don't kick my box

Don't touch the fish

Ask me if I not make mistake

I not hurt him

There are some new developments in this third stage, though apparently not so many as in the second. However, as is often the case in child language, superficial changes are not a valid guide to changes taking place in a child's underlying system. Grammar can develop "silently." Whereas the five new forms of the second stage resulted from changes (in Klima and Bellugi's analysis) of little scope, the negative sentences of the third stage come from a grammatical system that has been fundamentally altered: there are now auxiliary verbs; a transformation for do-support is now present; and, in Klima and Bellugi's analysis as well as in the alternative analysis given above, there is a transformation for Neg-transportation.

A basic development is the first appearance of the English system of auxiliary verbs. Unlike the second stage, there are now affirmative sentences with modal verbs, as in I can do it, can I have it?, etc. Negation is therefore no longer tied to the auxiliary, as in the second stage, for the constituent Aux<sup>neg</sup> has been differentiated into its <sup>negative and auxiliary</sup> components. Since do and Neg co-exist in the surface structure but are not united in the deep structure, a transformation for do-support becomes necessary to derive sentences like I don't like you. The continuity of surface forms between the second and third stages masks a basic discontinuity in the grammar.

The development of the auxiliary system is very rapid and pervasive during the third stage. It is as if the auxiliary, once freed from negation, rushed to fill all space available in a child's grammar. As Bellugi (1967), who has studied these developments closely, puts it:

"The change suggests a carefully prepared complex system which is beginning to be set in and intricately hooked up to the children's previous language systems. If the change were not so widespread, and occurred over a long period of time in many little separate aspects, nothing would be surprising in this development... It is the fact that much of the apparatus comes in in a relatively short period of time and appears in a variety of structures that surprises us." (p. 90).

Table 6 gives some impression of the pace of these changes. In it are shown the number of times that one child, Eve, used modal verbs in several different grammatical contexts in three successive samples of her speech; the samples were collected over a period of a month and a half. In parallel with the growth in numbers is a growth in variety -- more and more modal verbs appear with more and more main verbs, tenses of verbs, subjects, etc.

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Insert Table 6 here

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Negation in English is a complex system. Klima's (1964) analysis for example, includes almost two dozen phrase-structural and an equal number of transformational rules. The sketch presented here -- including as it does only three phrase-structural and two transformational rules -- is clearly highly selective and incomplete. Bellugi (1967) goes somewhat farther, but detailed understanding of the entire system is far from being at hand; as noted before, the work has only begun.

Two other aspects of children's negation should be mentioned, however. Both illustrate the autonomous and inventive character of child grammar, and its indirect dependence on the speech of adults.

One has to do the rather special corner of the English negative system that controls such verbs as think, believe, anticipate, expect, and want. All have the unique property that when in sentences with embedded object complements, either these verbs or the verb of the complement may be negated, and meaning does not change (Lakoff, 1966). Compare, for example, the following quartet of sentences, the first pair of which includes a verb open to this option, and the second pair of which does not.

- (a) I think that he won't come on time
- (b) I don't think that he will come on time
- (c) I know that he won't come on time
- (d) I don't know that he will come on time

Sentences (a) and (b) mean the same thing, whereas (c) and (d) do not.

For the small set of verbs admitting such moveable negation, Bellugi counted the number of times each option was employed in the speech of the parents of Adam and Sarah. (Eve's records contained no examples of such embeddings.) The verbs most often used were think and want, and in all utterances except one, negation fell on the matrix sentence. I don't think that he will come in time was more frequent by a large margin than was I think that he won't come on time. Such is the linguistic evidence given to Adam and Sarah.

children's  
However, in the  $\wedge$  own speech, precisely the opposite arrangement dominated. The following is an exhaustive list:

- He thinks he doesn't have nothing
- I think it's not fulfilled up to the top
- He thinks he doesn't have to finish it
- I think we don't have a top
- I think he don't like us no more
- I think I can't find white

I think I don't better cut it

I think I don't know what it is

I think I don't

The explanation of the difference between what children do and what is presented to them is simple. Verbs such as think and want are exceptions to the general rules of negation in English. Unexceptionable verbs are not open to the option of moveable negation in this way. Children, if they have worked out the general rules of negation but not yet the exceptions, will treat think as any other verb. They will do so even though they are contradicted by the evidence of parental speech. We have again an indication of the inviolability of children's grammar, and the strong filtering effect it exerts on the speech of adults.

Another phenomenon in the acquisition of negation similarly reveals the autonomy of grammar, in this case that children's grammar is autonomous when it changes just as when it does not. In English, adults say affirmatively, I want some supper, and at an early point in development children do the same (Bellugi, 1964). To negate such utterances, adults may either say I want no supper or I don't want any supper. Children at first use neither of these forms, but say I don't want some supper instead. After a few months, however, the grammar changes, and denial takes the form of double negation, as in I don't want no supper. It is only after many months that children at last say I don't want any supper. Thus, the order of appearance of pronouns in negative sentences is some - no - any. Other pronouns built on these forms -- e.g., something, no one, anybody -- behave in the same way.

Sentences with some, such as I don't want some supper, occur at the second stage of negation described above, and result from the insertion of don't as an Aux<sup>neg</sup> into such affirmative sentences as I want some supper. A child receives no examples of this process in the speech of adults; it is an

autonomous consequence of his own grammar. The double negatives of the next stage are even more interesting. The middle-class parents of children who say I don't want no supper do not themselves use double negatives; indeed, Cazden (1965) found some indication that children exposed to a double-negative dialect differ both from middle-class children and from the dialect to which they are exposed. Middle-class parents, far from providing examples of double negatives, <sup>tend to</sup> correct such utterances with one or another of the well-formed forms of denial. Of the two possibilities, sentences with any are favored -- you don't want any supper is more natural than you want no supper. We have therefore a rather extreme example of the autonomy of child grammar: by correcting some-forms with any-forms, parents cause children to use no-forms.

Bellugi (1967) interprets the double negatives of the third stage as "negative coloring" -- a kind of emphatic denial -- although it is unclear of what negative coloring consists, except a tendency to use double (and sometimes triple) negatives. It is also unclear why there is not "affirmative coloring" in cases of emphatic assertion, if indeed emphasis has anything to do with double negation. It seems rather that the double negatives of the third stage are a natural development of negation in the second stage; for some speculations along this line, see McNeill (in press).

The exclusive schema for negation in the first stage was Neg + S or S + no. In the second stage, sentences adhering to these schemas continued to appear but they were no longer the exclusive means of negation. In the third stage, negation based on these simple schemas disappeared completely. As was pointed out earlier, this sequence of events also appears in the acquisition of French, Russian, and Japanese, at least. It is possible, therefore, that the two schemas Neg + S and S + Neg are universal starting points for negation.

Let us propose that a fundamental ability for negation, from which all children build, allows children to deny a proposition by affixing to it something like a minus sign. If this were actually the case, all children would commence their linguistic careers with one or another of the two schemas mentioned before, and all languages would have sentence-external negation as the deep structure of negative sentences. The suggestion is identical to a remark made by Grégoire in 1937 (p. 169, quoted by Braine, in press): "pas devance [la phrase] à la façon d'un sign algébrique qui l'annule."

From such a beginning, children develop in two general directions. On the one hand, the semantics of negation evolves from its primitive starting point, whatever that may be, to a level where distinctions are drawn between such different forms of negation as, for example, no (I don't want it), no (it is untrue), and no (it is not here). On the other hand, children must discover the syntax of negation of their local language -- a process traced in part for English in the preceding pages.

Let us briefly consider semantics. Bellugi (1967) reports an impression that the meaning of negation develops quickly. In the first stage of development, negation seemed, diffusely, to mean refusal, rejection, or displeasure. By the second stage, however, a number of cases appeared where a child clearly negated the content of a previous proposition. For example,

Adult: Daddy's getting old, huh?

Child: No, I get old

Adult: That's your valentine

Child: No, Becky valentine

McNeill and McNeill (1966) found a similar sequence in a study of the development of negation in Japanese children. An initial incoherent period, where denial seemed to depend on the absence of an object, was followed within a few months by the emergence of a single semantic contrast between



the denial of the truth of propositions and the denial of the existence of objects or events -- that is, by the form of negation observed by Bellugi. McNeill and McNeill (1966) found that negation in the sense of rejection or refusal did not appear until some time later.

When a child says, for example, no, Becky valentine, he denies the truth of an intrinsic predicate -- that the valentine is Becky's. If, as claimed above (p. ), intrinsic predicates are the first form of predication to appear in child language, the initial meaning of the "algebraic minus sign" must be the negation of such predicates. Only later, when extrinsic predication also becomes available, will children negate the existence of things or events. The first distinction drawn in the semantics of negation, therefore, will be between the denial of truth and the denial of existence.

McNeill and McNeill (1966) analyzed the semantic system of Japanese negation into three such contrasts, and then traced the emergence of each. It is conceivable that the same system applies to English negation also, and that children learning English acquire the system in a similar way.

Figure 7 shows the Japanese arrangement. The contrast between

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Insert Fig. 7 here

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"Truth" and "Existence" refers to the negation of intrinsic and extrinsic predicates respectively. The contrast between "Entailment" and "Non-entailment" refers to the difference between, for example, no, that's an apple, not a pear and no, that's not a pear. Both deny the truth of an intrinsic predicate (as in that's a pear), but in no, that's an apple, not a pear, the denial of one predicate "entails" the contrasting truth of another (that's an apple). The examples above from Bellugi (1967) apparently are of the entailment type. A final contrast, between "Internal" and "External," refers to

the difference between denial on internal grounds (e.g., I don't want it to happen) and denial on external grounds (e.g., it didn't happen.)

As already mentioned, the Japanese children studied by McNeill and McNeill (1966) developed first the contrast between "Truth" and "Existence." A few months later, they began to honor also the contrast between "Internal" and "External." However, before this time their expression of refusal took an apparently dogmatic form. The Japanese expression for "I don't want" (iya) was not used in situations where refusal was evidently intended (as in reply to "Let's give your sister some"), but instead the expression for "it doesn't exist" was used (Nai, an Adjective). The children therefore expressed a lack of willingness with a term already known to express a lack of existence; clearly, the distinction between "Internal" and "External" did not yet matter. Finally, after several more months, the contrast between "Entailment" and "Non-entailment" appeared.

The entire structure represented in Fig. 7 emerged within a period of four to six months. Although it may be true that semantic development is generally slower than is syntactic development (cf., ), that is not the case with negation. Accepting Bellugi's examples at face value, "Entailment"-Non-entailment" appears in the language of American children when negation is still fused syntactically with the auxiliary system, and a number of months before the transformations of neg-transportation and do-support make their first appearance.

The development of questions. Questions at the outset are simple in the extreme, and in this respect are like negation. Rising intonation, or the use of one of a few Wh-words, is the only interrogative device. Nonetheless, even very young children distinguish between yes-no and Wh-questions -- asking, for example, both see hole? and what doing?

The following account will concentrate on the development of Wh-questions, and, within this limit, will concentrate on the second and third

stages of development defined by Brown, et al. (in press). The first stage comprises essentially the simple system just described.

In the second stage children ask Wh-questions of the following kinds:

Where my mitten?

What me think?

What the dollie have?

Why you smiling?

Why not he eat?

Why not...me can't dance?

A clue as to the structure of such questions lies in the fact that in every case except one deleting the Wh-word (or why not in the case of <sup>negative</sup> questions) leaves a "grammatical" sentence as a residue. My mitten, me think, you smiling, he eat, and me can't dance are all possible declarative sentences in the second stage; the only exception is the dollie have, which lacks a NP-object. In general, therefore, Wh-questions are formed simply by using a Wh-word to begin a declarative sentence, the sentence otherwise being left undisturbed.

Questions asking why and why not are not different from other Wh-questions, although the <sup>of the former</sup> distribution is more restricted. Why not itself seems to be a single Wh-word possessing negative import, not a construction made up of why and negation as separate parts. More significantly, both why and why not tend to be restricted to discourse exchanges in which the declarative part of the question comes from a previous utterance of an adult and the Wh part comes from the child. Table 7 presents some examples from the speech of Adam

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Insert Table 7 here

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and his mother (Brown, et al., in press). The other Wh-words available to children in the second stage of development do not depend on such discourse exchanges. McNeill (1963) found a<sup>discourse</sup> restriction similar to the restriction of why and why not in children's use of personal pronouns -- in its first occurrences the first-person pronoun, I, always followed adult sentences with you.

It is clear from Table 7 that Adam's rule for deciding between why not and why is to choose the former when his mother's sentence is negative and the latter when it is affirmative. However, it is difficult to say what semantic constraints exist for Adam's why and why not questions. He wants to know, for example, why you see seal?, why me bend that game?, and why not me careful? Such questions suggest that although Adam probably seeks an explanation when he asks why or why not, his conception of an explanation is remote from an adult's. It would be surprising, of course, if it were otherwise; Piaget (1924) long ago demonstrated that children are unable to conceive of true explanations at Adam's age. Nonetheless, the possibility of explaining things -- as opposed to what counts as an explanation -- apparently exists early in development.

Wh-questions in the third stage reveal a number of interesting features. Some examples from Klima and Bellugi (1966) are the following:

Where small trailer he should pull?

Where the other Joe will drive?

What he can ride in?

What did you doed?

Why he don't know how to pretend?

Why the kitty can't stand up?

How he can be a doctor?

How they can't talk?

The third stage, it will be recalled, is marked by a general emergence of the English auxiliary system, and this development is much in evidence in the Wh-questions children ask. However, children do not use auxiliary verbs in quite the English manner. They ask, for example, what he can ride in? or why he don't know how to pretend? An adult would put these questions differently -- what can he ride in? or why doesn't he know how to pretend? Both the child and adult versions have a Wh-word in the initial position of the sentence, but the child version does not invert the order of auxiliary verbs and subjects. Children do not invert the order of subject and auxiliary in Wh-questions even though they do invert these same elements in yes-no questions. Along with what he can ride in? children also say can he ride in it?

Brown, et al. (in press) take the different treatment of Wh- and yes-no questions to mean that children perform just one major transformation per question, even though they have more than one appropriate transformation available. In yes-no questions, only inversion of subject and auxiliary is required, and it is performed. However, in Wh-questions, both inversion and a transformation called "preposing" are required, and children perform only the latter.

"Preposing" refers to one of the transformations in Klima's (1964) and Katz and Postal's (1964) grammar for Wh-questions. In this analysis, the derivation of a Wh-question begins with a deep structure that contains, in effect, a blank for the constituent being questioned. The deep structure of what can dinosaurs eat?, for example, is roughly dinosaurs can eat  $\Delta$ , where  $\Delta$  stands for the NP about which information is sought. One relation between the deep structure dinosaurs can eat  $\Delta$  and the surface structure what can dinosaurs eat? is therefore preposing  $\Delta$ . The result of this transformation is  $\Delta$  dinosaurs can eat; morphophonemic rules convert  $\Delta$  to what.

A second relation between the deep and surface structures of what can dinosaurs eat? is inversion of can and dinosaurs.

Since children say what dinosaurs can eat in the third stage of development, it appears that they do not perform the second transformation when they perform the first. What dinosaurs can eat? is an example of what Brown, et al. call a "hypothetical intermediate" -- a structure defined by the grammar of adult English only at an intermediate stage of derivation.

The account of Brown, et al. assumes that the transformations correspond to actual operations in the production of sentences; it is because of such correspondences that psychological complexity is reduced by eliminating transformations. Some might object to this assumption. Nonetheless, evidence from a number of experiments with adult subjects shows that transformations indeed do contribute to the psychological complexity of sentences, although it is far from clear how such effects are brought about. (e.g., Miller and McKean, 1964; <sup>McMahon, 1963</sup> Gough 1965; Mehler, 1963; Slobin, 1966c; Savin and Perchonock, 1965; but also see Fodor and Garrett, 1966). It is possible, though not yet demonstrated, that a similar relation between psychological and linguistic complexity holds for small children.

However, there is a problem of a different kind. Children always eliminate the same transformation. Children never say, for example, can he ride in what? or will the other Joe drive where? -- questions in which subject-auxiliary inversion has occurred but preposing has not. If children actually reduced complexity by eliminating one of two generally available transformations, it would seem that both types of Wh-question must occur.

One way to explain the presence of what he can ride in and the absence of can he ride in what? is to assume that the underlying form of the Wh-questions of the third stage is not yet the adult form -- in particular, that the vacant constituent △ is not in the object position of sentences. In

that case there would be nothing to prepose, and a transformation for preposing could not exist in a child's grammar. As in the second stage, Wh-words in the third stage are instead added to the beginning of sentences and therefore invariably appear there. What + he can ride in is a possible question under this arrangement, whereas can he ride in + what is not.

However, this suggestion also encounters difficulty. If different Wh-words are introduced at the beginning of sentences, it is puzzling that such questions are semantically appropriate. But the Wh-questions of the third stage are semantically appropriate, a fact that demonstrates an association of Wh-words with particular sentence-constituents, and (in contrast to the consistent omission of subject-auxiliary inversion) suggests the existence of a preposing transformation. The contradiction only deepens when we recall that the Wh-questions of the second stage, when Wh-words are introduced at the beginning of sentences, also are semantically appropriate.

How could appropriate Wh-questions be derived, if not by preposing? Perhaps the contradictory indications just mentioned can be resolved through a more careful scrutiny of the status children give to questions. Klima and Bellugi (1966) list the following answers of children to Wh-questions asked by adults. All are from the second stage.

Adult: What d'you need?

Child: Need some chocolate

Adult: Who are you peeking at?

Child: Peeking at Ursula

Adult: Who were you playing with?

Child: Robin

Adult: What d'you hear?

Child: Hear a duck

Every question is answered appropriately from a semantic point of view. However, in every example except one, the child's answer is a full VP instead of the NP customary in English. A semantically appropriate reply appears in an unusual syntactic setting; what and who evidently are not associated with NP.

Let us suppose that what has as part of its lexical entry a feature such as [+ common noun], that who has [+proper noun], and that why has both [+ common noun] and [+ proper noun] as two options; such is the lexicon of Wh-words in the second stage. Whenever one of these Wh-words is heard in an adult question, nouns of the specified type are given in reply. Let us also suppose that each Wh-word is understood as a kind of introductory word for an entire sentence, and not as a replacement of a constituent of a sentence as in adult grammar. Then a child's answer to an adult Wh-question will be a sentence that contains a N of a type specified by the Wh-word; it will not be a noun or verb phrase. Moreover, a child's own Wh-questions will be declarative sentences with Wh-words before them. Children with such a grammar can ask semantically appropriate Wh-questions and not have to prepose Wh-words while doing so.

The facts almost fit this explanation. As expected, a child's own Wh-questions in the second and third stages are generally sentences with Wh-words before them; it is for this reason that subject-auxiliary inversion does not occur in Wh-questions. But the explanation also leads us to expect that a child's answers to adult Wh-questions are sentences, whereas the answers actually given in the second stage are VP's.

However, there is a natural explanation of the VP's of the second stage. A child answers an adult Wh-question with a sentence that includes the material specified by the Wh-word, but he omits the redundant subject of the sentence. Omitting redundant subjects, of course, is a common occurrence in sentences



with intrinsic predicates, especially when the subject makes first-person reference (p. ). The omitted subjects in the child answers given above are all the pronoun I.

In the third stage of development, children answer adult Wh-questions with NP's, as is customary in English (Brown, et al., in press). Doing so, however, contradicts the tendency of children at the same stage to ask Wh-questions by placing a Wh-word before a sentence. There is no process in child speech, corresponding to the omission of subjects, which systematically reduces sentences to NP's. However, such contradictions are not peculiar to Wh-questions. As has been widely noted, children often comprehend syntactic forms before they produce them (e.g., Fraser, Bellugi, and Brown, 1963; Dixon, 1965; Lovell and ^ ), and such apparently is the case here.

The third stage of development is transitional. Children understand Wh-words in the speech of adults as representing particular constituents, but children do not yet produce Wh-questions this way. McNeill (1966a) offers some speculations on the cause of the gap between the production and comprehension of speech -- essentially, that the constraints of memory are less on comprehension than on production.

#### THE ROLE OF ADULT SPEECH

One major interaction that takes place between a child's linguistic abilities and his linguistic experiences is localized in the acquisition of transformations. A large part of the problem of understanding language learning is precisely the problem of understanding how this step is taken. In the present and final section on syntax, we shall consider what can be said of the process of transformational development.

Imitation. Imitation has already been mentioned (p. ) but can be considered again in the present context. There is no reason in principle why imitation cannot be used as a strategy for discovering transformations.

By imitating the surface forms of adult sentences, children can pair well-formed surface structures with deep structures of their own devising, and so notice how the two are related. Situational cues might suggest particular deep structures, so the method need not proceed blindly. However, the potential usefulness of imitation is confronted by another principle, which, in actual practice, dominates it. Children systematically convert adult sentences into forms allowed in their own grammatical system. The consequence is that even though deep and surface structures are paired through imitation, the only relations established in this manner are relations already known. Apparently children always assimilate adult models into their own grammars; imitation thus can play no role in the acquisition of new transformations.

Expansions and "prompts." One way to avoid the problem of assimilation is to place the burden of introducing new surface forms on adults. In that case, assimilation to child grammar cannot occur. Brown, et. al. (in press) discuss two situations that have such an effect, one they call "expansion" and the other "prompting." The effectiveness of the first is open to dispute and the usefulness of the second is so far unknown, but both at least illustrate some of the possibilities that exist.

An expansion is an imitation in reverse. An adult, imitating a child's telegraphic sentence, typically adds to the child's sentence the parts he judges the child to have omitted. The result is an expansion. There are always a number of possibilities available as expansions, and an adult will choose the one that he believes best expresses the child's intended meaning. That mommy hairband, for example, could be expanded in many directions -- that's mommy's hairband, that was mommy's hairband until you dismantled it, that looks like mommy's hairband, etc. Usually one sentence will best fit the extra-linguistic situation, and that sentence becomes the expansion.

An expansion that fits both a child's utterance and the extra-linguistic situation reveals one or more transformations. If the child's meaning is correctly guessed from the extra-linguistic situation, the expansion presents a surface structure that expresses the deep structure the child has in mind. The expansion is necessarily experienced by the child in contiguity with his intended meaning, and is effective when the child notices the way the two are related. In this case, there is no intrusion of a child's tendency to assimilate adult speech to his own grammar.

Cazden (1965) looked into the effectiveness of expanding child speech by deliberately increasing the number of expansions a group of children received. The children were two-and-a-half years old, from working-class homes, spent each week day in a nursery school, and received in the normal course of events few expansions either at school or at home. In Cazden's experiment every child spent one-half hour a day, five days a week, looking at picture books with an adult who systematically expanded everything the child said. At the beginning and at the end of the experiment, three months later, the children were given a specially devised test of linguistic performance (covering, for example, NP and VP complexity and the imitation of various syntactic forms).

These expansion children were compared to two other groups of children, taken from the same nursery school, who received in one case what Cazden called "models," and in the other case no special treatment at all. "Modelling" was commenting. Everything said by a child in the modelling group was commented upon rather than improved upon through expansion. If, for example, a child said doggie bite, an expansion might be yes, he's biting, whereas a model might be yes, he's very mad. Children in the modelling group also spent one-half hour a day, five days a week, looking at picture books with an adult.

The results were clear cut. Relative to the group of children who received no special treatment, there was a modest gain in linguistic performance among the children who received expansions, and a large gain among the children who received models. Cazden interpreted her result by pointing to a difference in the variety of syntactic and lexical forms required for expanding as compared to modelling child speech. In expansion an adult is closely led by a child -- he must use the child's words and something like the child's syntax. The opposite is typically true of modelling. Apparently, therefore, constraint by a child's own utterances is not beneficial to linguistic development. However, it is this very fact that presumably makes expansion advantageous; clearly, if Cazden is right, the theory of expansion is wrong.

Cazden's experiment shows beyond doubt that modelling benefits linguistic development. However, it is less clear that expansions are not beneficial also. The rate of expansion of the speech recorded of middle-class children is about 30%. One can ask why this rate is not higher -- say 50% or 70%. There must be many reasons why the rate of expansion stabilizes where it does, but one reason is particularly significant: not everything said by a child has an unambiguous meaning in the extra-linguistic context, and in such ambiguous circumstances adults tend not to expand (McNeill, 1966b).

In Cazden's experiment, on the other hand, the rate of expansion was 100%, by design. Aside from the possibility that young children might not pay attention to most expansions in the face of an avalanche of expansions (Brown, et al., in press), some utterances in Cazden's experiment must have been inappropriately expanded. In such cases a child could formulate a "transformation" that does not belong in English -- for example, one that relates the meaning of "that's mommy's hairband" to the surface structure of that looks like mommy's hairband. If such misinterpretations took place,

the poor showing of expansion in Cazden's experiment is to be expected even on the excessively strong assumption that expansions are decisive in the acquisition of transformations. The question of the effectiveness of expansion therefore remains open.

Brown, et al. (in press) have recently looked at the matter in another way, and again obtain negative results. However, yet again, counter-arguments arise in defense of expansion. As noted before (p. ), Brown, et al. calibrate the linguistic development of their subjects against the mean length of utterances, rather than, as usual, against chronological age. When the calibration is done against utterance length, the rate of advancement of the three subjects in Brown's study is (in declining order) Sarah, Adam, and Eve. This order of development is not the same as the order of expansion by the children's parents. In this case it is Adam, Eve, and Sarah. In other words, Sarah, who is most advanced relative to utterance length, received the fewest expansions.

However, one can dispute the choice of base-line by Brown, et al. At any given utterance length, Eve used fewer modal verbs, inflections, prepositions, articles, and other superficial sentence-forms than did Sarah. Length for Eve was increased with content words -- nouns, verbs, and adjectives. Thus Sarah's speech was syntactically more like adult English at any given length and Eve's was more informative, as Brown, et al. point out. Sarah might have said that's mommy's hairband, a well-formed sentence five morphemes long, whereas Eve might have said, semi-grammatically, but with the same length, that mommy broken hairband there.

Cazden (1967) concludes from the differences between Eve and Sarah that Eve's intellectual development was greater than Sarah's. A difference between Eve and Sarah in intellectual level may well exist, for comparisons of children on syntactic complexity relative to mean utterance length is one

appropriate way of demonstrating such a fact -- at every point, Eve had more to say but Sarah said it better. Such comparisons, however, do not bear on the alleged role of expansions. This role is to facilitate the acquisition of transformations. A child who receives more expansions has more opportunities to observe relations between deep and surface structure and therefore can formulate these relations sooner. An appropriate base-line against which to measure this effect is chronological age; relative to chronological age Eve's linguistic development is far in advance of Sarah's (Brown, et al., in press).

The role, or lack of role, of expansion in linguistic development is thus open to dispute. The one experiment done on the phenomenon has an ambiguous outcome. The evidence of recorded adult and child speech can be interpreted in diametrically opposite ways, depending on the base-line of comparison.

"Prompting" is discussed by Brown, et al. as a possible training variable, but its effectiveness is yet to be investigated. As noted before (p. ) one transformation in the derivation of Wh-questions in English is a preposing of  $\Delta$  to the head of a sentence. Dinosaurs can eat  $\Delta$  becomes  $\Delta$  dinosaurs can eat. In a "prompt" something very much like preposing is demonstrated to a child.

A "prompt" begins with a Wh-question from an adult -- what did you eat? If a child does not answer, the question may be repeated in a different form -- you ate . . . what? The second version differs from the first in several respects, one being that preposing has not occurred. If a child understands the second question, and so has in mind the deep structure you eat  $\Delta$ , he is in a position to observe the relation of this deep structure to the surface structure of what did you eat? (McNeill, in press). The relation is preposing, and for a child who has not formulated the trans-

formation, a "prompt" may provide an occasion to do so. Brown, et al. note that children usually answer non-preposed questions, so "prompting" is at least potentially effective in revealing preposing to a child.

Brown, et al. describe a third parent-child exchange, "echoing," which also can be mentioned although it cannot provide an opportunity for children to learn a transformation. An "echo" begins with a child's utterance that is in part unintelligible -- for example, I ate the gowish. An adult may then echo the child but replace the unintelligible part with a Wh-word -- you ate the what? The form of the adult question is the same as in "prompting." However, even if a child understands the adult question he could not discover preposing, for that relation is nowhere revealed. The only relations available in an "echo" are, on the one hand, between the deep structure you ate  $\Delta$  and the surface structure of you ate the what?, and on the other hand, between you ate  $\Delta$  and the surface structure of I ate the gowish. If a child recovers the deep structure of you ate the what?, he already understands that relation; if he notices the relation between you ate  $\Delta$  and I ate the gowish, he observes the relation of a question to an answer. "Echoing" might tell a child something about answering questions, therefore, but it cannot teach him about preposing. "Echoing" might also help a child discover what in his own utterance belongs to a single sentence-constituent (Brown, et al., in press): the what of you ate what?, for example, replaces a NP in the child's sentence; the where of you got it where? replaces a locative adverbial; etc.

A general condition for learning transformations. Both expansions and "prompting" have in common an ability to demonstrate transformational relations; "echoes" on the other hand do not have such a property. There are no doubt other exchanges between parents and children that reveal transformations, and it is helpful in the search for such exchanges to

isolate the condition that all must meet. The condition is this. In order for a child to observe a transformational relation not yet part of his linguistic competence he must have in mind the deep structure of a sentence obtained from the speech of someone else; a structure that can only be in a child's mind must co-exist with another structure that can only be in the speech of an adult. Expansions, "prompts," and imitation, for example, meet this demand, but "echoes," talking to oneself, rote practice, and many utterances simply overheard by children, do not (McNeill, in press).

Such situations as expansion or imitation, which potentially combine a child's deep structure and an adult's surface structure, may not, of course, always result in the discovery of transformations. In the case of imitation discovery is systematically blocked by a contradictory tendency to imitate in terms of a child's own grammar. The usefulness of expansions and "prompts," while not systematically blocked, depends on a child actually noticing that both <sup>a</sup> deep and surface structure are available. Children may not always do this.

Universal transformational relations. There is a more fundamental aspect of the discovery of transformations. Bringing deep and surface structures together for a child makes the discovery of a transformation possible. But the transformation must then be formulated. Doing so is the heart of learning language, and all else, including the training situations considered by Brown, et al., is background for this process.

We next take up the question of formulating transformations. However, the reader is forewarned that little can be said of what takes place; this remarkable activity of children remains quite obscure.

Languages differ hugely in their surface structures; they also differ hugely in the transformations that relate surface structures to deep structures. Although most linguistic universals influence the deep structure of sentences,



there is also a small number of universal transformational relations. A transformation discussed in the Appendix (pp. ) permutes the order of verbs and affixes in developing an auxiliary verb. The transformation appears in French as well as in English (Ruwet, 1966), and possibly in other languages also, but it is not universal. Nonetheless, the relation of permutation is universal. It is available to all languages; the English transformation is idiosyncratic only in that it is restricted to verbs and suffixes.

Besides permutation, the addition of elements (as in the English passive) and the deletion of elements (as in the English imperative) are universal transformational relations. So is the requirement that deletions from the deep structure be recoverable (forcing, e.g., English relative clauses to be made up of constituent and matrix sentences with identical NP's; see Appendix, pp. ). There may be a few other relations of universal scope; but their total number probably is less than the total number of fingers.

Universal transformations may play a crucial role in language acquisition, for it is possible that they describe relations to which young children are innately predisposed. Indeed, that would be at least one reason why they are universal. Let us ask how children could make use of such innate predispositions to discover the idiosyncratic transformations of their language.

Universal transformational relations can be regarded as a set of general hypotheses available to children to explain the interrelations of the deep and surface structures that are displayed to them. The displays may be arranged through parent-child exchanges, as described above. For example, a child who understands you ate what, and so has in mind you ate  $\Delta$ , can relate this deep structure to what did you eat? by a double addition --

add what and did in that order to the front of a sentence. Such is one hypothesis based on a universal transformational relation for constructing Wh-questions in English. It is, of course, an incorrect hypothesis and a child entertaining it might ask such questions as what did you will do? or what did I running?, as well as what did you eat? or what did that Santa Claus do?

To eliminate sentences of the first type and retain sentences of the second, a child must revise his hypothesis. Perhaps he tries the single addition of what instead of the double addition of what and did. That yields what you will do? and what you eat?, which is like the solution arrived at by the second stage of development (cf., pp. ).

Further revisions are necessary if a child is to acquire the grammar of English, for the correct relation in the derivation of Wh-questions is permutation (of S and △), not addition. One cannot say what drives a child to this hypothesis, although a grammar of Wh-questions without the relation of permutation may grow to intolerable levels of complexity (cf., McNeill, 1966a, for a general discussion along these lines). It is also possible, of course, that some children use permutation as an initial hypothesis to account for the relation between the surface and deep structure of Wh-questions. The formulation of hypotheses is probably an unconscious process, although the systematic play and exploration of Weir's (1962) child suggests that the activity sometimes reaches a voluntary level.

If indeed the acquisition of transformations proceeds through the formulation and refinement of hypotheses, the hypotheses <sup>take</sup> form <sup>apparently the</sup> most general possible. Children are not cautious theoreticians. They do not, for example, attempt to find an integrating principle that covers two or three local observations, to which they add the results of other small theories devised elsewhere -- that is, they do not follow the model of a systems engineer. They are more like theologians in this

respect, as their goal is to find hypotheses with the largest possible scope and the fewest possible exceptions. The consequences are visible throughout language acquisition -- in inflectional imperialism, in the differentiation of grammatical classes, in negation, and in Wh-questions.

It is possible that the systematization carried out by children can itself be described in terms of a regular principle. The so-called simplicity metric of linguistic theory (e.g., Halle, 1964b; Katz, 1966) is designed to select the simplest grammar that fits both the rest of linguistic theory and the intuitions of native speakers. Children, in extending linguistic hypotheses to cover different cases, may act in a manner described by such a simplicity metric.

It is worth considering the possibility that children cannot avoid formulating hypotheses about language. Given any kind of linguistic experience, children may instantly develop rules that cover the experience. A few instances, perhaps only one instance, of a NP and a VP becoming a sentence may lead to the hypothesis that all sentences are NP-VP constructions. The tremendous generality of children's first grammars suggests the existence of such a phenomenon. Generalizations appear inevitably; what requires time and further experience is the modification of these generalizations. If such is actually the case, then children do not have to learn rules in learning a language, but rather must learn the limitations on rules. Language acquisition would in this case be the opposite of concept formation, where certain strategies are followed that lead to the discovery of rules (Bruner, Goodnow, and Austin, 1956), <sup>and</sup> indeed it would be different from most other forms of learning studied by psychologists.

The starting-point of grammar is more or less the same for all children; a good deal of space in the preceding pages has been devoted to describing this initial condition. Being universal, child grammar is not

the grammar of any language, but is instead something that can become the grammar of any language through a process of formulating and modifying linguistic hypotheses.

In so evolving, language for a child moves from a maximally diffuse to a maximally articulated state. It starts with an intimate and extremely general relation between sound and meaning; it progresses from there to a less intimate and general relation mediated by deep structures; eventually it arrives at the complex and systematic relation between sound and meaning that comprises a transformational grammar. Such is the sequence of events that has been traced in these pages.

SEMANTICS

Semantic development is at once the most pervasive and the least understood aspect of language acquisition. It is pervasive because the emergence of a semantic component in a child's grammar has repercussions in wide areas of cognition beyond language itself. It is little understood because there has as yet been little guidance from linguistic theory on what to expect. However, theories of semantics are currently under active development, and matters in this quarter may soon improve (c.f., Katz and Fodor, 1963; Katz and Postal, 1964; Katz, 1966; 1967; Weinreich, 1963; 1966).

The level of sophistication in the study of semantic development is not comparable to the level in other aspects of linguistic development. It differs from syntax, where by now several investigations of language acquisition have been carried out under the general, if not the specific, influence of contemporary linguistic theory. And it is diametrically opposite from the situation in phonology. In semantics there are huge quantities of data, but no theory to say which are relevant; in phonology, there are almost no data, but there is a theory to say what relevant data would be like in the event they should be collected.

The treatment of semantics below will concentrate on a few topics -- the development of semantic "features," semantic influences on syntax, the association of semantics with action, and the exchange of information among children. The topics have been chosen in part because of their general interest and in part because they suggest certain theoretical issues.

Studies mainly of a statistical or normative nature are not included. Such studies mostly have to do with children's word associations (e.g., diVesta, 1964a; 1964b; Riegel, 1965b; Piaget and Feldman, 1967; Riegel and Zivian;1967; and

children's ratings on the semantic differential (e.g., diVesta, 1966c; diVesta and Dick, 1966; Rice and diVesta, 1965). Extensive norms of children's free word associations have been published recently by Entwisle (1966), and of children's restricted associations by Riegel (1965a) and diVesta (1966a) has published norms of children's semantic differential ratings.

Also omitted are studies of children's cognitive development, including those that deal with the role of language. The latter open a Pandora's Box filled with the former, and the reader should consult Chapters elsewhere in this Manual for reviews of this work. See also Bruner, Olver, and Greenfield (1966) for a summary of recent research on the topic.

For summaries of work on vocabulary development and the development of reference, see previous editions of this Manual, Brown (1958), and, from a special point of view, Werner and Kaplan (1951).

#### SEMANTIC FEATURES

It is clear that children have some kind of semantic system at a very early point in linguistic development. Children at first use words holophrastically (p. ). One way of viewing this phenomenon is to conceive of the earliest semantic system as consisting of a dictionary in which words are paired with sentence-interpretations. Each such interpretation embodies a particular predicative relation, and the dictionary is so constructed that each word is paired with several interpretations. A holophrastic dictionary is burdensome for a child's memory and susceptible to ambiguity. The ambiguity might lead to the creation of a revised dictionary in which words are paired with single sentence-interpretations; this dictionary would be one-to-one. However, a one-to-one dictionary is even more burdensome on memory than is a many-to-one dictionary, as each word must be entered several times, and it too is abandoned. The ultimate solution is a word dictionary. A word

dictionary has the same effect as a sentence dictionary, but not the same bulk (Miller, personal communication).

Both these transitions effects a re-working of a child's semantic system. Of the two, however, the second is by far the most significant, and it is from the point of its first construction that we can date the rudiments of a system basically similar to adult semantic competence (see Katz and Fodor, 1963). In the change from a holophrastic to a sentence dictionary, a child continues to store undifferentiated semantic information; the definition of one sentence is not related to the definition of any other. In the transition from a sentence dictionary to a word dictionary, a fundamental change is introduced in the format of the dictionary entries themselves. A child begin to elaborate a system of semantic features, and sentences come to be interrelated through semantic rules for using dictionary entries.

The evidence is that the accretion of semantic information, in contrast to the acquisition of syntactic information, is a slow process not completed until well into school age. It is on the development of a word dictionary that the present section will have the most to say.

A child's first effort to compile a word dictionary presumably does not occur earlier than his use of base-structure rules in the construction of sentences. It is difficult to conceive of a word dictionary that does not receive input from some sort of syntactic component; without such input, a word dictionary would constitute a retreat to a point even more primitive than a holophrastic dictionary. A word dictionary without syntax would result in a loss of power to encode sentence meaning. If one cause of the transition to a word dictionary is a need to retain sentence meaning while reducing the load of a sentence dictionary on memory, compilation of a word dictionary ought not to begin before the first sign of a base-structure grammar, at about 18 months. This sets a lower bound on the beginning of a true semantic component

of grammar.

Setting an upper bound is more difficult. Children could continue to use a sentence dictionary after becoming able to construct grammatically organized sentences; each construction would be referred to the dictionary to learn its meaning. However, such an effort must end when the variety of sentences becomes at all large. Probably an extensive use of transformational rules promotes the doom of a sentence dictionary: an effort to persist with a sentence dictionary once transformations play a part in child grammar would have an effect exactly opposite from the reduction in memory load achieved by a sentence dictionary in the first place. A sentence dictionary coupled with transformations requires storing the same sentence-meaning in many places, once for each transformation of the same base structure. The result would be an increase in the size of the dictionary.

On the other hand, transformations lead to a reduction in dictionary size if linguistic competence includes a word dictionary. A word dictionary therefore may be favored by the development of transformations. We can thus set an upper bound for the first compilation of a word dictionary as the time when transformational rules come to be used extensively, at about 28-30 months.

One can only guess how the compilation of a word dictionary is carried out. A simple assumption is that semantic features are sequentially added to dictionary entries. Such an assumption is no doubt incorrect in its simplest form. It ignores, for example, the possibility that features are related to one another, and so may enter a dictionary together (Katz, 1966). Nonetheless, a sequential accretion of semantic features is plausible as an initial hypothesis, and is not unlike the development of syntactic features, which <sup>apparently</sup> also emerge in sequence (cf. p.     ).

Consider a purely hypothetical example. An entry for the word flower would have to include at least the following: a syntactic feature [common noun],



several semantic features, perhaps (physical object) (living) (small) (plant), plus certain selection restrictions. An adult dictionary contains more than four semantic features for flower, but the ones given constitute a minimum set. The assumption that dictionary entries are built up sequentially means that the semantic features (physical object), (living), (small), (plant) are added one at a time.

The addition of each feature is an event with widespread consequences. By definition, semantic features appear in more than one dictionary entry; in some cases -- the feature (small), for example -- a feature appears in a great many dictionary entries. Each new semantic feature is a distinction that separates one class of words from another, a fact that may contribute to the apparently slow manner in which such additions to a dictionary take place.

If the compilation of dictionary entries is sequential, words can be part of a child's vocabulary but have semantic properties different from the same words in the vocabulary of an older child or adult. Semantic development in this case consists of completing the dictionary entries of words already acquired, as well as the acquisition of new words. Simple vocabulary counts miss <sup>this</sup> internal aspect of semantic development entirely, and give a misleading picture of a child's linguistic advancement.

Semantic anomaly. One consequence of the sequential enrichment of a word dictionary is that sentences regarded as anomalous by adults and older children will be regarded as acceptable by younger children. Every dictionary entry contains a set of "selection restrictions" (Katz and Fodor, 1963), which set forth information about a word's allowable contexts. The selection restrictions of a word consist of those semantic markers that can appear as context for the word. A semantic marker in one of the senses of crane, for example, matches the selection restrictions of construction; so we can have construction crane. However, none of the semantic markers of construction

crane matches the selection restrictions of the predicate laid an egg; so we avoid as anomalous the construction crane laid an egg, even though we accept the crane laid an egg.

A child who lacks knowledge of some semantic features of a word will accept grammatical combinations that an adult, with a fuller dictionary entry, marks as anomalous. A child accepts anomalous combinations when the features and selection restrictions responsible for the anomaly are missing from his dictionary. If we think in terms of distribution classes -- that is, in terms of words that can appear in the same contexts -- we can say that a child has distribution classes wider in scope than those possible for an adult. The result of adding semantic markers is a narrowing of distribution classes and an increased tendency to reject as anomalous once accepted word-combinations.

Miller and Isard (1963) performed an experiment in which adult subjects listened to three different kinds of verbal strings through a masking noise. The strings were fully grammatical sentences (the academic lecture attracted a limited audience), or anomalous sentences (the academic liquid became an odorless audience), or scrambled strings (liquid the an became audience odorless academic). A subject's task was to shadow the strings as they were heard. Since a masking noise obliterated parts of the acoustic signal, performance depended on the ability of subjects to fill in the obliterated parts by guessing the structure of each string on the basis of what was actually heard.

At several noise levels, Miller and Isard's subjects shadowed fully grammatical strings most accurately, anomalous strings next most accurately, and scrambled strings least accurately. The difference between grammatical and anomalous strings reflects an ability of subjects to exploit the semantic restrictions on word combinations, whereas the difference between anomalous and scrambled strings reflects an ability to exploit syntactic restrictions.

What should we expect of children in this experiment? If a child lacks some semantic features, he will be less able than an adult to guess the words of a fully grammatical sentence obliterated by noise. If both a child and an adult heard...ate the cheese, an adult might guess that the subject of the sentence was mouse, but a child might not. What of anomalous sentences? In this case adults and children should not differ, as the presence or absence of semantic features in a dictionary is irrelevant to the reconstruction of sentences where semantic features and selection restrictions do not match in the first place.

Thus, to the degree that a child lacks knowledge of semantic features, performance on fully grammatical and anomalous sentences should be the same. McNeill (1965) repeated Miller and Isard's experiment with children five, six, seven, and eight years old. The procedure was identical to Miller and Isard's in all respects except that McNeill used less exotic vocabulary and that the task was immediate recall. Children of five take so long to respond when shadowing that the test was converted automatically into immediate recall.

The results are summarized in Fig. 8 which shows the percent of complete strings correctly recalled by children of different ages. (The percent of content words correctly recalled shows essentially the same result, although the data are less regular.)

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Insert Fig. 8 here

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The conclusion to be drawn from Fig. 8 is clear: five-year-olds are less able than eight-year-olds to take advantage of semantic consistency in sentences. Accurately guessing the obliterated parts of sentences depends on the sentences being constructed in accordance with semantic principles available to the guesser; five-year-olds evidently depart from the <sup>semantic</sup> rules of English.

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However, a lack of semantic markers does not affect the accuracy of guessing the obliterated parts of anomalous sentences, and performance with anomalous sentences changes very little between ages five and eight, as can be seen in Fig. 8.

A third curve in Fig. 8 summarizes the performance of children with scrambled strings. Accuracy in this case is parallel to, but always worse than, accuracy with anomalous strings. The difference suggests that the ability of children to exploit the syntactic information contained in anomalous strings does not change between five and eight, a fact consistent with the slow development of dictionary entries relative to the rapid development of syntax.

In general, one can conclude from this experiment that children of five find fully grammatical sentences only slightly superior to anomalous sentences. It apparently makes little difference whether one says to a child wild Indians shoot running buffalos or wild elevators shoot ticking restaurants. The sentences are equally remarkable, and both must have a meaning for children that cannot be correctly grasped by adults.

If this is the case, one wonders how children and adults understand each other; for that matter, one also wonders how children understand other children. However, both questions arise on the false assumption that children do understand adults and each other. As we shall see below (p. ), they do not; at least, they do not understand the speech of others well.

The experiment described above revealed a tendency for children to reconstruct anomalous and fully grammatical sentences in the same (inappropriate) way. The poor performance was presumably a matter of poor perception. Turner and Rommetveit (in press) have in addition observed anomalous sentences in the linguistic productions of children -- for instance, the tractor drives the farmer, the pony rides the girl, and the branch carries the bird. These sentences were not uttered in play or fantasy; they were mistaken but serious

descriptions of pictured scenes -- a farmer driving a tractor, a girl riding a pony, and a bird resting on a branch.

The word associations of children also show effects of incomplete dictionary entries. If stimulus and response are regarded as forming a grammatical unit in word association, children's responses often make anomalous combinations with their stimuli. Soft-wall, bright-rake, and fast-shout are adjective-noun combinations given in association by six and seven-year-olds, and all are anomalous. Adults rarely if ever respond in this way.

Word associations may be divided into two general categories according to the grammatical relation of the stimulus and response. If the response belongs to a different grammatical class from the stimulus, the association is called "syntagmatic" (Ervin, 1961) or "heterogeneous" (Brown and Berko, 1960). If the response is in the same grammatical class, it is called "paradigmatic" (Ervin, 1961) or "homogeneous" (Brown and Berko, 1960). Both Ervin (1961) and Brown and Berko (1960) noted that young children respond mostly with syntagmatic associations, whereas older children and adults respond mostly with paradigmatic associations. The change from a predominance of one response to a predominance of the other takes place between six and eight years -- the same ages at which children come to distinguish anomalous and fully grammatical sentences in the experiment by McNeill (1965).

The coincidence of ages suggests that the shift to paradigmatic responding occurs because of semantic, not syntactic, consolidation. McNeill (1965; 1966d) offered a view of how the shift is accomplished on semantic terms -- essentially, that early "syntagmatic" responses are often actually paradigmatic, but fall outside the grammatical class of the stimulus because of the breadth of the semantic categories available to young children. Entwisle (1966) has found some support for this account in her extensive data on children's word associations.

Why is semantic development so slow? We have reviewed some evidence for the slow, sequential development of dictionary entries. Word association and the recall of sentences both indicate that children continue to compile dictionary entries as late as age eight, at least. Semantic development thus stands in contrast to syntactic development, which appears to be complete in most respects by four or five.

Why is there such a difference? There must be numerous reasons, but we can barely guess at them. Nonetheless, a few possibilities come to mind. One certainly is the complexity of the information that is encoded in a dictionary. Another must be that developments in a child's lexicon, far more than developments in syntax, depend on achieving a certain level of intellectual maturity. A child capable of saying of 20 wooden beads, 15 white and 5 green, that white beads outnumber wooden beads is also likely to say both Lassie's not a cat, she's a dog and Lassie's not an animal, she's a dog. Presumably it is with reference to semantic development that Piaget (1967) comments, "...[intellectual] operations direct language acquisitions rather than vice versa."

Occasionally, one hears the suggestion that children acquire semantic knowledge from explicit definition. A parent may say the zebra is an animal, from which a child may acquire the semantic feature (animal). Perhaps the slow advance of semantic development is a result of a dependence on definitions; unlike syntax, adults may have to provide explicit instruction in semantics.

However, this interpretation is fallacious and it is so for a simple reason. The sentence the zebra is an animal may indeed serve to introduce the marker (animal) into the dictionary entry for zebra; but it cannot serve to introduce the marker (animal) into a child's linguistic competence. Explicit definitions may work to expand vocabulary, but they are irrelevant to the problem that has been considered in this section -- the addition of semantic features to a dictionary. In order for the sentence the zebra is an animal

to influence the dictionary entry for zebra, the feature (animal) must already be in the dictionary entry for the word animal. If it were not, the sentence the zebra is an animal would be without effect on a child's dictionary. But if animal contains the feature (animal), then obviously (animal) is already acquired, and the defining sentence merely locates it in a new entry. Explicit definitions are not the vehicle for enlargement of a child's stock of semantic features.

Not all semantic development is slow. The emergence of various semantic distinctions in negation has already been mentioned (p. ). They apparently are fully developed by children of two-and-a-half. Greenfield (1967) has made a similar analysis of the infantile term dada, tracing the development of its meaning in the speech of her 11-month old daughter. The relevant semantic distinctions (e.g., male versus female; caretaker versus non-caretaker) had all appeared by the first birthday!

It is clear that only some aspects of semantic organization develop slowly. Negation and the idea of a parent emerge very early. So must many other semantic distinctions. Yet five-year olds fail to distinguish anomalous from fully grammatical sentences in McNeill's (1965) experiment and they describe a picture of a girl on a pony as the pony rides the girl in Turner and Rommetveit's (in press) experiment. It is a fair measure of our understanding of semantics that we cannot say how the last two examples differ from the first two.

A method for discovering semantic features. One major obstacle faced in the study of semantic development is a sweeping ignorance on the part of psycholinguists of the semantic features of English. Very few features have been isolated, and the procedure for discovering them is difficult and slow (see Katz, 1964), for an example).

Recently Miller (1967) has devised a method, based on word-sorting and cluster-analysis, which yields categories of words not unlike the categories defined by the semantic features of linguistics. The method requires subjects to classify large samples of words into self-imposed groups, and cannot therefore be used with young children. However, the results of the method with adult subjects can be used to organize such observations of children as are available.

For example, Miller (1967) found that the nouns yield, exhaust, battle, kill, deal, play, labor, joke, question, vow, counsel and help fall into the clusters pictured in Fig. 9. Each node in the tree represented in Fig. 9

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Insert Fig. 9 here

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is taken to represent a particular semantic feature; every word beneath a node possesses that feature, but no word above or beside it does. Although one cannot obtain such structures from young children, it is possible to see if children honor the distinctions recovered from adults. Do children distinguish, for example, between the clown told a joke and the clown told a battle? If they do, we infer that children are acquainted at least with the semantic features defining the two large clusters containing joke and battle. We can also ask about the narrower distinction between joke and help. Do children distinguish, for example, between jokes make everybody laugh and help makes everybody laugh? The method is suggestive and deserves exploration.

Semantic influences on syntax. Slobin (1963; 1966) performed an experiment with children of five, seven, nine, and 11 years, in which the truth of sentences was judged against pictured scenes. A picture might have shown, for example, a dog in pursuit of a cat. A true sentence describing this picture might be the dog chases the cat, and a false sentence might be the



cat chases the dog. Slobin presented such true and false descriptions in several syntactic forms, using the familiar transformations of negation and passivization to produce variants. For the picture of a dog chasing a cat the following sentences were available:

True

The dog is chasing the cat  
The cat is being chased by the dog  
The cat is not chasing the dog  
The dog is not being chased by the  
cat

False

The cat is chasing the dog  
The dog is being chased by the cat  
The dog is not chasing the cat  
The cat is not being chased by the  
dog

One variable in the experiment therefore was syntactic type -- simple declarative sentences were compared to negative sentences, passive sentences, and negative-passive sentences. Another variable was the truth or falsity of the description. A third variable was semantic content; it is with this variable that the present section is concerned.

Two semantic factors are involved. One is negation, and it in turn appears in two forms. Each sentence, being a description of a picture, invokes negation in the sense called "Existence" by McNeill and McNeill (1966). On the other hand, a subject in judging the truth or falsity of a sentence must react -- affirmatively or negatively -- to the dimension called "Truth" by McNeill and McNeill. The two varieties of negation were therefore invoked at different points in the experiment. Slobin found negative sentences to be more difficult than affirmative sentences -- a result also found by Wason (1965). Slobin also found judgments of False to be more difficult than judgments of True when sentences were affirmative, but to be easier than judgments of True when sentences were negative. The interaction of affirmation and truth reveals a general difficulty in combining affirmation and denial: Slobin's task was relatively easy both when affirmative judgments

of Truth (in the sense of McNeill and McNeill) were made of sentences affirmative on Existence, and when negative judgments of Truth were made of sentences negative on Existence; but the task was difficult whenever affirmation and negation had to be combined, either as an affirmation of Truth for a negation of Existence, or as a negation of Truth for an affirmation of Existence.

A second semantic consideration is something Slobin called "reversibility." A picture of a dog chasing a cat is reversible. Cats can chase dogs as well as vice versa. Deciding whether a sentence is true or false with respect to such a picture depends on deciding which words -- cat or dog -- are the grammatical subject and object, and then matching this grammatical analysis to the episode shown in the picture. The difficulty of the comparison should be increased when the superficial and underlying subject and object are not the same -- as in passive sentences. Thus Slobin expected, and found, that judgments of truth or falsity were less accurate and took longer with passive than with active sentences.

The problem of verification is simplified, however, with pictures of a second type, called "non-reversible" by Slobin. A non-reversible picture shows, for example, a girl on a pony. In this case, if a child understands that the underlying object of the passive sentence the girl is being ridden by the pony is girl, he can correctly judge the sentence false without matching the sentence to the picture. A semantic constraint simplifies verification of the sentence by making possible a judgment on internal grounds: Slobin found non-reversible passives to be as accurately and as rapidly judged as non-reversible actives. This result holds true of children of every age studied by Slobin.

Thus two semantic effects -- negation and reversibility -- influence children's ability to verify sentences. Negation, although less complex

syntactically than passivization, retards verification more. It is the semantic and not the syntactic effect of negation that dominates. Non-reversibility has even greater impact than negation, as it removes every vestige of passivization as a source of difficulty in verification.

Turner and Rommetveit (in press) report a similar result with reversible and non-reversible pictures. They required children to describe pictures as well as to judge the truth or falsity of sentences about pictures. In production, as noted above (p. ), children often reverse the order of subject and object -- e.g., the pony rides the girl. The gains produced by non-reversibility for comprehension thus do not seem to extend to production at the ages studied (four to nine years). Describing a picture of a girl on a pony with the sentence the pony rides the girl is equivalent to saying that the girl is being ridden by the pony is a true sentence. In Turner and Rommetveit's experiment, children who commit the first error do not commit the second.

Some recent work by Bever (1967) clarifies the role played by reversibility in these experiments. Bever's subjects were very young; two to four years, compared to five to 11 years in Slobin's experiment. The difference in age makes for an important, and surprising, difference in outcome. Bever found that the semantic constraint of non-reversibility does not help performance at all at two years, even though children this young can comprehend passive sentences roughly half the time. By three years, however, children's comprehension of reversible passive sentences begins to deteriorate and their comprehension of non-reversible passive sentences correspondingly begins to improve. Children begin at three years to perform as in Slobin's and Turner and Rommetveit's experiments. Thus, at first, reversible and non-reversible situations are treated alike when described by passive sentences; later they are treated differently, and children actually retreat from a

level of performance previously reached in reversible situations.

Bever argues plausibly that children adopt strategies in understanding sentences -- e.g., that most English sentences describe an actor, an action, and an object acted upon. Such semantic strategies depend on knowledge of what makes a situation reversible or non-reversible and are distinct from grammatical knowledge -- e.g., that the underlying relations in a sentence are subject, verb, and object. The strategy of expecting sentences to contain an actor, an action, and an object acted upon is acquired later than knowledge of the grammatical order of elements, and is based on information of a different kind -- a statistical predominance in speech of sentences describing actors, actions and objects acted upon, instead of the basic grammatical relations of subject, main verb, and object. The strategy is a method, based on semantic coherence, for facilitating a syntactic analysis.

Under the influence of this semantic strategy, reversible passive sentences might be construed as active sentences, even though the transformation of passivization is available. The cat is being chased by the dog can become under the strategy: cat (actor), chase (action), and dog (acted upon). The semantic coherence of a cat chasing a dog leads to a reversal of grammatical subject and object. The same strategy, however, protects a child from a reversal of subject and object in non-reversible situations. Pony (actor), ride (action), and girl (acted upon) must be rejected by a child expecting semantic coherence, so the pony is being ridden by the girl is easily declared false. Young children without a semantic strategy of this kind treat reversible and non-reversible situations alike and sentences describing both are open to the same confusions.

The strategy of exploiting non-reversibility is an example of what Jakobson (1960) has called the "meta-linguistic" function of language. An expectation that sentences will contain an actor, an action, and an object

acted upon is a hypothesis about language. It is comparable to such other hypotheses as, for example, that all words have a rhyme, or that all sentences have a middle. It is different from the linguistic hypotheses considered in the section on Syntax (p. ), which comprise the syntactic competence of a child.

The association of semantics and action. The strategy mentioned above -- that sentences contain an actor, an action, and an object acted upon -- can take other forms. For example, children following this strategy can use sentences to direct their own activity. They can do so, that is, if the actor in an action and the subject of a sentence directing the action are the same. But if children must perform an action that violates the strategy, performance becomes disrupted. Such is the conclusion reached by Eisenberg and Strauss, Huttenlocher, and Strauss (in press) and Huttenlocher and Strauss (in press).

The experiments are elegant in their simplicity. In one (Huttenlocher, et al., in press) a child sees before him a "road" consisting of a flat board divided into three spaces. The middle space already contains a toy truck. The child has in hand a second truck, which he is told to place either before or after the fixed truck. It is the way of telling that counts. Assume that the child's truck is painted green and the fixed truck is painted red. Any one of four possible instructions can then be given: (1) the green truck is pulling the red truck; (2) the red truck is pulling the green truck; (3) the red truck is pulled by the green truck; and (4) the green truck is pulled by the red truck. In every case, the actor is the green truck the child is holding; it is the one that must be moved. Thus, in sentences (1) and (3) the actor and the underlying subject of the sentence are the same, whereas in sentences (2) and (4) the actor is the underlying object of the verb pull. Sentences (1) and (3) should therefore be more easily followed as instructions than

sentences (2) and (4).

Sentences (1) and (2) are active sentences, whereas (3) and (4) are passive. If children treat the superficial instead of the underlying subject of a sentence as an actor, then sentences (1) and (4) ought to be easiest, and (2) and (3) hardest, as green truck is the superficial subject in the first pair and the superficial object in the second pair.

, et al.

Huttenlocher found the amount of time for nine-year-old children to place the moveable truck correctly increased from sentence (1) to sentence (4). Since (1) < (2) and (3) < (4) it is clear that children associate the subject of a sentence with the actor of an action. This is the strategy discussed by Bever (1967). Since (3) < (4) it is also clear that the underlying and not the superficial subject is the one associated with the actor. Finally, since (2) < (3) it is clear that passivization poses problems of its own; the situation in Huttenlocher's experiment was reversible.

An experiment by Huttenlocher and Straus (in press) produced similar observations of children following instructions of the form, the red block is on top of the green block and the yellow block is under the brown block.

A child in this experiment was faced with a ladder, the middle rung of which contained a block; the instruction told him to place a second block above or below the block already fixed in place, the position depending on the color of the block the child had in hand. The instructions were easiest to follow when the actor (the child's block) was also the subject of the sentence. Since there are no passive forms of the sentences used in this experiment, the association of an actor with the underlying subject of a sentence could not be demonstrated.

Many psychologists have claimed that language and action in children are closely associated. Although this sometimes has meant that child

language is primarily an expression of action (cf., de Laguna, 1927), a directivere~~l~~ation has been most often studied (however, see Clark, in press, for evidence that prepositions are at first expressive of movement.) The many experiments of Luria (1961; also, see Luria, 1959; Birch, 1966) have traced the development of verbal control -- i.e., the ability of children to follow verbal instructions. The experiments of Huttenlocher, et al. and Huttenlocher and Straus bear on the same question. The present chapter is not the place to explore the possibility that the emergence of verbal control in children depends on the emergence of the meta-linguistic hypothesis that sentences describe an actor, an action, and an object acted upon. However, the matter deserves investigation. Such an exploration presumably would look into a child's knowledge of grammar in relation to his application of such strategies; it is clear that the two are not the same, and the problem arises of how they are interrelated.

This problem arises with particular acuteness in the experiments described by Luria (1959; 1961). Working within the general framework established by Vygotsky (196?), Luria and his colleagues have traced the development of what they consider to be voluntary action. In the Vygotskyan scheme of things there is a basic continuity between the control of one's action by others and the voluntary control of action by oneself. All control is a matter of following verbal instructions, either external or internal. Self-control depends on the development of inner speech, and inner speech in turn derives from socialized speech. Self-control is therefore preceded genetically by external control.

To very young children, commands are simply occasions for action. The speech of others triggers an action a child is ready to perform. For example, a child who has repeatedly been made to retrieve a coin beneath an inverted cup will search under the cup when told to find a coin under a

nearby glass. The specific property of the instruction -- that it contains the word glass rather than cup -- has no effect. The same tendency appears in other situations. Told to press a ball when a light flashes, children younger than two-and-a-half immediately look for the light and press the ball. When the light is subsequently flashed a child looks at it but ignores the ball. A command at this stage initiates two independent acts that are not put together. Children fail to react to the grammatical structure of the command.

Commands possess for young children what Luria (1961) calls an "impulsive quality." If children of three are told not to press a ball when a light goes on, they press anyway. Moreover, if they are told to say "don't press" when a light goes on, they still press even while saying "don't press." A three-year-old child's reaction to his own speech is independent of the content of his speech. Speech is more like a metronome than like an instruction. If told to say "I'll press twice" when a light goes on, a child of three presses once and maintains pressure for the duration of the sentence. If, on the other hand, he is told to say "go! go!" when the light goes on, he presses twice because there are two impulses. It is not until four-and-a-half or five that children react to "go! go!", "I'll press twice," and "don't press" in the appropriate way.

One wonders, in line with the remarks above, if the change at four or five results from application of a meta-linguistic strategy that relates the grammatical subject, verb, and object in a sentence to the actor, action, and object acted upon in a situation. Because such a strategy is discovered relatively late in development, children before this point react to commands as if they had no internal structure, but are instead merely external signals to act. However, once such a strategy is adopted "...the regulatory function is steadily transferred from the impulsive side of speech to the analytic system of elective significative connections which are produced by speech (Luria,



1961, p. 92; italics omitted)."

The exchange of information among children. Piaget (1923) long ago devised an experiment in which children instructed other children on the operation of a mechanical device -- a syringe, for example. Children less than six are not very good at this. They use gestures and such pronouns as this, that, something, there, and here -- even when the child being instructed is, for example, blindfolded. For Piaget, the difficulty of communication arises from the egocentrism of children. The instructor takes it for granted that the other child already knows how a syringe works, since he, the instructor, also knows how it works. All that must be done in order to communicate therefore is to make reference to common knowledge.

More recently Glucksberg and Krauss, and various of their collaborators (Glucksberg, Krauss, and Weisberg, 1966; Glucksberg and Krauss, in press; Krauss and Rotter, n.d.; Krauss and Bricker, 1967; Krauss and Weinheimer, 1964; 1966), have looked at the same phenomenon as a matter of communication efficiency. Viewing an exchange of information as a question of communication efficiency is not, of course, incompatible with explaining poor efficiency by reference to egocentrism.

In a typical experiment two children (or adults) are seated on opposite sides of an opaque screen. One is an encoder and the other is a decoder of messages about a set of unusual visual forms. The forms are chosen in advance as ones without readily available names in English; the experiment therefore differs from Piaget's, where vocabulary existed (in fact, was taught) to describe the object.

In general, the success of children's messages to other children is low. Children use shorter descriptions than adults do, and the descriptions are sometimes highly idiosyncratic. Idiosyncratic messages are not meaningless, however, even though they are poor for communication; when children serve as

their own decoders, the level of accuracy is relatively high (Glucksberg, et al., 1966). Brevity of description is characteristic of adults when the same form has been described several times previously, and presumably arises because messages about familiar things tend to minimize redundancy (Zipf, 1935; Krauss and Weinheimer, 1964). That young children begin with such messages possibly reflects the egocentrism discussed by Piaget, and suggests that children differ from adults in their conception of familiarity.

When children are given messages encoded by adults, communication accuracy soars (Glucksberg, et al., 1966). It would appear therefore that children are better decoding than encoding messages. Whereas an adult will say of a figure that it looks like an "upside down cup," a description to which children respond, a child may say that it looks like "mother's dress," "ideal" (referring to the trade mark of a brand of toys), "digger hold," "a caterpillar," or "a ghost."

However, children as decoders do not treat the communicative messages of adults differently from the non-communicative messages of other children. All messages are accepted passively and with little comment. Moreover, children as encoders do not modify messages when explicitly requested to do so by adult decoders (Glucksberg and Krauss, in press). In these respects children are sharply different from adults, who request and receive new descriptions when a description seems to them insufficiently precise. One of the children described by Glucksberg and Krauss (1967), when told to pick up "this one," asked "do you mean that one?"; the reply was "yes." Although children can understand the messages of adults, they act as if they can understand every other message as well. The implications for school-room dialogues are not the best.

## PHONOLOGY

If semantics is regarded as the sub-basement of syntax, then phonology is the penthouse. It is ironic that little can be said of the acquisition of this most visible part of language. Little can be said, even though the study of sound has long been a dominant concern of linguistics and even though an explicit theory of phonemic development has existed for more than a quarter of a century (Jakobson, 1941; 1958). The challenge posed by phonology has never been accepted.

We must distinguish at the outset between phonemic and phonological development. The first refers to the emergence of the sound units of a language. Something can be said about phonemic development, and it is here that Jakobson's theory applies. Phonological development refers to the emergence of rules for combining sounds into sequences pronounceable in a language, and for relating such sequences to the surface structure of sentences. Virtually nothing can be said about this aspect of development.

The relation of babbling to speech. All parents know that children babble during the second six months of life. Before that time vocalization is highly limited; after that time speech proper begins with the appearance of holophrastic utterances. During the babbling period children vocalize an immense variety of sounds in ever more complex combinations, and it is possible that the babbling period is a bridge between the limited vocalization of the first six months of life and the appearance of communicative speech itself. Such a hypothesis has indeed been proposed. Allport (1924) believed that children develop the phonemic system of their native language by matching speech sounds they hear to sounds they produce in babbling. Staats and Staats (1963) and Mowrer (1952; 1960) hold a similar view. However, it is a view with no basis in fact; there is on the contrary a sharp discontinuity at both

ends of the babbling period. Babbling, if it plays a part in the emergence of speech, does so far behind the scenes. It is not a bridge.

The direction of development during the first year of life is from the back to the front of the mouth for consonant-type sounds and from the front to the back of the mouth for vowel-type sounds (Irwin, 1947a; 1947b; 1947c; <sup>1948;</sup> McCarthy, 1954; however, <sup>see</sup> see Bever, 1961, for some qualifications). The direction of development during the second year of life is exactly opposite. First to appear as speech sounds are front consonants and back vowels. The back consonants and front vowels that were the first uttered in the period of pre-speech are among the last organized into a linguistic system.

Children younger than three months vocalize such consonant-like sounds as /k/, /g/, and /x/, and such vowel-like sounds as /i/ and /u/. That is the beginning. In the babbling period many more sounds are added -- sounds necessarily more forward in the case of consonants and more backward in the case of vowels. When linguistically meaningful utterances first occur, however, they consist of a front consonant, /p/ or /m/, and a back vowel, /a/. Front consonants and back vowels provide a starting point for speech regardless of the language to which children are exposed: children exposed to English say tut before cut; children exposed to Swedish say tata before kata; children exposed to Japanese say ta before ka; etc. (Jakobson, 1941).

The baby talk of adults usually corresponds to the initial phonemic organization of children. Ferguson (1964) found replacement of velar by dental consonants in the adult speech addressed to children among speakers of Syrian, Marathi, Comanche, English, and Spanish. An English example is tum on for come on (phonemically, /kum/). The only exceptions among the languages Ferguson reviewed were Arabic and Gilyak, and in both

languages velar consonants play a particularly large role. Baby talk is conventionalized speech for children. In spite of the large differences among the phonemic systems of Syrian, Marathi, Comanche, English, and Spanish, the conventions for baby talk are the same, presumably because actual child speech in each of these languages is organized in the same way.

The front consonants and back vowels organized by children into an initial linguistic system also occur in babbling. However, the fact that /p/, /m/, and /a/ are babbled before they are used linguistically is a fact of little significance. Many sounds occur in children's babbling, including the back consonants, /k/ and /g/, and the front vowels, /i/ and /u/, which are added to a child's linguistic system only after many months of further development. Rather than continuity there is discontinuity in development. Children quickly pass from a wealth of vocalization to concentration on a few sounds for communication. It is not a question of selecting some sounds from many; it is rather a question of why the same specific sounds constitute the beginning of every child's phonemic system. Intentional vocalization requires a structure that unintentional vocalization does not. Thus, for example, a child who uses only /p/, /m/, and /a/ in speech will at the same time use /k/, /g/, and many other sounds in non-speech (Jakobson, 1941). As Jespersen (1929) remarked

"It is strange that among an infant's sounds one can often detect sounds -- for instance, k, g, h, and uvular r -- which the child will find difficulty in producing afterwards when they occur in real words ... The explanation lies probably in the difference between doing a thing in play or without a plan -- when it is immaterial which movement (sound) is made -- and doing the same thing of fixed intention when this sound, and this sound only, is required... (Jespersen, 1925, p. 106)."

Jakobson's theory of phonemic development is addressed to the sound structure of early speech. However, before discussing his theory, let us look a little more carefully at the period of development before the emergence

of speech. Doing so will make more concrete the discontinuity between speech and pre-speech.

Pre-speech and neurological maturation in the first year of life.

There are in fact two discontinuities during the first year of life -- one at four months and a second at 11 or 12 months. The two together roughly bracket the babbling period. Bever (1961) reanalyzed the extensive data reported by Irwin and his collaborators (Irwin, 1947a; 1947b; 1947c) in terms of the rate of change in sound development. Irwin transcribed children's vocalizations in the International Phonetic Alphabet, so his data consist of information on a large number of separate phonetic types; in general the data reveal a steady proliferation of phonetic types with age. Bever focused instead on the rates of change of phonetic types and found discontinuities at four and 11 or 12 months.

The two discontinuities mark off three periods. The first period from birth through the third month, consists of a very rapid rate of change in the frequency and variety of vowel-like sounds and a somewhat lower, though still rapid, rate of change in the frequency and variety of consonant-like sounds. At four months, the rate of change drops abruptly, which ends the first period and starts the second. The second period is a succession of peaks without intervening troughs. A peak in the rate of change in the variety of vowel-like sounds occurs between five and six months; then a peak in the rate of change in the variety of consonant-like sounds (dental and labial consonants particularly) occurs at seven months; finally a large peak in the rate of change in the variety of all consonant-like sounds occurs at nine or 10 months, which is followed by a total collapse at 11 or 12 months. The collapse at 11 or 12 months is the beginning of true linguistic development; the events it introduces are the topic of the next section.

Bever points to similar cyclical phenomena elsewhere in development (e.g., in the amount of sleep per day), and argues that the episodic advance

of vocalization reflects a series of changes in cerebral maturation, particularly of an unfolding pattern of inhibition and integration during the first year of life. The hypothesis is provocative and worth quoting:

"The cycles observed in vocal development are produced by phases of neurological maturation. a) The first cycle is concurrent with and presumably a manifestation of a primary level of neurological organization of vocal behavior. b) The end of the first cycle is a result of the end of the reflex stage of behavior due to cortical inhibition. c) The second vocal developmental cycle occurs as the cortex gradually reorganizes the activity it had inhibited.

"The difference in the manifest behavioral characteristics of the first and second cycles in vocal development are due to differences between the lower and higher levels of neurological organization. a) There are two essential features of the first cycle of vocal development, and those of the primary neurological phase, a concern with tonal activity and the primary differentiation of affective crying. b) The second cycle and thus the second neurological phase is associated with the development of consonant-like activity, and is often referred to as the period of 'preparation' for the onset of language-learning proper. The babbling stage is presumably a reflection of the process of integrating vocal activity and cortical organization." (Bever, 1961, p. 47).

So much for pre-speech and its alleged connection with the nervous system. We now turn to the beginnings of language.

The differentiation of distinctive features. The name of Roman Jakobson is associated with what, beyond doubt, is one of the most useful concepts in contemporary linguistics. It is the notion of a linguistic feature. In phonemics, where Jakobson developed the idea, one refers to distinctive features, but essentially the same insight into language has been invaluable in semantics and syntax, and previous sections of this Chapter have relied on it heavily.

It is Jakobson also who first applied the concept of a linguistic feature to questions of language development. In a celebrated paper -- Kindersprache, aphasie, und allgemeine lautgesetze -- Jakobson (1941) first traced the development of a phonemic system in terms of distinctive features.

He also presented for the first time a modern conception of the relation between linguistic universals and the development of language. (The general importance of universal grammar had been realized centuries before; see Chomsky, 1966). Developmental psycholinguistics thus owes Jakobson a considerable debt. It is fortunate that Kindersprache has at last been translated into English by A. Keiler; (Jakobson, 1968). For a brief discussion of the theory, Jakobson and Halle (1956); for a general discussion of distinctive features, see Jakobson, Fant, and Halle (1963).

It is remarkable that Jakobson's theory has inspired so few empirical investigations. The few studies that have been conducted, however, support the general line of argument, although not every detail (cf., Valten, 1943; Leopold, 1947).

The development of a phonemic system, according to Jakobson, is the result of filling in the gap between two sounds, /a/ and /p/. The process of development is differentiation. /p/ is a consonant formed at the front of the mouth; it is a stop; it is unvoiced; and it represents a nearly total absence of acoustic energy. /a/ contrasts with /p/ in each of these respects. It is a vowel; it is formed at the back of the mouth; it results from a complete opening of the vocal tract; and it represents a maximization of acoustic energy. One might say that /a/ is an optimal vowel and /p/ is an optimal consonant. Each is the extreme example of its type, and the contrast between them is as large as possible. With this contrast, linguistic development begins on a phonemic level.

However, neither /p/ ~~nor~~ /a/ ~~are phonemes~~ at the outset of development. A phoneme is a meaningless sound used to distinguish meaningful messages. /p/ and /a/ are instead meaningful sounds that distinguish no messages. The consonant always appears with the vowel, and there are only two possible utterances: pa and (with reduplication) papa. The meaning of these words



may be highly diffuse, and a child may attempt to communicate more than one message with each word, but there is not yet a phonemic system.

In order to establish a phonemic system, the space between /p/ and /a/ must be differentiated. The first such split occurs on the consonant side and (according to Jakobson's observations) results in a distinction between a labial stop /p/ and a nasalized labial /m/. The distinction therefore is between nasal and oral sounds and it creates two words -- ma and pa or (with reduplication) mama and papa -- distinguished by what are now two phonemes, /m/ and /p/.

Velten (1943) found the first consonant distinction to be slightly different: labial stops were first contrasted with continuants (/f/ and /s/), and only later with nasals. The nasal-oral distinction thus appeared second in development rather than first.

The vowel /a/ at this stage merely supports the consonants /m/ and /p/, and itself has no phonemic status. However, the vowel plays a crucial role of a different kind, for together with consonants /a/ establishes a syllable. Syllabification is present from the outset of speech. It is not obvious why such should be the case. Perhaps there is some basic rhythmicity underlying speech, as Lenneberg (1967) has argued, which takes as its earliest manifestation syllabification and reduplication. Jakobson (1941) believed that children always formed consonant-vowel (or vowel-consonant) syllables in earliest speech, but apparently this is not invariably the case. Weir (1966) observed Chinese children uttering syllables that consisted of vowels only, although Russian and English-speaking children also included consonants, as expected. Chinese is a language in which syllabification is measured by vowels alone, whereas Russian and English are not. Weir's findings may reflect the existence of appropriate syllabification at an extremely early age.

After the consonants have been divided into nasal and oral categories, there appears a division of oral consonants into labial and dental categories.

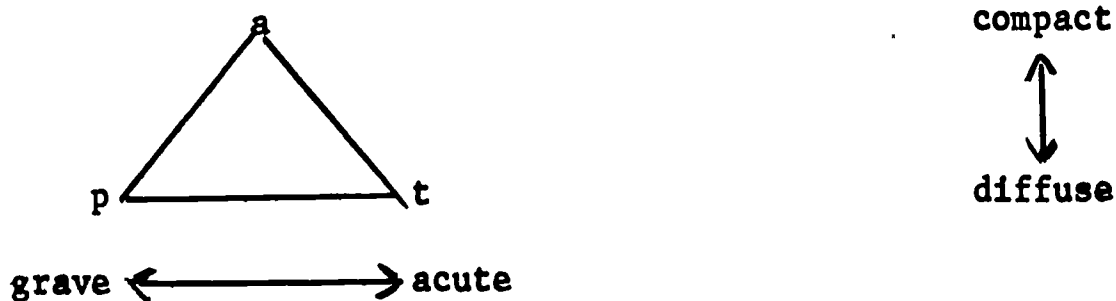
/ta/ comes to be contrasted with /pa/ (Jakobson, 1941). After this there occurs the first division on the vocalic side. Narrow vowels are set off against wide vowels, as in /pi/ versus /pa/. The next step according to Jakobson may be in either of two directions. One alternative is to divide the narrow vowel into a narrow palatal vowel /pɪ/ and a narrow velar vowel /pʊ/. The other alternative is to create a High-Mid-Low vowel series by inserting /e/ between /a/ and /i/, as in /pa/ versus /pe/ versus /pi/.

Jakobson argues that the sequence of phonemic development is invariant and universal among children. All children pass through the same steps, although children may differ from one another in the rate of advancement. Moreover, the phonemic system created by the first two or three steps in phonemic development is universal among the languages of the world. "...the child possesses in the beginning only those sounds which are common to the world, while those phonemes which distinguish the mother tongue from the other languages of the world appear only later" (Jakobson, 1968; quotation from the Keiler translation of Jakobson, 1941).

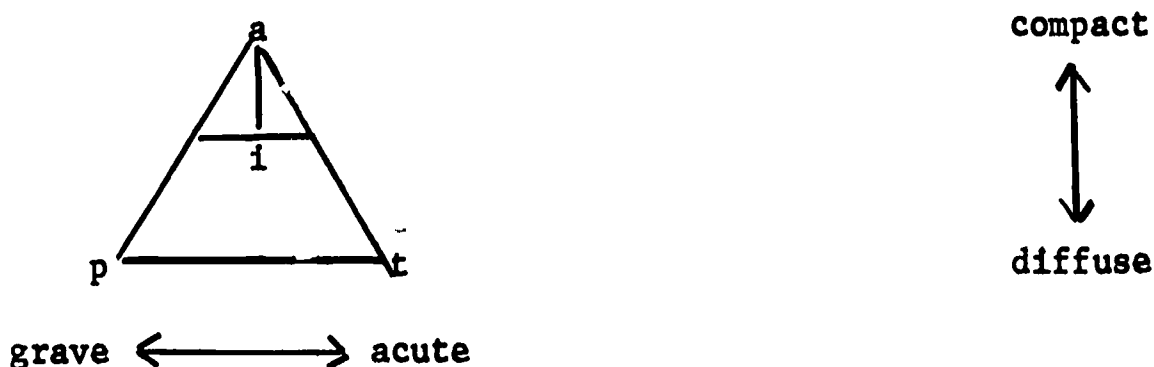
There is a striking similarity between phonemic and syntactic development. Both begin with a primitive form that is universal. In both, the starting point is not any particular language, but is so organized that it may become any language through a process of differentiation. Perhaps we should not be surprised at the similarity; the separation of sound and syntax is a scholarly artificiality. In fact, human communication always takes a specific form and it is the same form in all its aspects.

The differentiation of the space between /p/ and /a/ is the result of successively introducing certain distinctive features. Jakobson summarizes the process of development in terms of a series of vowel and consonant triangles (Jakobson, 1941; Jakobson and Halle, 1966).

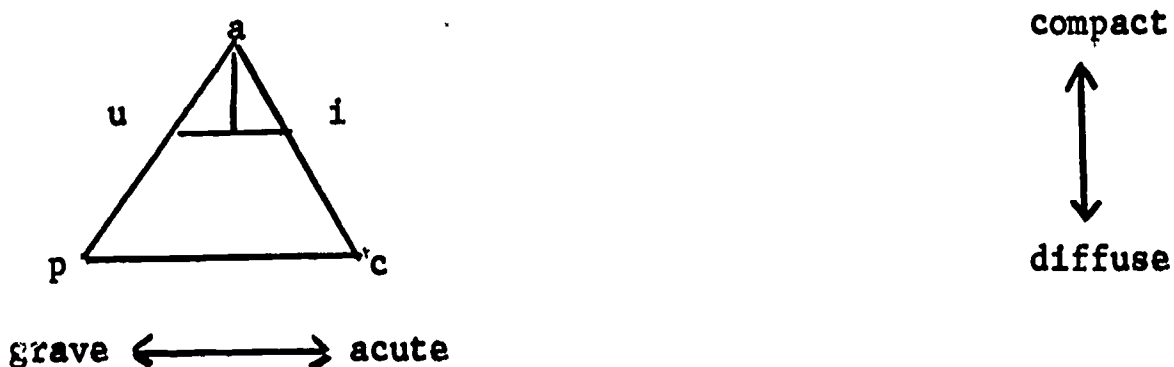
The first phonemes, /p/ and /t/, together with the optimal vowel /a/, comprise what Jakobson and Halle call the "primary triangle." It defines two distinctive features -- compact-diffuse on the vertical axis and grave-acute on the horizontal.



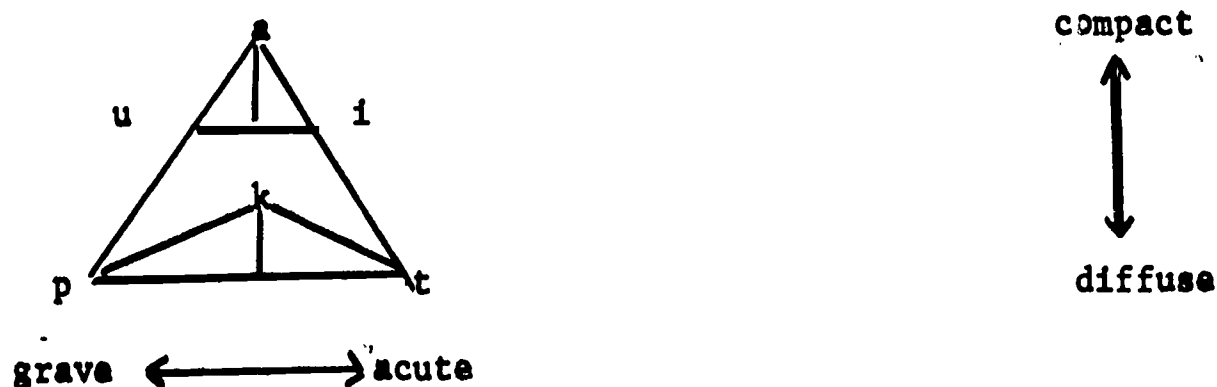
When the vowel /a/ is in turn differentiated into wide (/a/) and narrow (/i/) vowels, the distinction between compact and diffuse is introduced into the vocalic category. The distinction no longer sets vowels off from consonants, and we have instead,



If the narrow vowel /i/, which is also palatal, is next distinguished from the velar vowel /u/, which is also narrow, the distinctive feature grave-acute is likewise introduced into the vocalic category. Grave-acute is therefore the first contrast shared by vowels and consonants. It gives rise to the following triangle,



At this point, vowels embody more distinctions than consonants. Balance is restored when the front consonants /p/ and /t/ are distinguished from the back consonant /k/; /p/ and /t/ are diffuse whereas /k/ is compact. We now have two complete triangles defined by the same features,



The succession of vowel and consonant triangles explains why the first phonemic contrast that children draw is between /a/ and /p/ and not between /a/ and /k/, or /i/ and /p/, or some other pair. /a/ is the most compact of all sounds, whereas /p/ (along with /t/) is the most diffuse. It is on the distinctive feature of compact-diffuse that /a/ and /p/ are the optimal vowel and consonant. To utter /a/ the mouth forms a funnel opening forward; to utter /p/ it forms a funnel opening backward. In the case of /a/ a large amount of acoustic energy is concentrated in a narrow band of frequencies; in the case of /p/ a small amount of energy is distributed over a wide band of frequencies. The sound /t/ is as diffuse as /p/ in terms of the distribution of energy, but it differs less from /a/ in the location of closure of the mouth, and for this reason is not chosen first as the consonant to be set off against the vowel /a/.

The development of a phonemic system and the laws of "irreversible solidarity." The laws of irreversible solidarity describe universal asymmetries in the phonemic systems of the languages of the world. For example, no language has back consonants without also having front consonants; however, languages exist with front consonants but without back consonants. There is an irreversible "solidarity" between back and front consonants such that the former presupposes the latter but not conversely. The laws of irreversible

solidarity describe languages (see Greenberg, 1963 and 1966 for a number of examples of universals of this kind). Jakobson's (1941) suggestion is that the same laws describe the development of language by children (as well as the loss of language by aphasics). Thus no child arrives at back consonants without first developing front consonants. /p/ and /m/ always appear before /k/ or /g/, for example. Jakobson gives many examples of such an identity between the order of acquisition and the distribution of phonemes among the languages of the world.

Phonemes that are rare among the languages of the world -- for example, the English /θ/ as in "that" -- are among the last phonemes acquired by children exposed to languages that contain them. It is as if, when children must push farther and farther from the universal core of language, fewer and fewer languages manage to force them to do so. In general, rare phonemes embody more distinctions, of a more subtle type, than do phonemes of wider distribution and earlier appearance. If the acquisition of phonemes is the result of differentiation, as Jakobson argues, then phonemes that embody numerous and subtle distinctions are naturally acquired after phonemes that embody less numerous and less subtle distinctions. The more subtle distinctions result from differentiation of less subtle ones. A natural order of acquisition and distribution therefore results from the latent but universal structure of distinctive features. Jakobson (1941) argues that the structure inherent in the set of distinctive features is the result of general perceptual principles, and that the order of appearance of phonemic contrasts corresponds to the order of complication of any complex perception.

Jakobson and Halle (1956) give the following series, presumably universal, for the successive differentiation of distinctive features. The numbers are analogous to paragraph headings or indentations. Thus, 1.0 is the first contrast to be developed (/t/ versus /p/); 1.1 is the second

contrast; etc. Later contrasts occur rarely among the languages of the world; examples in English are given where possible.

Consonants: dental vs. labial (e.g., /t/ vs. /p/)	1.0
Vowels: narrow vs. wide (e.g., /i/ vs. /a/)	1.1
Narrow vowels: palatal vs. velar (e.g., /i/ vs. /u/)	1.11
Wide vowels palatal vs. velar	1.111
Narrow palatal vowels: rounded vs. unrounded	1.112
Wide palatal vowels: rounded vs. unrounded	1.1121
Velar vowels: rounded vs. unrounded (e.g., /a/ vs. /a/)	1.113
Consonants: velopalatal vs. labial and dental	1.12
Consonants: palatal vs. velar (e.g., /s/ vs. /k/)	1.121
Consonants: rounded vs. unrounded or pharyngealized vs. non-pharyngealized	1.122
Consonants: palatalized vs. non-palatalized	1.123

Phonological rules. Besides the phonemic structure of a language there are rules for using this structure. Sporn is not a word in English, but it could be a word; perhaps the name of an acne cure. However, kporn could never be a word in English, even though the individual phonemes of kporn are within the language just as are the phonemes of sporn. A phonological rule of English requires initial consonant clusters all to begin with /s/ (Halle, 1964b). Other phonological rules determine the intonation patterns of sentences. In black board (a kind of board) main stress falls on board, but in blackboard (a writing surface) it falls on black. One rule for relating stress to the surface structure of sentences in English requires main stress to fall on the first vowel of a N, but to fall elsewhere in constituents of other kinds, (Chomsky, Halle, and Lukoff, 1956). Blackboard is a N and so receives main stress on black; black board is a NP and so receives main stress elsewhere, in this case, on board.

There are many such rules; for examples, see Chomsky, Halle, and Lukoff, 1956; Halle, 1964b; Chomsky and Halle, 1966; Chomsky and Halle, forthcoming. It appears from informal observation that children continue working on phonological rules for many years, but there are few actual studies of the development of phonology. The entire question is both ripe theoretically and untouched empirically. It is certainly hoped that future work will push in this direction.

We can mention the handful of studies that have been conducted on phonological questions. Berko's (1958) well-known work on children's morphology belongs in part in this category. Anisfeld and Tucker (in press), and Anisfeld, Barlow and Frail (1967) have found evidence for sensitivity to the featural properties of sounds among six-year old children. However, Menyuk (1967) finds that four- and five-year old American children are no better at memorizing sound sequences drawn from English than they are at memorizing sequences drawn from other languages, although they are better at repeating English sequences. And Messer (1967) finds even younger children able to discriminate between English and non-English sequences that differ by no more than one or two distinctive features. Clearly work in this area has barely begun.

### Linguistic Appendix

"Take a sentence of a dozen words, and take twelve men and tell to each one word. Then stand the men in a row or jam them in a bunch, and let each think of his word as intently as he will; nowhere will there be a consciousness of the whole sentence" (James, 1893, p. 199).

Thus did William James state one psycholinguistic problem. Consciousness of a whole sentence takes place in a single mind. It is something done with the separate words of a sentence, and this something could not be done under the conditions of James' proposed experiment. In this section, we review what is known of the process leading to the consciousness of sentences.

Propelled by the same revolution of thought that led to behaviorism in psychology, American linguists of the 1920's and 1930's were concerned to describe language in absolutely neutral terms. Descriptions were to reflect data. Linguistics was engaged in the discovery of the structure inherent in samples of speech. The aim was for completely objective, automatic, and rigorous procedures that would, when correctly applied, yield a correct portrayal of these structures. This would be the grammatical analysis, and it was not only to be correct, but also independent of extra-linguistic suppositions. Thus, Bloomfield (1933) wrote: "We have learned that we can pursue the study of language without reference to any psychological doctrine, and that to do so safeguards our results and makes them more significant to workers in related fields." Although one can question Bloomfield's actual independence from behaviorism, the general tenor of linguistic thought in the 1930's was that linguistics had no responsibilities in psychology. By the same token, psychology had little direct concern with linguistics. It is not surprising, therefore, that James' problem received little attention.



However, a different approach is possible, and, of late, has been under active development. In this alternative approach, linguistics aims to describe exactly what Bloomfield wanted to avoid -- the specialized form of human knowledge that we bring to bear in the comprehension and production of sentences. Descriptions of knowledge have obvious import for psychology: whatever we know, we know by some psychological process. Under its new development, therefore, linguistics makes strong psychological assumptions, with the result that it occupies common ground with psychology. As we shall see, the direction of traffic through this common region has been almost entirely one way. Discoveries in linguistics pose the challenge; psychology is attempting to assimilate them. Perhaps, in the future, two-way traffic will become possible. If so, a full answer to James' problem will be at hand. We will understand the process that leads to a consciousness of a whole sentence. Until then, however, our discussion must be limited to describing the linguistic knowledge that is applied in this process, and it is to this better understood question that we now turn.

Linguists call the systematic characterizations of linguistic knowledge grammars. It is important to realize that these grammars are psychological theories. They strive to portray certain facts about the mind, i.e., they are supposed to be psychologically correct and they stand or fall accordingly (Katz, 1964). The psychological interest in such grammars is, therefore, straightforward. However, it is important -- even crucial -- to understand the limitations placed on this claim of psychological validity. A grammar relates to mental phenomena of a particular kind; it is not an all-purpose psychological theory. In particular, it is not a theory about behavior -- the actual encoding and decoding of speech. This brings us to a fundamental distinction.

Competence and performance. A sharp distinction between competence and performance has been traditional in linguistics since Saussure's Cours de linguistique générale (1916), and was first drawn at least as early as the 18th century (Chomsky, 1966). One can think about language in either of two ways. There are, first of all, actual acts of speaking and hearing, taking place in time, subject to various distractions, limited by memory and by the general weakness of human flesh. These were called actes de parole by Saussure and performance by Chomsky (1957). Performance is linguistic behavior, either encoding or decoding speech. A theory of performance would clearly be a psychological theory, a fact that presumably needs no defense. At the present time, there are no theories of linguistic performance. Indeed, there is only the most fragmentary knowledge of the relevant parameters of such a theory, although the problem is one that now inspires considerable interest. A number of recent experimental studies can be regarded as bearing on it (e.g., Miller, 1962; Miller & Isard, 1963, 1964; Mehler, 1963; Slobin, 1966; McMahon, 1963; Gough, 1965; Savin and Perchonock, 1965).

The second aspect of language is the knowledge of syntax, meaning, and sound that makes performance possible. Saussure called such knowledge langue, and Chomsky has called it competence. A theory of competence is also a psychological theory, although of a type not usually considered by contemporary psychologists. Piaget, perhaps, comes closest in his aim to characterize the structure of logical thought. Because a grammar is concerned with knowledge, not behavior, factors (such as memory limitations, time restrictions, etc.) that are important to performance can be disregarded when thinking about competence. Competence is an idealization, an abstraction away from performance (Chomsky, 1965). Theories of performance and competence, therefore, deal with different topics. A grammar is not a recipe for producing sentences. That recipe is given by a theory of performance. Indeed, the problem for a theory

of performance is to explain just how the information represented by a grammar is realized in actual acts of speaking and hearing (Miller, 1962). The linguist's solution will not answer the psychologist's problem.

Perhaps the distinction between competence and performance, and the way in which they are related will become clearer if we consider an artificial example. In Table 8 are several strings of letters.<sup>1</sup> In each string there is an a or a b or both. Some of the strings have been circled. These we shall call "sentences," by which is meant that they have a certain structure in common not shared by the other strings, the "non-sentences." Table 8 is a skeletonized version of the set

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Insert Table 8 about here

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of all possible strings -- all possible combinations of the letters a and b -- and thus is analogous to the output of that hypothetical set of one million monkeys set before one million dictionaries, who, in their random pointing, work out the plays of Shakespeare and next week's shopping list, along with every other combination of English words.

Our problem is to discover the structure that makes a string a "sentence" in Table 8. This can be done by the reader if he carefully examines the "sentences" and "non-sentences" listed in the table -- the problem is not a difficult one. The reader can then test his discovery by judging the status of new examples. Try, for instance, aaaaabbbb, aaabbbbb, aaab, bbbbaaaa, aaabbbb. The second and the last of these are "sentences," the rest are not.

Knowledge of the principle that determines which strings are "sentences" and which are not is competence. It is not performance. Understanding the principle does not automatically lead to a correct judgment. It would not, e.g., in the case of a string that contained 10,000 a's followed by 10,001 b's. One must count the a's and b's and judge the result against the principle.

Conversely, counting without knowledge of the principle will not tell one that aabb is a "sentence". Counting is performance, whereas knowledge of the principle that adjudicates the result of counting is competence. A grammar is concerned with the latter only. Some further theory is needed to explain how the principle is applied to the result of counting; this would be a theory of performance. There is, of course, competence in the counting, but that is a different domain (Klima, 1966).

The status of a grammar is the same as for any other scientific theory. It is an empirical hypothesis that deals with a mental phenomenon. Because it is an empirical hypothesis, a grammar is either true or false, and observations are made to discover its adequacy in this respect. Because it is a hypothesis about a mental phenomenon, the relevant observations have to do with knowledge of language. The possibility of describing a branch of human knowledge in an explicit way is surely one of the most exciting aspects of contemporary linguistics.

Let us now continue the example of Table and consider several hypotheses that might account for the reader's understanding of the structures represented there.

Finite-state grammars. One method of representing structure, and, hence, competence, is to construct a state diagram. Such a diagram can be thought of as portraying a machine that can be in any of several states. The machine is so restricted that when it is in one state, it can move to other states only over specified legal routes. The resulting network of states and transitions will then embody a structure. Can such a machine, however construed, talk correctly? In particular, can it produce the "sentences" in Table 8 ? To make the machine talk at all, we must provide it with a means of recording its progress as it moves from state to state. We can do this by having the machine utter the name of the state it has just left. Since, in Table 8, the machine must produce strings of a's and b's, all the states will be labeled a or b, and nothing else.

There is one further requirement to place on our machine. We want it to be superior to a mere list. One could, if patient enough, prepare a list of all the "sentences" made up from a and b -- writing down ab, aabb, aaabbb, etc. The difficulty with this list is that it would be endless, because there is no longest sequence of a's and b's. Thus, to be an advance over a list, our machine must be finite, although it may be large. It must have a finite number of states connected by a finite number of transitions, and yet be capable of producing an infinite number of correct sequences of a and b. Such a machine, if successful, would provide the grammar of the "sentences" in Table 8. Let us now try to construct a grammar along these lines.

The top diagram of Fig. 10 shows a machine of three states and three

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Insert Figure 10 about here

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transitions, which is able to produce the "sentence" ab.. It cannot, however, produce "sentences" longer than this. Running the machine twice yields a repetition, not a new "sentence," since we obtain ab.ab.. In order to produce the next longer "sentence" we must add two new states and three new transitions, as in the second diagram of Fig. 10. This new machine produces aabb.. as well as ab.. However, it produces nothing else, and to enrich it we must add two more states and three more transitions, as in the third diagram. However, this machine is likewise restricted -- its longest "sentence" is aaabbb.. In short, for each additional length of sentence, we must add further states and transitions. Since the list of "sentences" consistent with Table 8 is endless, the number of states and transitions we must add is endless also. The machine thus fails the last requirement stated above. It is not superior to a mere list which means that different kinds of grammars are needed.

Before considering these different grammars, however, it should be noted that the "sentences" in Table 8 and the grammars in Fig. 10 are not simply empty

exercises. On the contrary, they are directly relevant to the concerns of this chapter. English has sentences of the kind listed in Table 8, and much psychological theorizing accounts for structures of the kind diagrammed in Fig. 10. The fact that Fig. 10 cannot represent the "sentences" in Table 8, therefore, means that much psychological theorizing cannot account for significant portions of the structure of English. Let us take up the matter of structure first.

The "sentences" in Table 8 are built like an onion. The shortest is ab. The next longer "sentence" consists of another ab sealed inside the first ab, and the next longer one yet results from surrounding aabb with still another ab, and so on. If we use parentheses to indicate how the a's and b's are paired, a "sentence" of length six would be written as (a(a(ab)b)b). Such structures are called embeddings, and, if not too long, are commonplace in English. (The race (that the car (that the people sold) won) was held last summer) stretches the bounds of credulity but it is a perfectly grammatical sentence (Miller, 1962).

Now let us take up psychological theory. The way to construct a finite-state device clearly is to link states by transitions. If the device is also to be a model of a learner, then it must be exposed to each transition link in the chain in such a manner that states will be connected by transitions that move in the correct directions. In the case of the first diagram in Fig. , the device must have been exposed first to an a, then to a b, and finally to a period. This requirement is inescapable. So long as the structure to be acquired can be presented in this steplike way, a finite-state device will faithfully reproduce it. All other structures, however, lie beyond its grasp.

This limitation -- faithful reproduction of transitions but nothing else -- is shared by every stimulus-response theory of learning, from the simple (Skinner's) to the complex (Osgood's). It is inherent in the basic S-R paradigm. Learning occurs when one presents an appropriate stimulus together

with the correct response and stamps in a connection between the two through (depending on the theory) reinforcement, repetition, drive reduction, etc. All S-R theories are variations on this basic theme, and they all lead to the development of a finite-state device. This, therefore, is the relevance of Table 8. The "sentences" there could not be learned through any process consistent with S-R theory. . . The reader who understands the principle of producing these "sentences" is himself a refutation of all consistent S-R models.

This critique might be answered by observing that there is no proof that our knowledge of the "sentences" in Table 8 is anything other than what the diagrams in Fig. 10 claim. The requirement of infinite productivity might be psychologically meaningless, and perhaps, a S-R analysis expresses the processes that actually take place.

There are, however, at least three things wrong with this defense. One is simply that it fails to explain how S-R theories are logically superior to the compilation of lists in the case of embedded materials. Even the most harassed housewife does not have a mind entirely awash with unstructured lists.

A second difficulty is that the diagrams in Fig. 10 cannot account for correct judgments about "sentences" never before encountered. If a novel "sentence" goes beyond the current degree of complication of a finite-state device, then it must be rejected as a "non-sentence," unless there is further training. This is the point of the test the reader was asked to take. If the reader had discovered the principle underlying the "sentences" in Table 8, he could correctly judge the sentencehood of novel strings without additional instruction. And if the reader could do this, then what he had learned could not be represented by a finite-state device.

The third difficulty is the opposite side of the coin. If we assume that a speaker's knowledge of English can be represented by a finite-state device, then we are forced to make quite incredible claims about the learning

ability of children. Take the following sentence: The people who called and wanted to rent your house when you go away next year are from California (Miller and Chomsky, 1963). It contains a grammatical connection between the second word (people) and the seventeenth word (are): changing either one of these words to the corresponding singular form would produce an ungrammatical sentence. If the connection between people and are is carried by a finite-state device in our heads, then each of us must have learned a unique set of transitions spanning 15 grammatical categories. Making the conservative estimate that an average of four grammatical categories might occur at any point in the development of an English sentence, detecting the connection between people and are signifies that we have learned at least  $4^{15} = 10^9$  different transitions. This is, however, a reductio ad absurdum. As Miller and Chomsky point out, "We cannot seriously propose that a child learns the values of  $10^9$  parameters in a childhood lasting only  $10^8$  seconds" (p. 430). And even a highly efficient child, one who somehow could learn 10 transitions a second, would still miss the dependency when people and are are separated by 16 words or more.

These three difficulties add up to a single flaw. There is no way for a finite-state device to express the idea of recursion -- the insertion of one component inside another component. However, recursion is a psychological fact. It is what the reader grasped in Table 8. It is behind the comprehension of sentences such as the race that the car that the people sold won was held last summer, as well as the people who called and wanted to rent your house when you go away next year are from California. What is needed, therefore, is a hypothesis about this mental ability. One is introduced in the next section.

Recursiveness and linguistic abstraction. Finite-state devices in general and S-R models in particular can copy only those structures that consist of states and transitions among them. These models will misrepresent anything that possesses some other structure. That was the difficulty with the



representation of the "sentences" in Table 8 by means of the state diagrams in Fig. 10. If the reader understands the principle underlying these "sentences," he can tell that the part missing from aab is a second b to go with the first a. Similarly, he can tell that the sentence the car that the people sold was held last summer is peculiar because there is an incorrect verb for the noun-phrase, the car. In both cases, part of what is known about the structure of the sentence is that elements separated from each other actually belong together and not with the material that separates them. What they jointly belong to is an important fact about the sentence, and a correct linguistic representation must somehow portray it. It is on this hidden structural feature that a finite-state device founders.

Consider now the following two grammatical rules. Together, they will produce all and only the "sentences" consistent with Table 8 .

$$X \longrightarrow aXb$$
$$X \longrightarrow ab$$

The arrow ( $\longrightarrow$ ) means that the element on the left is rewritten as, or becomes, the elements on the right. By employing a further notational convention -- that parentheses in a rule indicate optionality -- the possibility of choosing or not choosing an element -- the two rules above can be collapsed into one, as follows:

$$X \longrightarrow a(X)b$$

One may apply the expanded version of this rule (with the X) indefinitely.

Each application lays down an a and a b with another X in between. The new X calls for application of the rule again, literally ad infinitum. This is recursion. The development of a "sentence" comes to an end when the option of not including X is taken. Figure 11 shows the successive steps taken in

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Insert Figure 11 about here

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producing a "sentence" of length six, aaabbb.

The constituent in these "sentences" labeled X is the part to which each ab pair belongs, even though they are separated by other ab pairs. The existence of X is essential to the recursiveness of the rule, since its presence on the right is the only feature that requires another application of the rule.

However, note one important thing. The constituent X is abstract. It never appears in the final form of a sentence, only in its derivation: aXb is not a "sentence" in Table 8, just as the equivalent in English, the people Sentence are from California, is not a sentence. Nonetheless, an abstract constituent is part of the structure of these sentences. It is such an abstraction that the reader gleaned from Table 8 and it is such an abstraction that he discovers in the sentence, the people who called and wanted to rent your house when you go away next year are from California. On this hypothesis, therefore, speakers can grasp aspects of sentence structure that are never included in the overt form of a sentence. We shall return to the question of linguistic abstractions repeatedly, since it poses a most challenging problem for psychologists. Somehow, linguistic abstractions are developed by children -- just as the reader learned about X in Table 8, children learn about structural features in English that are likewise never presented to them.

Phrase-structure rules. A grammar, we have said, represents linguistic knowledge. A grammatical rule, accordingly, represents a bit of linguistic knowledge. In the case of a rewriting rule such as  $X \rightarrow a(X)b$ , the knowledge represented is that a(X)b is a species of the genus X. The rule itself is simply a means of expressing this idea.

Many aspects of language take such a form. The frog caught a mosquito, for example, is a sentence. The frog and the mosquito, in turn, are both noun phrases, and caught the mosquito is a verb phrase. Knowledge of these

elementary facts can be naturally represented by means of rewriting rules;

Table 9 shows how it is done for the frog caught the mosquito. Note that each

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Insert Table 9 about here

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of the examples given above, where one constituent is an instance of something else, is represented in the Table by a separate rule. The derivation makes the genus-species relation, as it applies to the sentence, explicit.

It is easy to show that the relations established by the rules in Table 9 correspond to facts that speakers of English know about the frog caught the mosquito. First of all, if a speaker is asked to divide the sentence into two major parts, the split will most likely be made between the frog and caught the mosquito, that is, between the NP and PredP of the first rule. If he is now asked to divide caught the mosquito into two parts, the line will come between caught and the mosquito, that is, between the V and NP of the second rule. It is very unlikely that a speaker would divide the frog caught the mosquito into the and frog caught the mosquito, or divide caught the mosquito into caught the and mosquito. Speakers honor the rules because the rules reflect information speakers have about the sentence. This correspondence can be revealed in a second way.

Suppose that we take the frog caught the mosquito and try to derive from it another sentence in the following manner (Miller, 1962). We try to find a single word that can replace a group of words in the original sentence without changing the grammatical structure. Our interest lies in seeing which groups of words can be so replaced. Replacements exist only for the constituents of the sentence -- English has no words that belong to no constituents. A series of these derivations is shown in Table 10, and it can be seen that the replace-

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Insert Table 10 about here

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ments obtained in this manner correspond exactly to the derivation obtained through application of the rules in Table 9 . We have here hard-core evidence for the validity of the rules in Table 9 .

The structures portrayed in Tables 9 and 10 are a part of the phrase structure of English. Accordingly, the rules in Table 9 that produce this structure are called phrase-structure rules, and the diagram in the table is called a phrase marker. The function of the rules is to define which constituents of sentences are superordinate to which other constituents, to establish the order of constituents, to display the grammatical elements of the sentence (e.g., NP), and to define (in a way that will be explained later) the so-called basic grammatical relations -- subject of a sentence, object of a verb, etc. The phrase marker is the structure produced through application of the rules. It can be presented as a diagram, as in Table 9 , or by means of labeled brackets.

( ( (the).(frog)) ( ( caught) ( ( the) (mosquito)))  
S NP Art N VP V NP Art N

includes exactly the same information as Table 9 , and both represent the structure that speakers of English find in the frog caught the mosquito.

Note that grammatical rules represent linguistic structure. They describe tacit knowledge, not explicit knowledge. No one claims that the rules given in Table 9 are known to speakers of English as rules. If that were actually the case, linguistics could not exist -- the field would be as pointless as would a "science" setting out to discover the rules of baseball. The distinction is perhaps obvious, but its importance justifies some elaboration.

One can imagine a continuum of interpretations of the rules in Table 9 . At the weak end of the continuum phrase-structure rules might be regarded as summarizing regularities in behavior. In this case, S  $\longrightarrow$  NP PredP means

that when English sentences occur, they consist of noun phrases followed by predicate phrases. There is no interest in representing linguistic competence. The relevant observations are the frequency of sentences following the NP PredP format, of PredP's following the V NP format, and so forth, and there is no doubt that such observations would falsify the weak interpretation of Table 9. Sentences like the frog caught the mosquito are simply not common.

At the opposite extreme, the strong end of the continuum, the claim is that English speakers know the rules in Table 9 in much the form that the rules take when written. Clearly, this claim is false for the vast majority of English speakers.

The mid-point on this continuum of interpretations is the one intended for Table 9. English speakers do not know the rules in Table 9. But what they do know (it is claimed) is represented by these rules. Observations relevant to the intermediate interpretation have to do with a speaker's intuitions -- for instance, that the mosquito is a grammatical constituent in English, whereas caught the is not. As we have already seen, such observations support this intermediate claim.

Phrase-structure rules, interpreted in the intermediate sense, are said to generate sentence structures. A term like "generate" tempts us to think that speakers actually plan sentences along the lines outlined in Table 9 -- they first decide to utter a sentence, then decide that the sentence will consist of a V and a NP, and then, only at the end, decide what vocabulary to use. Such a scheme is one possible, though improbable, hypothesis about linguistic performance. (Yngve, 1960, 1961; Johnson, in press). However, the theory of performance is not part of the grammatical analysis in Table 9. A grammar is quite neutral with respect to hypotheses about performance. The term generate is used by grammarians in a logical, not a mechanical, sense. As the linguist Lees once put it, a correct grammar generates all possible sentences

of a language in the same way that a correct zoology generates all possible animals. Both capture the structural relations within their subject matter. The term generate will be used throughout the remainder of this chapter in its logical, non-mechanical, sense.

The linguistic observations made so far serve a fairly obvious purpose. Presumably, the parsing of the frog caught the mosquito given in Table 9 does not require elaborate defense. The facts are straightforward, and the principal merit in discussing them at all is that they acquaint the reader with some linguistic notation at a point where it is reasonably easy to see what the notation means. However, there are more profound, and psychologically more significant, insights entailed by three other linguistic concepts; and it is to these concepts that we now turn.

Transformations and the notions of deep and surface structure. In a general way, language can be described as the system whereby sound and meaning are related to each other. That sound and meaning are separate, and so need relating, is evident from paraphrase, where the same meaning is expressed in different patterns of sound (the man pursued the woman and the woman was pursued by the man), and from ambiguity, where the same pattern of sound has different meanings (outgoing tuna). Between sound and meaning stands syntax. The relation between sound and meaning is, therefore, understood to the degree that the syntax of a language is understood. In this section we shall examine what is known of this relation.

Rationalist philosophers have argued since the 17th century that sentences have both an inner and an outer aspect -- the first connected with thought and the second with sound (Chomsky, 1966). The kind of evidence that leads to this conclusion, and hence to the phenomenon of concern here, is given in Table 11 (after Miller & McNeill, in press). The three sentences on the left of Table 11

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Insert Table 11 about here

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all have the same superficial form. They start with a pronoun, they, followed by are, followed by a progressive form, followed by a plural noun. Despite the superficial identity, however, there are clear differences in structure among these three sentences. To understand the differences, we will eventually need the notions of a transformation rule and of deep and surface structure.

Sentence (a) differs from sentences (b) and (c) in several fairly obvious ways. One difference is that the two kinds of sentences accept pauses in different places. With sentence (a), one might say they - are buying - glasses, but probably not they - are - buying glasses. It is the opposite with sentences (b) and (c). One could say they - are - drinking companions or they - are - drinking glasses, but not they - are drinking - companions or they - are drinking - glasses, unless the reference was to cannibalism or suicide. A second difference is in the proper location of articles. We have they are buying the glasses but not they are the buying glasses. We have they are the drinking companions but not they are drinking the companions.

The location of pauses in a sentence is fixed by its phrase structure. Pauses tend to go around constituents, not inside them. The location of articles is likewise determined by phrase structure. They go before NPs only. We can thus summarize the differences between sentence (a) and sentences (b) and (c) by saying that they have different phrase structures. In particular, the progressive form in sentence (a) is associated with the verb are, whereas in sentences (b) and (c), it has moved over to the plural noun. The essential parts of the three phrase markers are as follows: (they) (are buying) (glasses), (they) (are) (drinking companions).

Sentence (a) and sentences (b) and (c) are distinguished in their surface structures. The difference, as we have seen, has to do with the distribution of

pauses and the location of articles. As we shall see later, surface structure is also intimately connected with stress and intonation. In general, the surface structure of a sentence has to do with phonology -- with one of the two aspects of language that need to be related by syntax.

Let us now look more carefully at sentences (b) and (c). They accept pauses in the same way, they take articles at the same places, they are accordingly bracketed in the same way, and, indeed, they have the same surface structure. But it is clear that they are not structurally identical throughout. They differ in a way that is important to meaning, the other aspect of language that is to be related by syntax. That they differ in meaning can be seen in the paraphrases and non-paraphrases of the two sentences in Table 11. Sentence (b) means "they are glasses to use for drinking," and sentence (c) means "they are companions that drink." Exchanging the form of the paraphrase between (b) and (c) leads to a non-paraphrase. Sentence (b) does not mean "they are glasses that drink" any more than sentence (c) means "they are companions to use for drinking." Despite the identity of surface form, (b) and (c) differ importantly in underlying form. We shall say that they differ in deep structure, saving until later a more precise definition of what this means. First, however, let us note two implications that follow from the fact that (b) and (c) have the same surface structure but different deep structures.

One is that the relation between deep and surface structure must be different in the two sentences. The statement of this relation is assigned a special place in a grammar. It is done by rules of transformation, and it is these rules, together with the deep and surface structure of sentences, that embody the connection between sound and meaning in a language. The reader will have realized, of course, that in the statistical sense, sentences (b) and (c) are freakish. The vast majority of sentences that have different deep structures and different transformations also have different surface structures. Sentences



(b) and (c) happen not to, but for this very reason, conveniently illustrate what is true of all sentences. ... Every sentence, however simple, has some kind of deep structure related to some kind of surface structure by means of certain transformations. The substance of grammar consists of making explicit these three terms.

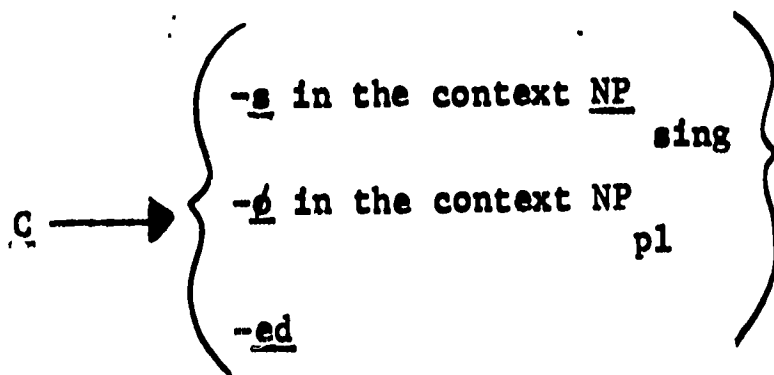
The second implication of the difference in paraphrase between sentences (b) and (c) is that the deep and surface structures of sentences are not identical. This is evidently true of at least one of these sentences, (b) or (c). In fact, it is true of all sentences. Transformations provide enormous flexibility in developing surface structures from deep structures, and this advantage has been pressed in even the most elementary sentence types (an example with simple declaratives is given below). Thus, the deep structure of every sentence is abstract in the sense given above. The underlying structure, the part connected with meaning, is not present in the overt form of any sentence. The acquisition of linguistic abstractions is a universal phenomenon -- it is a basic fact about the development of language and on its success rests the emergence of all adult grammar. It would be impossible to understand sentences (b) and (c) correctly if this were not so.

All these concepts -- deep structure, surface structure, linguistic abstraction, and the way transformations tie them together -- can best be seen in an example. The one we shall use is borrowed from Miller and McNeill (in press), and is based on Chomsky (1957). Consider the following sentences:

<u>He walks</u>	(present singular)
<u>They walk</u>	(present plural)
<u>He walked</u>	(past singular)
<u>They walked</u>	(past plural)

These four sentences mark two distinctions: number (singular and plural), and tense (present and past). Number is marked both in the form of the pronoun and in the inflection of the present-tense verb. Tense is marked in the inflection of the verb. Let us focus on the verbs, for it is here that a transformation becomes involved.

There are three verb suffixes -- -s, -ϕ (which means null, but is a suffix all the same), and -ed. They encode information of a certain type, viz., the form of the verbal auxiliary, so we might suppose that this information can be expressed by a re-writing rule of the kind already discussed. If we label the genus part of the rule C, then we can use the following context-sensitive rule:



and summarize all four of the sentences above by a single schema, NP + V-C.

Let us now complicate the sentences slightly by incorporating an auxiliary verb, be, and see what happens to C.

He is walking

They are walking

He was walking

They were walking

The first thing to note is that using a form of be adds -ing to the following main verb. C, for its part, has moved forward. It is no longer attached to the main verb but to the auxiliary, and we have be-s (pronounced is), be-ϕ (pronounced are), and be-ed (pronounced was or were, number being marked on past-tense verbs in this case -- a detail we can ignore). The schema for these sentences therefore is, NP + be-C + V-ing.

Next, consider the effect of adding a different auxiliary verb, a form of have, to the original sentences. Doing so, we obtain:

He has walked

They have walked

He had walked

They had walked

The main verb again takes a suffix, this time, -ed, and C again moves forward to the auxiliary. It is the same, therefore, as when be is the auxiliary, except that different pronunciation rules are involved (have-s is has, have-~~o~~ is have, have-ed is had) and the main-verb suffix is -ed, instead of -ing. Indicating these changes, we obtain the schema, NP + have-C + V-ed, for the use of have as an auxiliary.

The two auxiliaries can be combined, of course, as in these sentences:

He has been walking

They have been walking

He had been walking

They had been walking

Both auxiliaries have the effects already demonstrated. Be adds the suffix -ing to the following verb and have adds a "past" suffix to be. (In this case, it is be-en, another difference in detail that we can ignore.) C also follows its pattern, for it is still attached to the first auxiliary verb. The schema therefore is NP + have-C + be-en + V-ing.

These sentences can be complicated still further by adding one of the modal auxiliaries. Modals are the words, will, can, may, shall, must. Let us add will:

He will have been walking

They will have been walking

He would have been walking

They would have been walking

C has moved forward again, attached now to the modal. Have still adds a "past" inflection to the following be, and be still adds -ing to the following main verb. The schema thus is NP + M-C + have + be-en + V-ing, where M stands for "modal."

It is evident from these examples that C always appears with the first member of an auxiliary construction, no matter how long this construction is. The location of C is a fact known to all speakers of English -- he will had been walking obviously is not the way to indicate past tense in an auxiliary construction. Part of an English speaker's competence thus has C at the start of a verb phrase. Another part involves the contingency between have as an auxiliary and a following "past" inflection, as well as the contingency between be as an auxiliary and the following -ing. Let us try to represent these facts about competence by constructing a rule that meets the following two conditions: (1) the true order of elements is maintained, and (2) elements contingent on one another are placed together. Doing so will lead to a simple solution.

Meeting the first condition requires placing C first, then M, then have, and finally be. Since C appears in every sentence, our rule must make it obligatory. The remaining constituents, however, are optional, so we write them with parentheses. Let us call the whole construction "Auxiliary," abbreviate it "Aux," and put down the following rule:

Aux → C (M) (have) (be)

The following main verb (V) is omitted from this rule because it is introduced along with Aux by the PredP rule, which is now enlarged to read:

PredP → Aux V (NP)

The Aux rule is still incomplete, since it does not yet meet the second condition. The contingencies to be represented are that have goes with -en (or -ed), and be goes with -ing, so we write these elements together, and thereby

produce the following:

Aux → C (M) (have-en) (be-ing)

after which there will always be a V.

We now have all but one of the rules necessary to generate the examples given above. The missing one, a transformation, will be provided shortly. However, in order to see the need for the transformation, and to appreciate the role it plays in representing the structure of these sentences, we should first see the result of producing sentences without it. The structural relations to be expressed by the transformation will be those not expressed by the rules already developed. If we have done our job well, the division between the two kinds of rules, the transformation and the phrase-structure rules, will correspond to a real division between two kinds of structural information within sentences.

Figure 12 contains a phrase marker generated by the phrase-structure rules presented in the preceding paragraphs. Note that the order of elements at the

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Insert Figure 12 about here

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bottom of the phrase-marker is they + Past + will + have + en + be + ing + walk. This string and its associated structure is the deep structure of they would have been walking. The surface structure is a specific instance of the last schema given above -- they + will-Past + have + be-en + walk-ing. The deep structure thus differs from the surface structure in the order of suffixes and verbs. Accordingly, it is abstract in the sense used here, since the deep-structure order never appears overtly. It is important to realize, nonetheless, that the deep structure in Fig. 12 reflects actual linguistic knowledge -- the information summarized by C is always first in a predicate phrase, have and -en do always appear together, just as be and -ing do.

The deep structure must, therefore, be transformed in order to obtain

the surface structure. The transformation is simple: wherever the sequence suffix-verb appears in the deep structure, change the order to verb-suffix (Chomsky, 1957). If the reader applies this transformation, he will find the surface structure of they would have been walking rolling out quite automatically.

There remains one important point. Note that the linguistic information expressed by the phrase-structure rules in generating they would have been walking is fundamentally different from the information expressed by the transformation rule. Which is to say that the distinction between the two is linguistically meaningful. The former rules define such matters as the genus-species relations within the sentence (e.g., they is an NP), establish the basic order of elements (e.g., C is first in the PredP), and indicate what the elements are (e.g., have-en is an element). Information of this kind is essential for obtaining the meaning of the sentence. The relations just mentioned, among others, are exactly what we understand of they would have been walking.

The transformation, in contrast, makes no contribution to meaning. It exists only because sound and meaning are not identical in English (or any language), and its sole purpose is to state the relation between them. The distinction between phrase-structure and transformation rules is thus fundamental to the analysis of language. Without it, the insight that sound and meaning are separate in language would be lost; and to suggest, as some have done (e.g., Braine, 1965), that transformations are methodologically unsound because they lead to arbitrary linguistic solutions, is to miss the entire point of transformational grammar.

The distinction between sound and meaning is a basic justification of transformational grammar, but the use of transformations in grammatical analysis is supported by other arguments as well. One is economy. If we dispense with transformations and try to generate sentences with phrase-structure rules alone, the result becomes unnecessarily complex. The sentences given above,

for example, require eight different and independent phrase-structure rules, one for each combination of auxiliary verb and C, instead of the single phrase-structure rule required when a transformation is allowed. Without the transformation, we would need at least the following rules:  $\text{Aux}_1 \longrightarrow \underline{\text{V-C}}$ ,  $\text{Aux}_2 \longrightarrow \underline{\text{be-C}} + \underline{\text{V-ing}}$ ,  $\text{Aux}_3 \longrightarrow \underline{\text{have-C}} + \underline{\text{V-ed}}$ ,  $\text{Aux}_4 \longrightarrow \underline{\text{have-C}} + \underline{\text{be-en}} + \underline{\text{V-ing}}$ ,  $\text{Aux}_5 \longrightarrow \underline{\text{M-C}} + \underline{\text{V}}$ ,  $\text{Aux}_6 \longrightarrow \underline{\text{M-C}} + \underline{\text{be}} + \underline{\text{V-ing}}$ ,  $\text{Aux}_7 \longrightarrow \underline{\text{M-C}} + \underline{\text{have}} + \underline{\text{V-ed}}$ , and  $\text{Aux}_8 \longrightarrow \underline{\text{M-C}} + \underline{\text{have}} + \underline{\text{be-en}} + \underline{\text{V-ing}}$ . Note that these rules cannot be collapsed onto one another by means of the parentheses notation used before.

The phrase-structure version of the auxiliary, therefore, not only overlooks valid linguistic generalizations -- such as the fact that C always appears first in the auxiliary, or that there is an auxiliary, or that -ing depends on be and not on V -- but it is simply cumbersome. Relative economy is always an argument in support of one theoretical interpretation over another, and using it in the present case inclines the balance toward a transformational grammar.

The argument of economy has special significance in the context of language acquisition. We prefer to think of children doing the simpler thing, whatever that might be. In the case of linguistic development, the simpler thing is to acquire a transformational grammar instead of a phrase-structure grammar. Accordingly, it is the former that we suppose is learned.

The suffix-transformation used in generating the English auxiliary verb is one rule within a vast and intricate network of transformations making up the language. Passive sentences, negation, questions of various kinds, conjunctions, the apposition of nouns and adjectives, and many others, all depend on transformations. The technical literature dealing with these rules is large and sophisticated; rather than summarizing it here, a task almost as unnecessary as it is hopeless, the interested reader is encouraged to turn to original sources. A volume edited by Fodor and Katz (1964) contains a number

of significant papers. In addition, one should look at Chomsky (1957, 1963, 1964, 1965, 1966), Chomsky and Miller (1963), Chomsky and Halle (1966), Fillmore (1965), Katz (1966), Katz and Postal (1964), Miller and Chomsky (1963), and Postal (1964). A review of transformational grammar written for psychologists is contained in Miller and McNeill (in press).

There is one set of transformations of special significance, however, and this section will conclude with a discussion of them. Recall the artificial language presented in Table 8. Its "sentences" were built like an onion -- such structures as (a(a(ab)b)b). The rule given to generate the "sentences" in Table was  $X \longrightarrow a(X)b$ , in which there is an abstract recursive element, X. This much is phrase structure and it has an exact analogy in English (and all other languages).

In developing the deep structure of any sentence, it is possible to include the element S, thus calling for the insertion of another deep structure at that point. That sentence, in turn, may also have an S in it, calling for the insertion of yet another deep structure, and so forth. The result is the same onion-like structure presented in Table 8, and it has the same effect -- making infinite productivity possible through recursion. Figure 13 shows a succession of such deep structures, each with another deep structure embedded

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Insert Figure 13 about here

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within it.

Figure 13 is the result of applying phrase-structure rules alone. It is, in other words, the deep structure of (the ostrich (that was terrified by the zebra (that the hunter shot) )stuck its head in the sand), a sentence with two relative clauses. English employs several transformations to develop this surface structure from the deep structure in Fig. 13. In discussing them, we shall use terminology suggested by Lees (1960), and call the structure containing



S the matrix and the S contained the constituent. Thus, D3 in Fig. 13 is the constituent of the matrix D2, and both are the constituent of the matrix D1. In Fig. 13, D3 is only a constituent, D1 is only a matrix, but D2 is both -- a matrix for D3 and a constituent (containing D3) for D1.

These three components are complete structures unto themselves. If developed in isolation (ignoring the S in D1 and D2), each would result in a sentence. D1 is the deep structure of the ostrich stuck its head in the sand; D2 is the deep structure of a passive sentence, the ostrich was terrified by the zebra; and D3 is the deep structure of the hunter shot the zebra. It is obvious that more is required in combining these elementary structures than simply applying the transformations that each calls for alone -- the auxiliary transformation in every case, and the passive transformation in D2. Doing only this much produces non-English: the ostrich was terrified by the zebra the hunter shot the zebra stuck its head in the sand. To avoid a word salad like this, an embedding transformation must delete double occurrences of the same NP. Not every NP repeated in an English sentence need be deleted, of course. The ostrich stuck its head in the sand and the ostrich ate the worm is grammatical even though redundant and ambiguous. However, in the case of an embedded relative clause, deletion must occur, and the rule is that when the same NP is both a matrix subject and a constituent object the object-NP is moved to the front of its sentence structure and replaced by the word that. Let us call this operation the deletion transformation. In the case of Fig. 13, it produces the ostrich that the zebra that the hunter Past+shoot Past+terrify by+Passive Past+stuck its head in the sand. Applying the auxiliary transformation to this structure wherever called for (e.g., Past-shoot becomes shot), and the passive transformation to D2, the surface structure, of which Fig.13 is the deep structure, rolls out.

Again, notice that a natural distinction exists between the information contained in the transformation and the information contained in the deep structure. As before, the latter has to do with meaning and the former with the relation between sound and meaning. When one understands a relative clause, he grasps the fact that there are two or more deep structures, one inserted in the other, with the deletions not performed. Obtaining the meaning of the ostrich that was terrified by the zebra that the hunter shot stuck its head in the sand depends on knowing that the first that means ostrich and the second zebra, which is to disregard both deletions in the semantic interpretation of the sentence.

There remains one point and we shall be done with this brief introduction to syntax. If transformations are correctly stated in a grammar, they apply automatically whenever the proper conditions exist in the deep structure. In other words, transformations are obligatory (Chomsky, 1965; Katz & Postal, 1964). The specification of the "proper" conditions is done by the structural index of a transformation and setting it down is an important part of writing a transformational rule. Should the structural index be wrong, a transformation will inevitably relate wrong deep and surface structures, even though the operations described in the transformation are themselves correct. To supplement the rules already mentioned, then, we must add that the auxiliary transformation applies to any occurrence of suffix + V, the passive transformation to any occurrence of NP<sub>1</sub>, Aux, V, ... NP<sub>2</sub> ... by + Passive (the subscripts indicating that the two NP's must be different and the dots indicating that other, unspecified, material can be inserted), and the relative-clause transformation to any case where the matrix-subject and the constituent-object are the same NP. The structural index is clearly part of grammatical knowledge. Applying the relative-clause transformation to two deep structures where the subject and object-NP's are different results in a sentence that expresses the wrong meaning. If, for example, the deep structures of the ostrich stuck its head in the sand and the

ostrich ate the worm are connected by the relative-clause transformation, meaning shifts and the result becomes something out of Alice in Wonderland -- the ostrich stuck its head in the sand that ate the worm. Since violation of the structural index of a transformation leads to an inappropriate expression of meaning, it is evident that the structural index is a part of the relation between meaning and sound.

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Table 1

The first 7 "words" in one child's linguistic development.  
(after Leopold, 1949)

Utterance	Age	Gloss
ʔə?*	8 mos.	An interjection. Also demonstrative, "addressed" to persons, distant objects, and "escaped toys."
dididi*	9 mos.	(loud) disapproval (soft) comfort
mam:ɛ	10 mos.	Refers to food vaguely. Also means "tastes good" and "hungry."
nenene*	10 mos.	scolding
t t!*	10 mos.	used to call squirrels
pIti	10 mos.	Always used with a gesture, and always whispered. Seems to mean "Interested (-ing)"
dɛ :	10 mos.	An interjection. Also demonstrative. Used with the same gesture as above.

Table 2

Pivot and Open Classes from Three Studies  
of Child Language

Braine	Brown	Erwin
{ allgone byebye big more pretty my see night- night hi	{ my that two a the big green poor wet dirty fresh pretty	{ this that
{ boy sock boat fan milk plane shoe vitamins hot Mommy Daddy . . .	{ Adam Becky boot coat coffee knee man Mommy nut sock stool tinker- toy . . .	{ arm baby dolly's pretty yellow come doed : .
		{ the a
		{ other baby dolly's pretty yellow . .
		{ here there
		{ arm baby dolly's pretty yellow . . .

Table 3

Sentence Patterns That Correspond to Basic  
Grammatical Relations

Child's Speech		Corresponding Grammatical Relations
Pattern	Frequency	
P + N	23	modifier, head noun
N + N	115	modifier, head noun, subject, predicate
V + N	162	main verb, object
N + V	49	subject, predicate
Sum	349	
P + N + N	3	modifier, head noun
N + P + N	1	subject, predicate, modifier, head noun
V + P + N	3	main verb, object, modifier, head noun
V + N + N	29	main verb, object, modifier, head noun
P + N + V	1	subject, predicate, modifier, head noun
N + N + V	1	subject, predicate, modifier, head noun
N + V + N	4	main verb, object, subject, predicate
N + N + N	7	subject, predicate, modifier, head noun
Sum	49	

Table 4

Part of the grammar of a child 36 months old  
(Brown, Cazden, and Bellugi, in press)

Complete phrase structure rules

1.  $S \rightarrow ( \left\{ \begin{array}{l} \text{(imp)} \\ \text{Wh1} \end{array} \right\} ) (\text{Neg}) \text{Nominal} - \text{Predicate}$
2.  $\text{Predicate} \rightarrow \left\{ \begin{array}{l} \text{MV} \\ \text{Cop} \end{array} \right\}$
3.  $\text{MV} \rightarrow \text{Vb} \quad (\text{Comp})$
4.  $\text{Vb} \rightarrow (\text{Aux}) \text{V} (\text{Prt})$
5.  $\text{Aux} \rightarrow \left\{ \begin{array}{l} \text{V}^{\text{C}} \\ \text{B} + \text{ing} \\ \text{Past} \end{array} \right\}$
6.  $\text{Comp} \rightarrow \left\{ \begin{array}{l} \text{Adverb} \\ \text{Nominal (Adverb)} \end{array} \right\}$
7.  $\text{Cop} \rightarrow \text{B} - \text{Pred}$
8.  $\text{B} \rightarrow \left\{ \begin{array}{l} \text{be} \\ \text{B} \end{array} \right\}$
9.  $\text{Pred} \rightarrow \left\{ \begin{array}{l} \text{Det} \\ \text{Nominal} \\ \text{Adverb} \end{array} \right\}$
10.  $\text{Adverb} \rightarrow \left\{ \begin{array}{l} \text{locative} \\ \text{Adv} \\ \text{Prep Phrase} \end{array} \right\}$
11.  $\text{locative} \rightarrow \left\{ \begin{array}{l} \text{somewhere} \\ \text{Adv} \\ \text{Prep Phrase} \end{array} \right\}$
12.  $\text{Prep Phrase} \rightarrow \text{Preposition} \left\{ \begin{array}{l} \text{nominal} \\ \text{Adv} \end{array} \right\}$
13.  $\text{Nominal} \rightarrow \left\{ \begin{array}{l} \text{some (one)} \\ \text{(thing)} \end{array} \right\}$
14.  $\text{NP} \rightarrow (\text{Det}) \text{N}$

Two transformation rules

T1. WH incorporation for main-verb sentences

WH-Nominal-Verb (Nominal) - some $\Delta$   $\Rightarrow$  WH + some $\Delta$  - Nominal-Verb (Nominal)

T2. Affixation of Past

X - Pst - V - X  $\Rightarrow$  x - V+Past - X



Table 5

The Emergence of English, Inflections in the Speech of Two Children  
(Bellugi, 1964)

<u>Inflection</u>	<u>Age of Appearance</u>		<u>Combined rank order in Mother's speech</u>
	<u>Adam</u>	<u>Eve</u>	
Present progressive, <u>-ing</u>	28 mos	19 1/2 mos	2
Plural on nouns, <u>-s</u>	33	24	1
Past on regular verbs, <u>-ed</u>	39	24 1/2	4
Possessive on nouns, <u>-s</u>	39 1/2	25 1/2	5
Third person on verbs, <u>-s</u>	41	26	3

Table 6

The use of Modal verbs by one child  
(Bellugi, 1967)

<u>Context</u>	<u>26.5</u>	<u>Age in Months</u>	
		<u>27</u>	<u>27.5</u>
Affirmative	8	20	27
Negative	6	12	14
Yes-No question	-	4	12

Table 7

The restriction of Why and Why not Questions to Discourse  
(Brown, Cazden, and Bellugi, in press)

Mother

Adam

He was playing a little tune

Why he play little tune?

I see a seal

Why you see seal?

You bent that game

Why me bent that game?

Well, because she wanted to

Why she want to?

I think it's resting now

Why it's resting now?

I guess I'm not looking in the right place

Why not you looking right place?

Because you weren't careful

Why me not careful?

I don't see any

Why not me can't dance?

You're going to have to buy another one  
and give it to Ursula because you're  
breaking that one

Why not me break that one?

Table 8

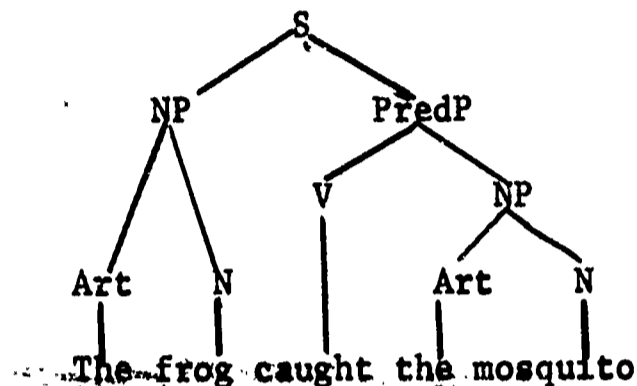
"Sentences" and "Non-Sentences" from a Language Made up of the  
Letters a and b. (Many Strings Have Been Omitted.)  
Circled Strings are "Sentences"

Length 1	a b
Length 2	aa <b>ab</b> bb
Length 3	aaa . aba . bbb
Length 4	aaaa . abaa . <b>aabb</b> . baba bbbb
Length 5	aaaaa . abbba . bbbab . bbbbb
Length 6	aaaaaa . aabbaa . <b>aaabbb</b> . bbbbbb
Length 7 and more	⋮

Table 9

Re-Writing Rules for Producing a Simple Declarative Sentence

1.  $S \rightarrow NP \text{ PredP}$
2.  $\text{PredP} \rightarrow V \text{ (NP)}$
3.  $NP \rightarrow \text{Art N}$



S = sentence. NP = noun phrase. PredP = predicate phrase. Art = article. N = noun. V = verb. Rule 2 covers both transitive and intransitive verbs, and for this reason has NP as an optional development. C.f. Chomsky (1965) for a more detailed treatment.

Table 10

The Result of Replacing Groups of Words by Single Words in a Simple Declarative Sentence  
(Based on Miller, 1962)

A sentence				
It			acted	
The	frog		acted	
The	frog	caught		it
The	frog	caught	the	mosquito

Table 11

Sentences	Paraphrases	Non-paraphrases
a. They are buying glasses	_____	_____
b. They are drinking glasses	They are glasses to use for drinking	They are glasses that drink
c. They are drinking companions	They are companions that drink	They are companions to use for drinking

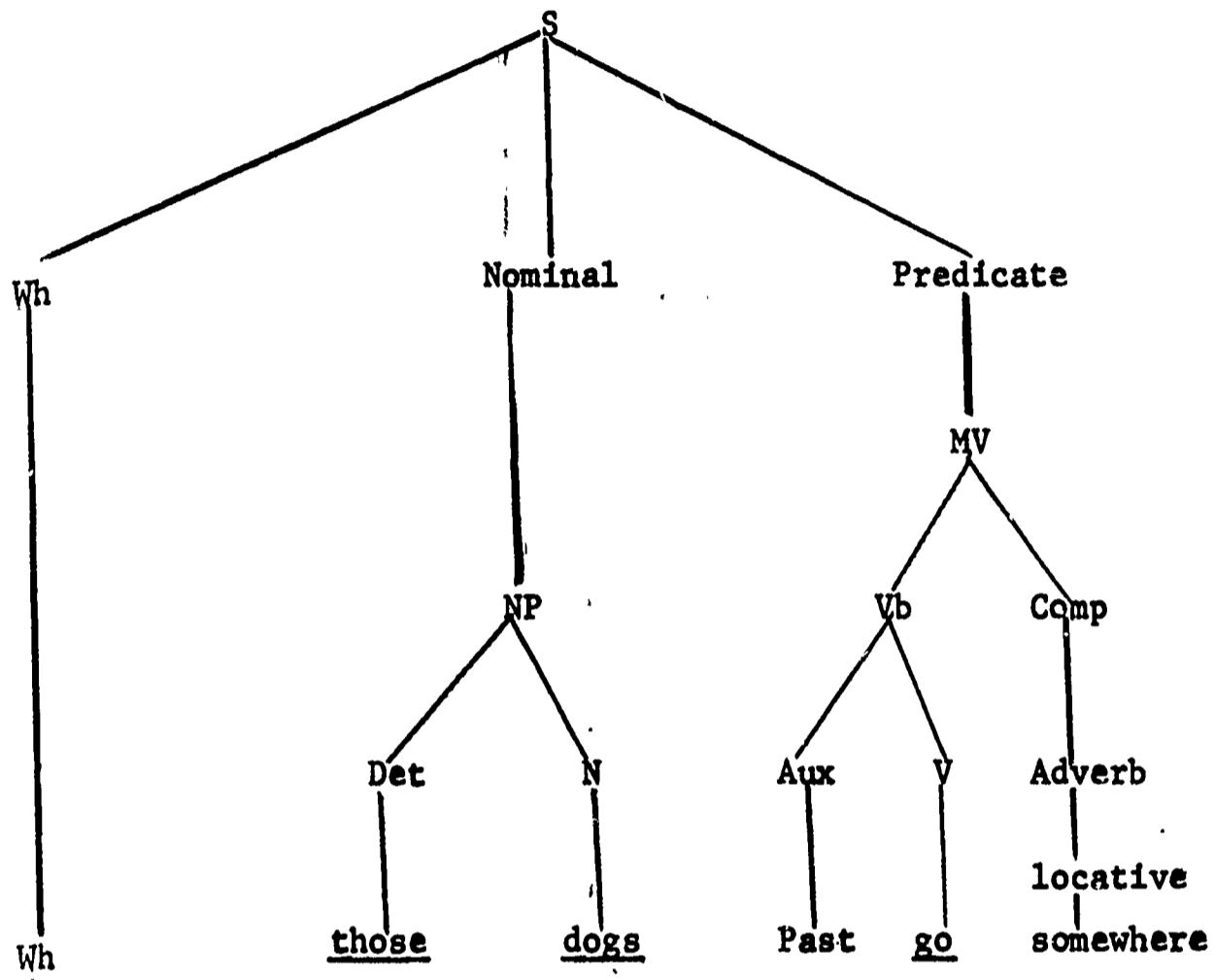


Fig. 1 Deep structure (before application of transformations) of where those dogs went?

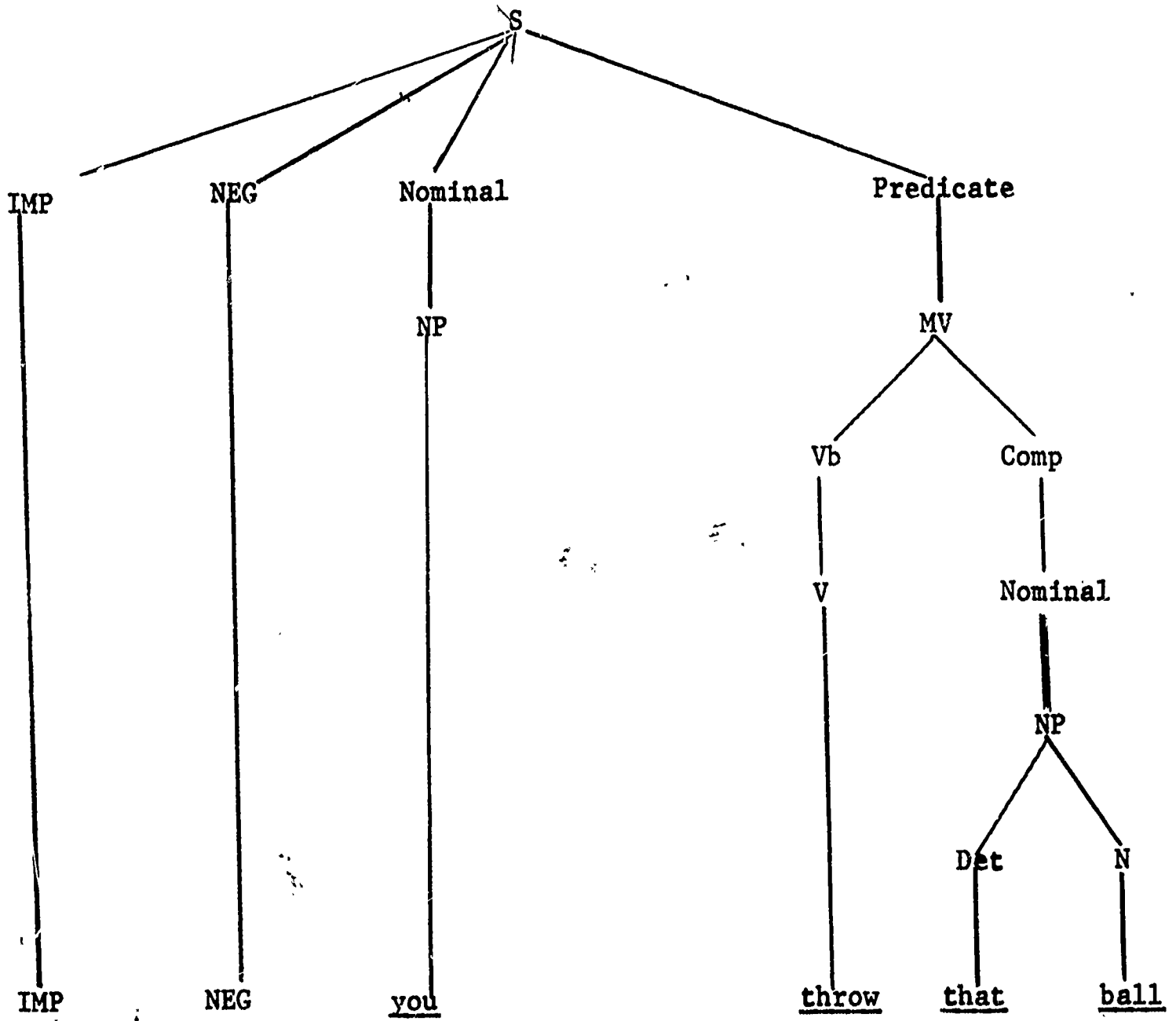


Fig. 2 ((IMP) (NEG) (you) ((throw (that ball))))). Deep structure of Don't throw that ball.



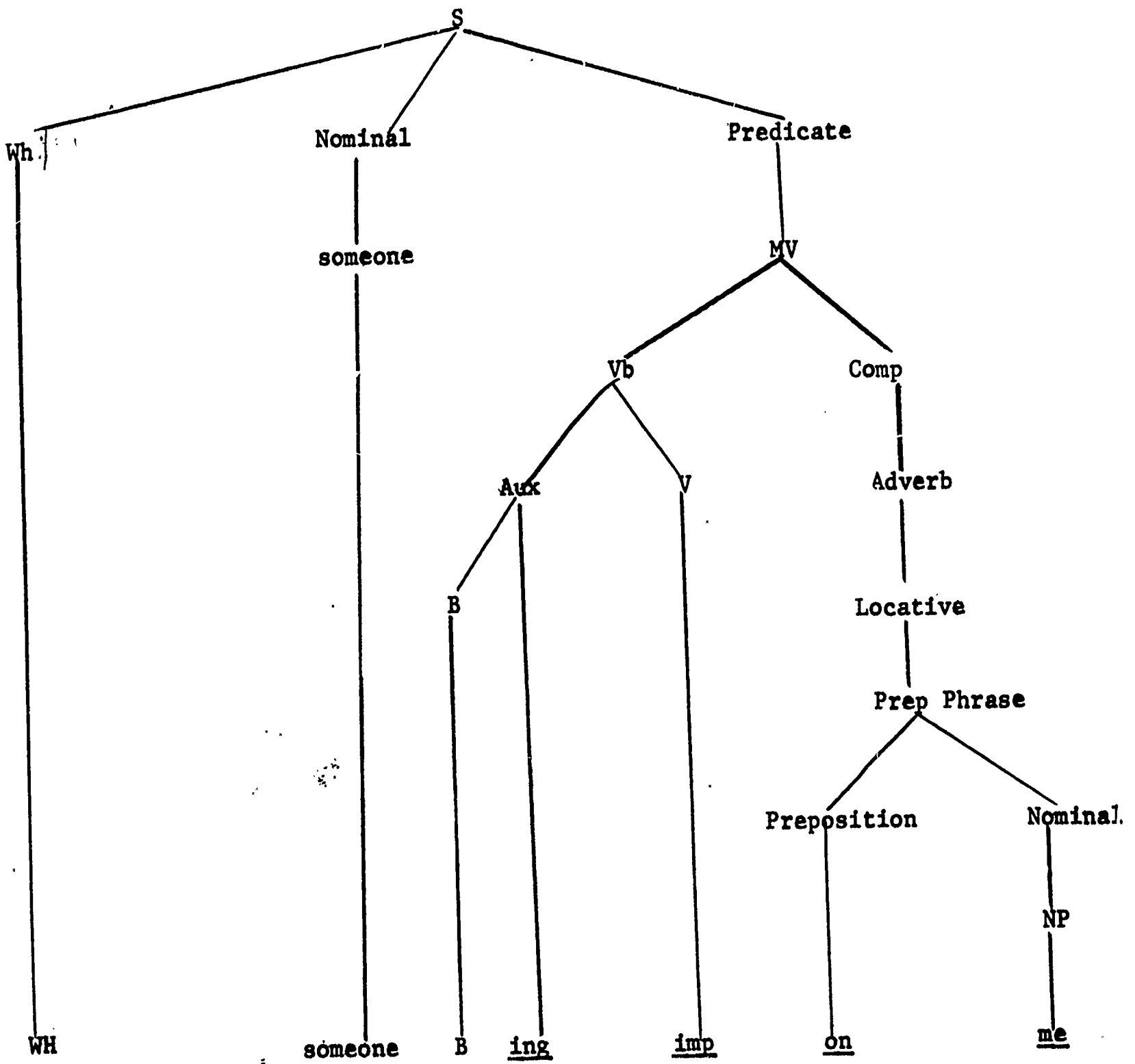


Fig. 3 (WH) (someone) (((B ing) jump) (on me)). Deep structure of who jumping on me.

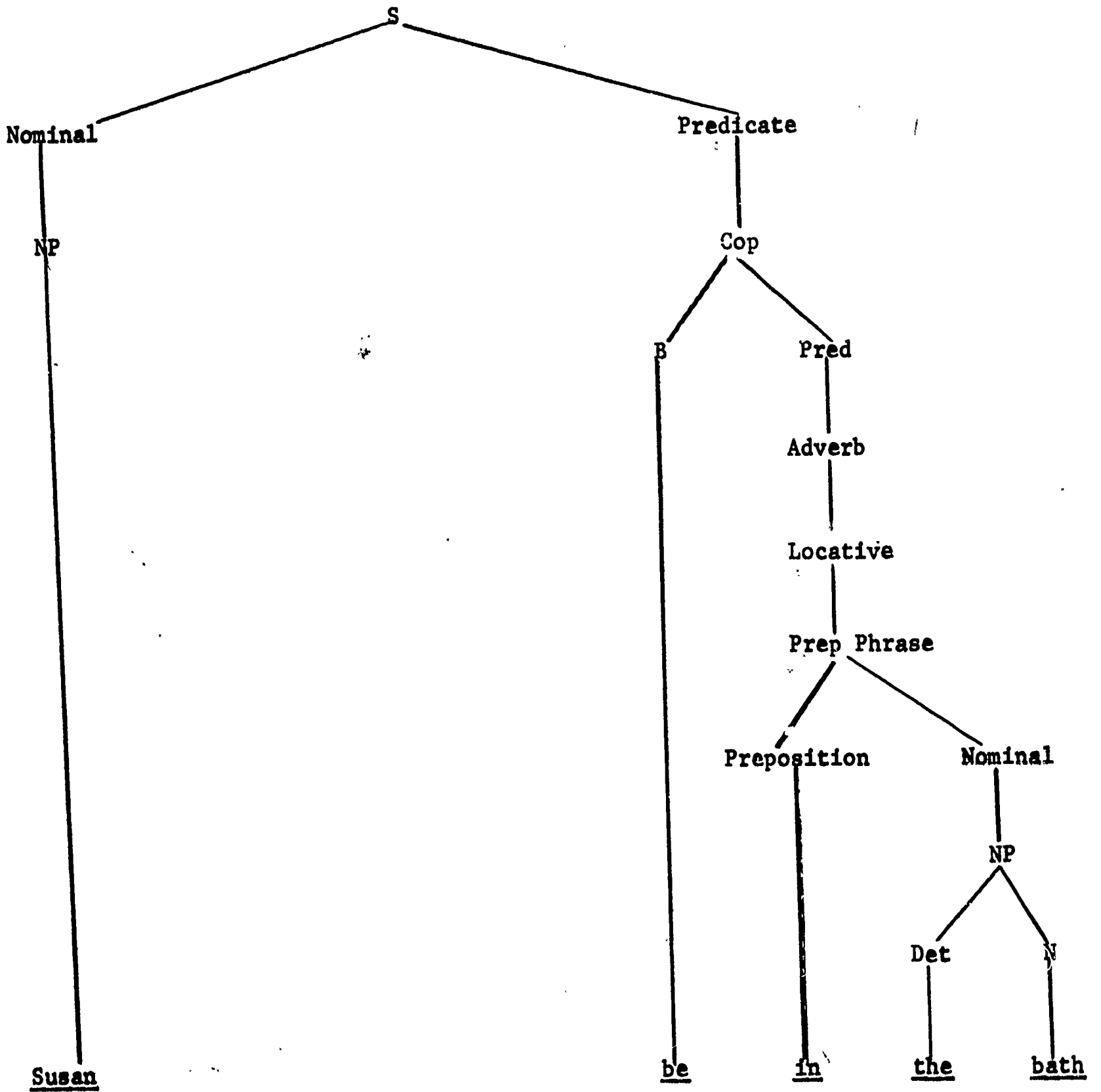


Fig. 4 ((Susan (be ( (in (the bath )))). Deep structure of Susan is in the bath

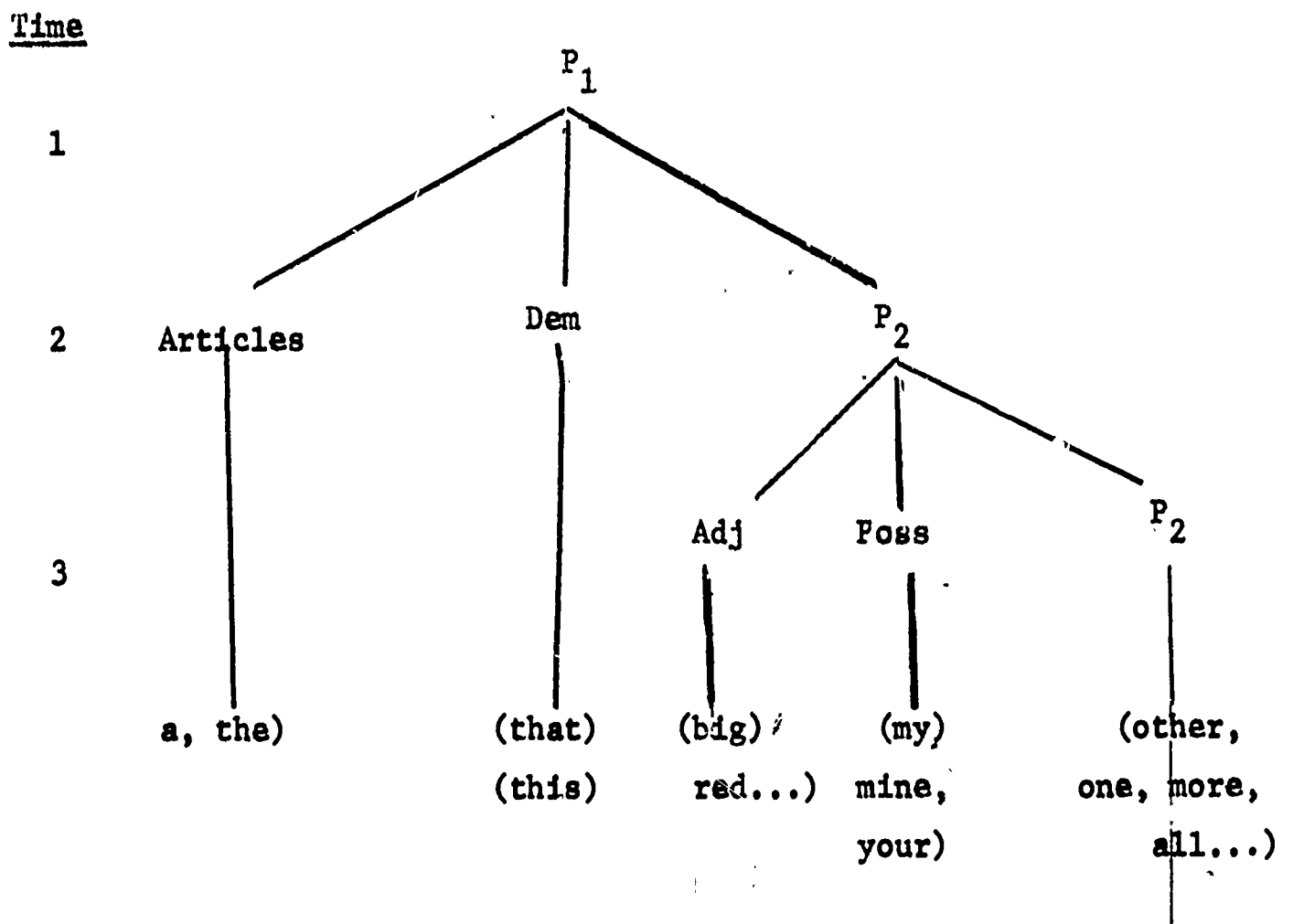


Fig. 5 Differentiation of one child's Pivot class (McNeill, 1966a).

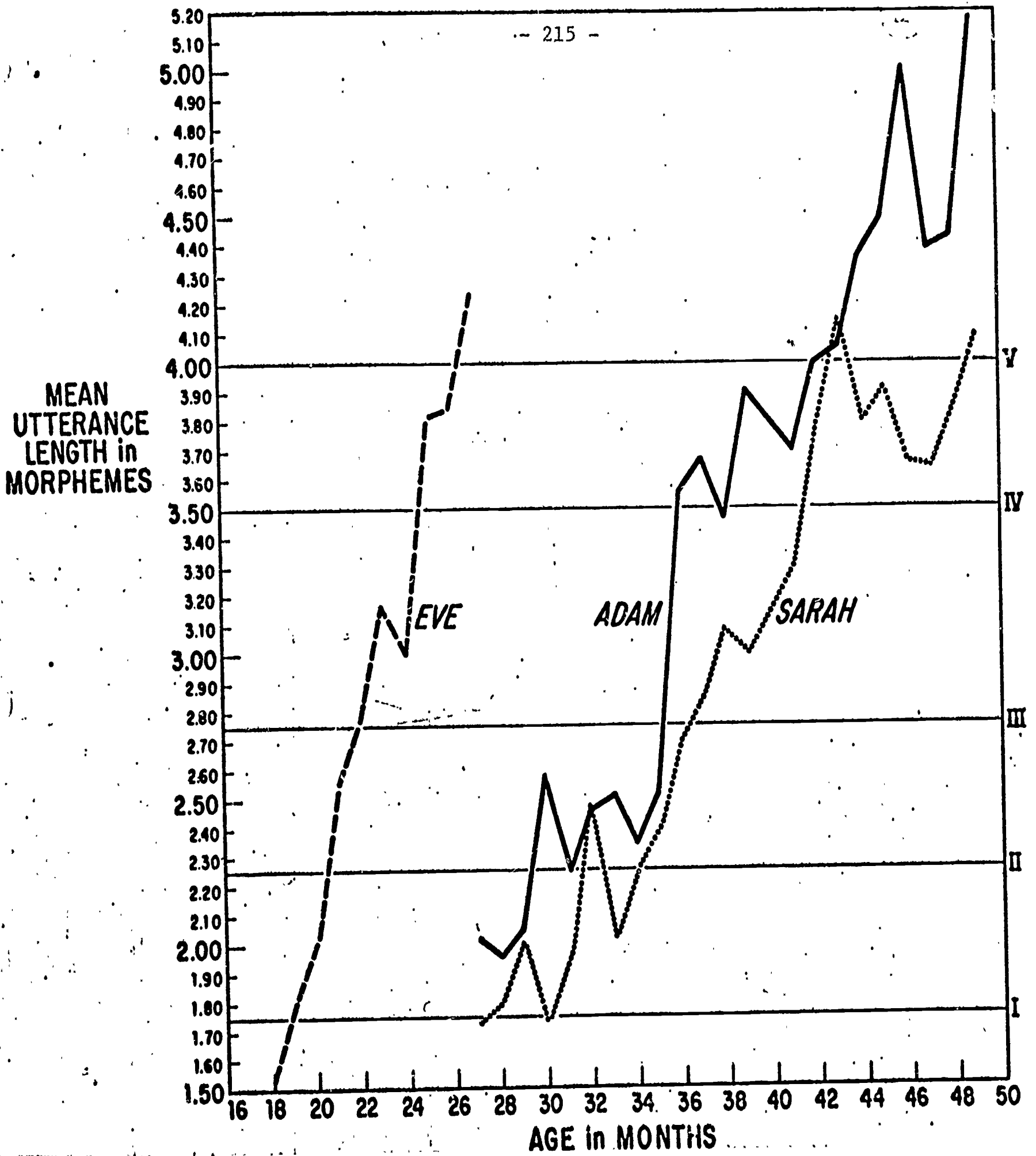


Fig. 6. Mean Utterance Length and Age in Three Children

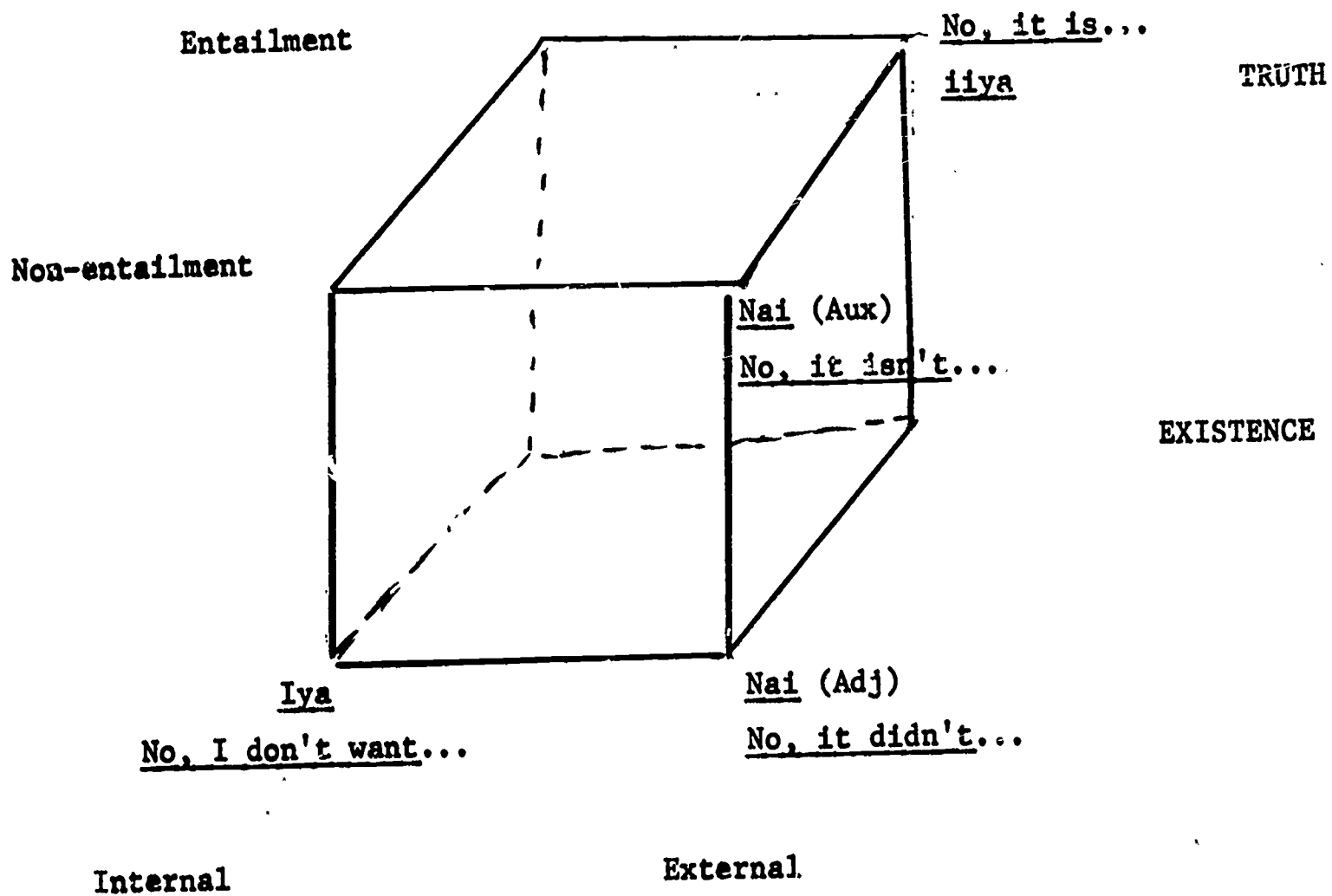


Fig. 7 The organization of negation in Japanese. Negative terms in Japanese and English are located at the appropriate corners. The English examples are merely representative of each contrast: No, it is a pear (and not an apple) versus no, it isn't a pear versus no, it didn't happen that a pear was thrown through the window versus no, I don't want a pear.

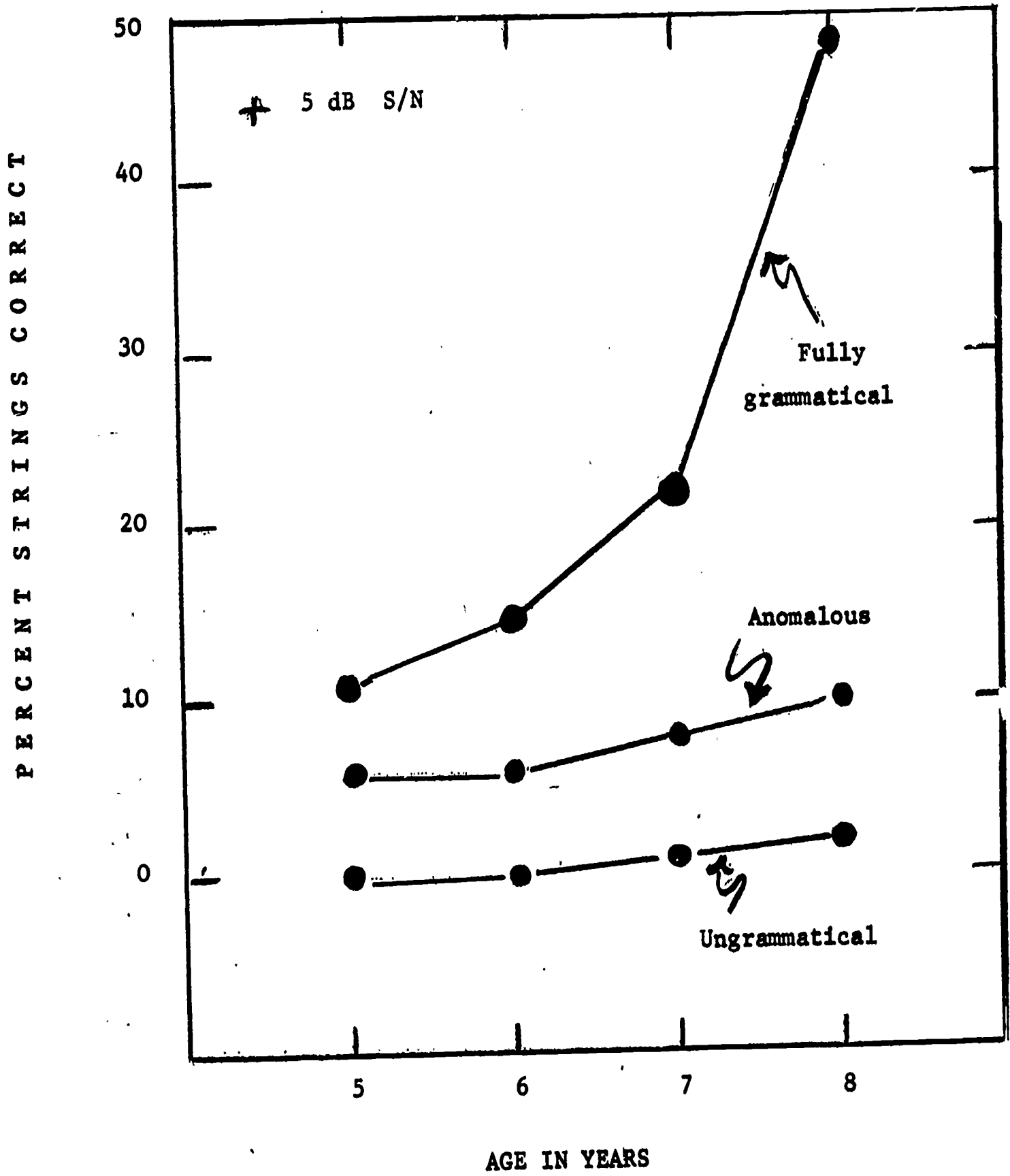


Fig. 8. Percentage of strings correctly recalled by children 5, 6, 7, and 8 years old (McNeill, 1965).

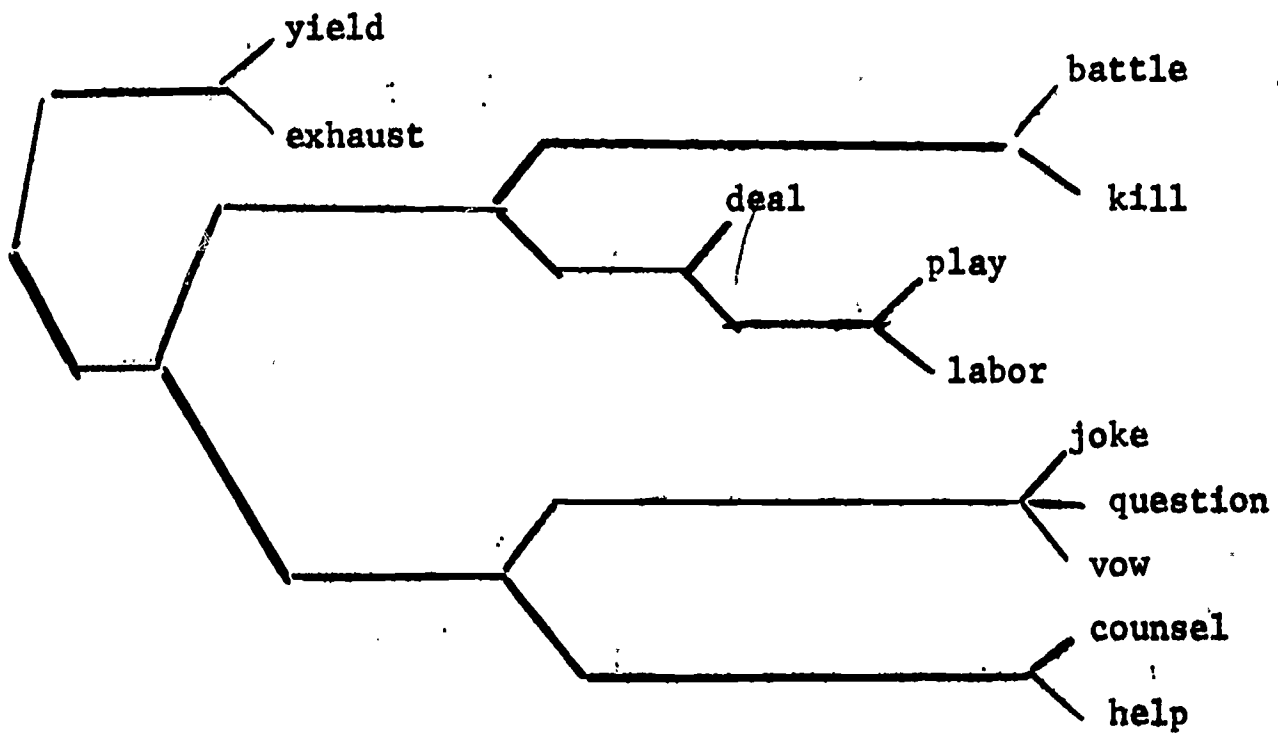


Fig. 9. Cluster analysis of some English nouns; data from adults (Miller, 1967).

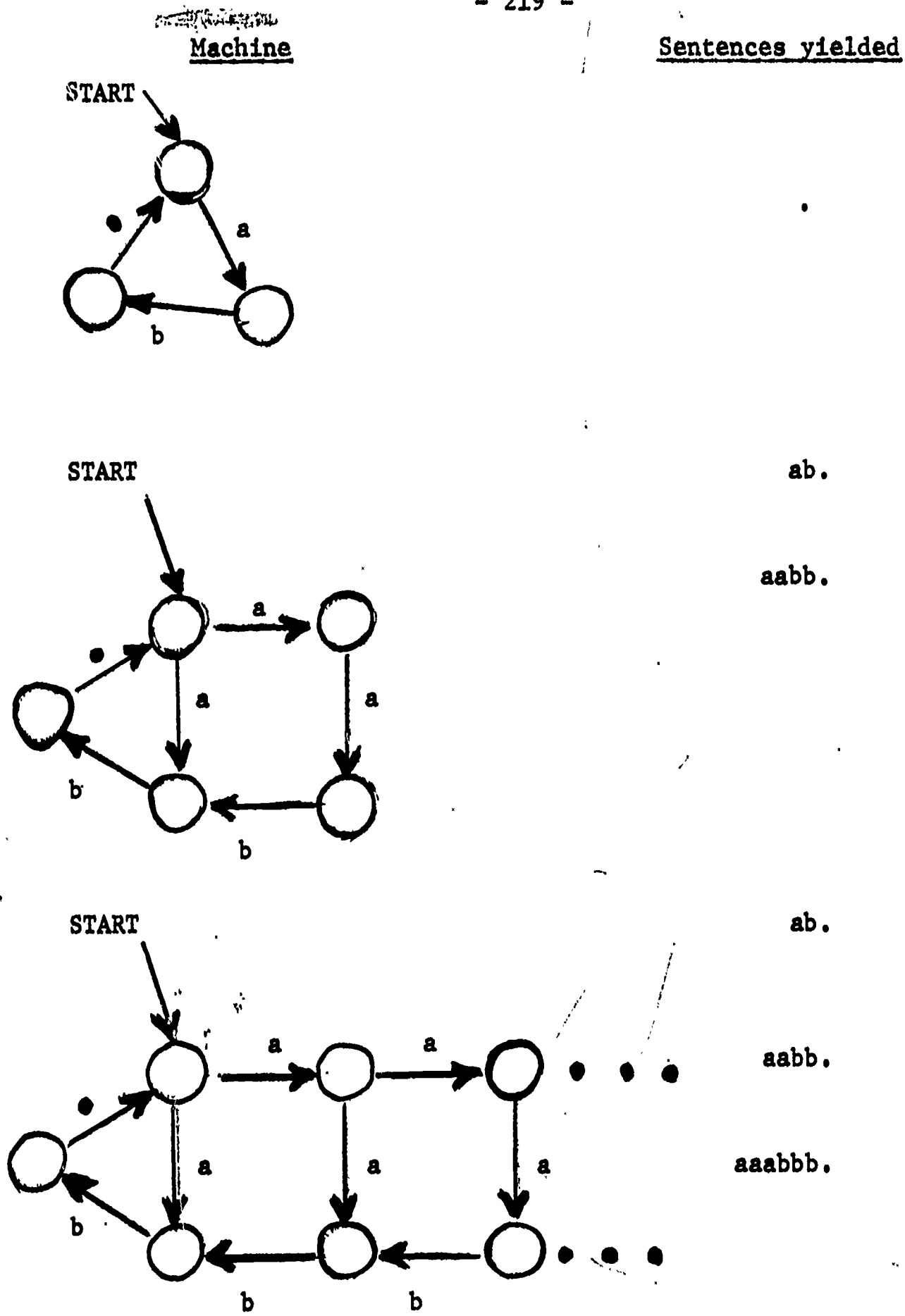


Fig. 10. Finite-state machines.



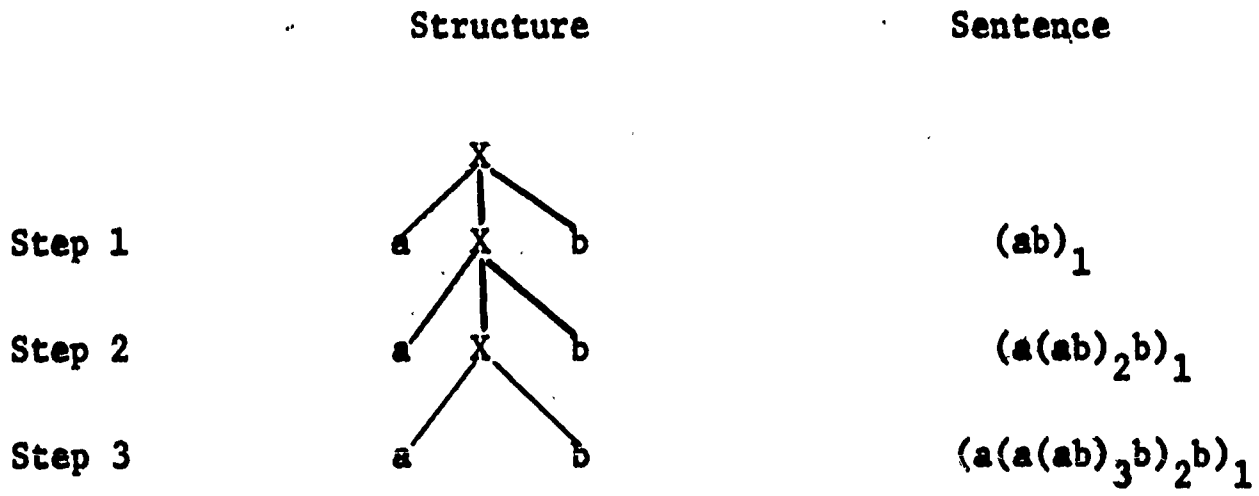


Fig. 11. Generation of aaabbb by phrase-structural rules.

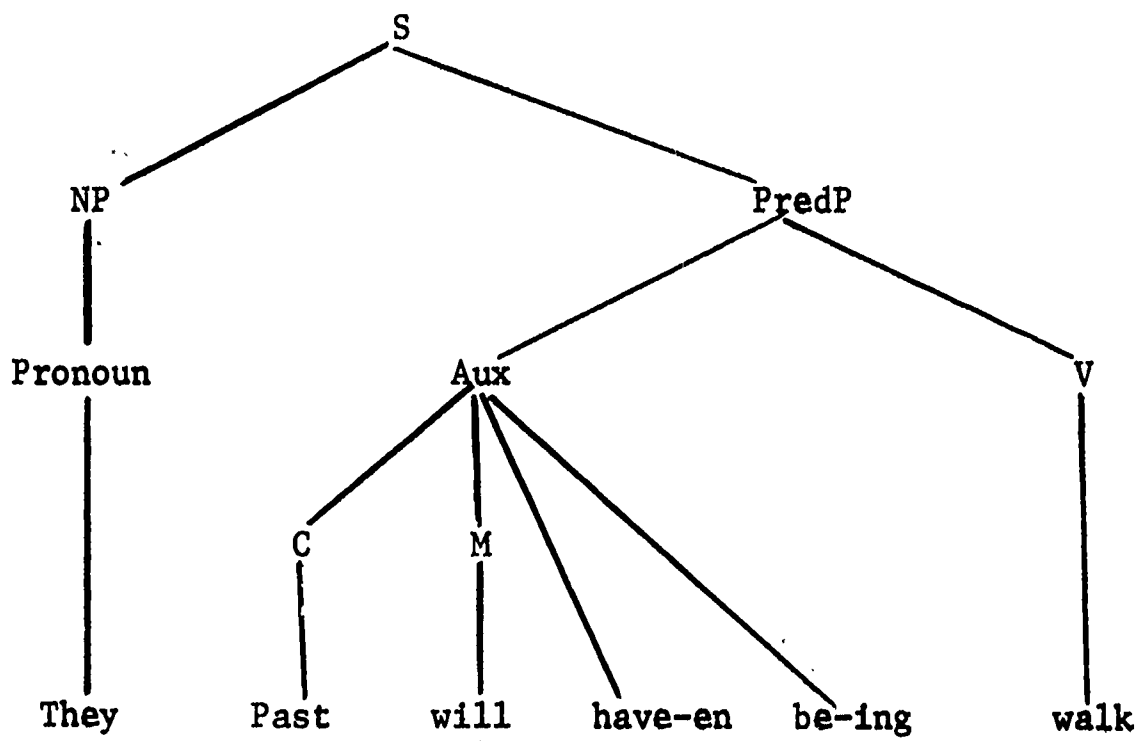


Fig. 12 Deep structure of they would have been walking.

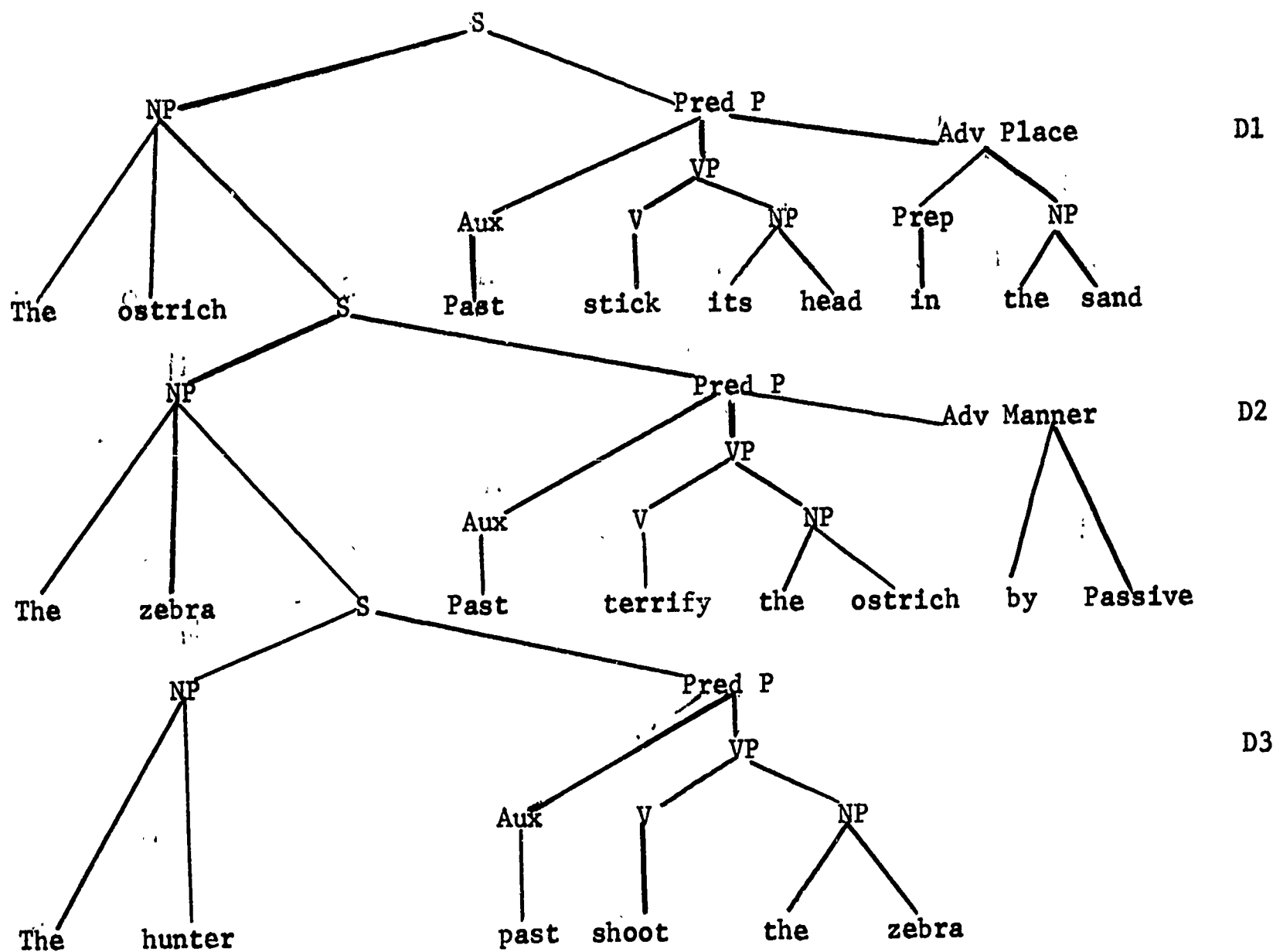


Fig. 13. Deep structure of the ostrich that was terrified by the zebra that the hunter shot stuck its head in the sand.