SYNTAX AND SENTENCE INTERPRETATION[•]

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Linguistic communication is a process whereby two or more individuals may send and receive messages encoded in a human language. A structural unit of these languages is the sentence. A theory of sentence interpretation seeks to explain how skilled listeners routinely interpret a wide variety of utterances encountered in their everyday linguistic activities.

The nature of understanding. An issue that immediately confronts any effort to develop a theory of sentence interpretation is that there are degrees or levels of understanding. My not understanding a request to close the door when spoken in Finnish is quite a different matter than my failure to understand a statement in English concerning some principle of quantum mechanics. Understanding is an open ended dimension; at one end it is fixed firmly upon specific linguistic information and skill, but it unfolds rapidly into a complex web of virtually unknown conceptual abilities and personal experiences.

In casual conversation we normally assume the listener is understanding us unless he questions us or makes an unexpected reply. However, we also know that merely participating in a conversation does not ensure that all participants understand each other—or even care to. In more important discussions or research contexts, one wants evidence that the listener understands the message. Repetition generally will not do. One expects something more, something that indicates some analysis or comprehension on the part of the listener. Of increasing reassurance might be evidence that the listener is able to answer simple questions, formulate reasonable paraphrases, and make plausible inferences on the basis of the utterance. Hearing that Sally is heavier than Sue, a listener who understands knows that Sue is lighter than Sally. After mentioning that I had to return a birthday gift because it was too tall for my livingroom, I can expect listeners to guess that the gift might have been a lamp, a plant, a grandfather clock or even a pet giraffe. Certainly, as readers may varify for themselves, the guesses are not made at random but are based instead on presuppositions on the use of the adjective tall (Limber, 1969) among other things. Indeed, it is the listener's ability to reliably make such inferences that provides an extremely important empirical constraint upon any theory of sentence interpretation.

The focus here is upon the role of syntax in the interpretative process. Hence, it is necessary to restrict the inquiry to those aspects of the message that are carried by the linguistic code itself. This is a substantial and artificial restriction, for it is clear that the interpretation accorded a sentence on any given occasion may vary according to a variety of extra-linguistic parameters. Such things as prior communications, winks, grimaces, gestures, tone of voice, metaphorical extension, and, of course, the pragmatics of reference (Limber, 1976) all contribute to the meaning of an utterance in conjunction with its intrinsic semantic content. We know that the subject of I am sick must refer to the speaker; yet the actual referent of I obviously depends on who the speaker is. An utterance of I'm not very hungry tonight may on one occasion be taken as a reflection of the speaker's hunger; yet on another, as a polite rejection of a second helping of sauerkraut with ginger. It is, therefore, common practice to distinguish between the meaning associated with a sentence on the basis of its linguistic form and an interpretation given to that sentence on any particular occasion of its use. To reinforce this distinction, it is useful to

• Limber, J. (1976). Syntax and sentence interpretation. In R. Wales & E. C. T. Walker (Eds.), New approaches to language mechanisms (pp. 151-181). Amsterdam: North Holland.

say that every sentence in the language has a semantic representation assigned to it by the grammar and a semantic interpretation constructed by the listener on the occasion of every utterance of that sentence.

Sentence interpretation is, thus, a function of the semantic representation of the sentence and the relevant context variables. The semantic representation in turn is computed from the phonological, syntactic, and lexical information available to the listener as a consequence of knowing a language. A theory of sentence interpretation, therefore, must be more than a grammar of a language in the sense of Chomsky (1957, 1965). Rather than just a characterization of the structures of language, it must deal with the psychological processes involved in using that grammatical information. As Chomsky has remarked more than once, a grammar is a model of neither a speaker nor a listener.

Programmatically it is useful to distinguish several stages in the development of a theory dealing with these processes of sentence interpretation: (1) determining the nature of the information a listener must extract from the sentences of a discourse, (2) formulating explicit hypotheses as to how that information might be obtained, and (3) evaluating those hypotheses with the available evidence to ascertain which of potentially many equivalent processes are in fact employed by listeners. Relevant evidence would include the listener's inferential performance as mentioned above, data relevant to the actual on-line processing of sentences, studies of language development, and even results of neurological investigations. Few would deny that at some far off time psychological theories must ultimately be reconciled with physiology. Studies of language development are likely to prove of more immediate benefit, because any prospective sentence processing model must be learnable. Moreover, it is not unreasonable to suppose that features of the interpretation process which are obscured in the skilled listener may be more transparent during their development. I shall come back to this point at the close of this discussion.

On the neglect of syntax. Until quite recently, psychology had ignored syntax even more than it did other aspects of language. From the time of Descartes through the behaviorism of the 1950's, few psychologists actively treated human language as a serious problem for psychology. There are a number of reasons for this neglect. While Descartes viewed language as one of the most important human behaviors, he saw it merely as a reflection of human thought or reason, and on many occasions he remarked to the effect that it would take very little effort for anyone to invent language and indeed if animals had any reasoning capacity at all, they too would use language. Influencing Descartes was the fact, egocentric to humans, that one's first language is learned and generally used without conscious effort by all humans, including the dumb, stupid, and insane. For Descartes, as for William James and many other psychologists, conscious activities were of foremost interest. James, for example wonders, in the opening of his Principles (1890) whether machine-like activities such as piano-playing, buttoning, or talking belonged within psychology. Of course, one of the basic features of language processes is its automatic nature, its inaccessibility to introspection. The behaviorists, on the other hand, saw no reason to treat human language any differently from other behavior. Why study something as messy and complex as language, when the same underlying principles of behavior can be obtained from simpler creatures in controlled situations?

Those few who did deal explicitly with human language seldom went beyond what Fodor, Bever and Garrett (1974) have termed the "naming paradigm" of language, the view that the learning and using of a language is the learning and using of names for things. When anyone did venture into language structure beyond associative or probabilistic structure, typically it was in connection with the analysis of a narrow class of constructions such as yellow wall, sincere prostitute, Tom is a thief, or colorful ball. Not surprisingly, it was primarily among those individuals with an applied interest—professional linguists, language instructors, missionaries, and students learning a second language—that a respect for the complex structure of human language developed.

The discovery of syntax. The recognition of the theoretical importance of syntax in human language arose from two sources during the 1950's; namely, the rapid development of digital computers and the work of Noam Chomsky (e.g. 1955, 1957). Computers had a dual influence. On one hand, the development of high level programming languages entailed increasingly complex syntactic processors; on the other, the availability of these machines fueled the hope of devising an automatic language translator that could translate from one language into another; for example, from Russian into English.

These developments were not unrelated. Chomsky's work (1959a, 1959b) on formal grammar was recognized as an important contribution to the growing field of computational linguistics while Chomsky himself was connected for a time with a machine translation project directed by Victor Yngve at M.I.T. Both computer applications and Chomsky continue to have a powerful impact on the psychological study of language processes, and syntax in particular. Chomsky not only constructed a formal theory of human language structure, he argued persuasively that linguistics actually was part of psychology. In addition he effectively challenged the relevance to the study of human language of the then dominant behaviorist paradigm.[1]

Syntax and Psychological Processes

In Syntactic Structures Chomsky suggested that the process of sentence understanding might be reduced to the problem of explaining how the underlying component sentences (then kernels) were understood, these basic sentences of everyday usage were formed. At the same time, he was careful to point out that his model of human language had no direct implications for the processes of either producing or understanding sentences, beyond characterizing the nature of linguistic structure. He has reiterated this admonition against considering a generative grammar as either a model of the speaker or listener in almost every later publication. A particularly detailed consideration of this matter may be found in Chomsky (1961), wherein he distinguishes clearly between the grammar G_I of some language and a function g, such that g (i, n) is the description of a finite automaton that takes certain of the sentences of the language as input and gives structural descriptions assigned to these sentences by G_I as output, and where n is a parameter determining the capacity of the automaton. That the automaton accepts only some sentences and not others is no more surprising than the fact that an individual who has mastered the rules of multiplication may be unable to calculate 3,872 x 18,694 in his head. Naturally one would expect that as n increases, the automaton will be capable of understanding, in the appropriate sense, more and more of the sentences of generated by G_1. Thus, while psychologists may well be puzzled as to the psychological relevance of the grammar, G_I, it is without question not a performance or process model like the automaton g_I, of which Chomsky has little more to say.

It is well known psycholinguistic history that Chomsky was not taken very seriously on this matter. The earliest influence of Chomsky's work that I know of is found in a paper by Goodglass and Hunt (1958). There the derivational history of a sentence is utilized as a metric for the complexity of certain psycholinguistic processes. Within a few years, psychologists looking for alternatives to associative or probabilistic structure had turned to syntactic structure. G. A. Miller's (1962) paper was perhaps the most enthusiastic and influential in this regard. A number of very similar psychological models incorporating a generative grammar came under

[1] Chomsky's (1959) criticisms of B.F. Skinner's speculations in Verbal Behavior were not only directed to Skinner's radical behaviorism, but also to any behaviorist or empiricist account of the nature of higher mental processes. As he remarks in a reprint of that review, Skinner's work was selected only because it was the most carefully thought out presentation of the empiricist position available (Jakobovits and Miron, 1967).

experimental investigation. Common to all of these models was the hypothesis that grammatical complexity—some formal index of linguistic structure—should predict processing difficulty. In one version, it was suggested that for every operation in the grammatical derivation of a sentence, there must be some corresponding mental operation involved in actually understanding that sentence. This came to be known as the derivational theory of complexity (DTC).

Despite some initial success, experimental efforts to demonstrate the psychological reality of grammar grew less convincing as a wider range of sentence types were examined. By 1966, Fodor and Garrett, in a review of the research up to that time, suggested an alternative proposal which they believed more compatible with the evidence than DTC. They proposed, in essence, that it was the "structural description of a sentence (including the specification of its base structure) but not the grammatical operations generating it, that was psychologically real."

That proposal was developed further in Fodor and Garrett (1967) and Fodor, Garrett, and Bever (1968). They suggested that listeners use a variety of surface structure cues to segment the sentence into clauses and to identify the main verb, which serves as the primary clue to the deep structure underlying the input. In other words, the grammatical organization of the input is dependent on heuristic procedures that assimilate the remaining surface structure elements to the appropriate deep structure "frame" associated with the verb of the clause.

I shall not take the time here to review the empirical evidence for and against either DTC or the Fodor, et al. proposals. Recent reviews are to be found in Greene (1972), and Fodor, Bever, and Garrett (1974). Instead it is worthwhile to take a closer look at the logic, such as it is, of these conceptions of the automaton, g, and their relation to the grammar, G.

The derivational theory of complexity has its most explicit realization in the context of an analysis by synthesis (A by S) model of speech perception (e.g. Chomsky, 1961; Matthews, 1962; Katz and Postal, 1964; and in particular, Halle and Stevens, 1964). In this model a sentence is recognized or understood when an acceptable match is obtained between some representation of the input signal and a synthesized, internally generated comparison signal. The grammar is explicitly employed as a source of these internally generated signals or structures. The representation of a recognized input sentence is determined as a joint function of the analysis done on the input and the structural description of the internal comparison signal at the time of a successful match.

One can imagine the A by S model operating along a continuum from extreme synthesis to extreme analysis, with a comparison possible at any point on that continuum. Extreme synthesis would involve generating a complete signal from the top down; that is, synthesizing the grammatical structure before selecting words and finally matching a completely synthesized sentence against a relatively unanalyzed representation of the input string. Extreme analysis, in contrast, would involve analyzing the input representation from the bottom up; that is, selecting words before grammatical categories and structures.

Extreme synthesis is surely a preposterous model of sentence recognition since no external constraints are placed on the recognition process until the synthesis is completed. In other words, no information about the input signal is utilized in the process of generating the comparison signal. Matthews (1962) estimated that a random synthesis of a given English sentence could take up to 10^{12} seconds, even with a priori constraint that no sentence could be more than 20 words in length. Extreme analysis, on the other hand, immediately takes the input signal into account and involves creating an increasingly abstract description of that input, applying the grammatical rules in reverse, as it were. It was recognized even in the first papers discussing the A by S model that powerful heuristics must be available to make rapid use of the input signal in order to constrain the synthetic component.

The question is, with respect to DTC, what possible A by S model or models could lead to the expectation that sentence complexity is a function of grammatical derivation? The extreme synthesis, top down model, might lead to this expectation just on those occasions when it came up with a successful match between its synthesized comparison signal and the input. But, of course, for every successful comparison there will be a number of unsuccessful ones. Thus, the expected value of any dependent variable, say processing time, must include a component for those syntheses that do not match but nevertheless contribute to overall complexity. Going into the dependent measure, whatever it is, will be the contributions of all grammatical operations conducted, whether in the derivation of the successful comparison signal or in those of the multitude of unsuccessful ones. This interpretation of DTC can scarcely be taken seriously.

The analytic, bottom up version of DTC does not fare much better. It is true that one could expect grammatical derivations to predict complexity if all that were involved were running the derivation backwards; that is, applying the grammar inversely, beginning with the input signal and concluding with the base structure. But remember that even in a grammatical derivation of any sentence, more is involved than simply applying a sequence of rules; some determination must be made of which rules to apply. Every phrase—structure rule option, every transformation—optional or obligatory—must be consulted in some manner in the derivation of every sentence. The same must be true for any inverse application of the grammar in DTC. The structural index of conditions on application for every rule must be consulted and the current input structure examined with regard to each rule, regardless of whether that rule ultimately is applicable. There is absolutely no justification to suppose that the computations determining the application of a rule are negligible with respect to some dependent variable and that only those rules which actually do apply contribute to complexity. Indeed it is likely that, in any existent real time computational system, determining applicability of a rule would frequently be far more difficult than applying that rule.

One is led to conclude that the entire DTC episode in psycholinguistics was an ill thought-out affair. Anyone can verify for himself the lack of explicit justification for the conclusions drawn from the various experimental studies of that era, i.e. that grammatical operations, rather than a host of other factors (see Fodor et al., 1974), were responsible for the obtained results. Nevertheless, most DTC studies that were published after Yngve (1960) and Chomsky (1961) had explicitly raised the very plausible hypothesis that certain grammatical rules served to reduce psychological complexity just ignored that possibility.

The Fodor and Garrett (1966) empirical critique of DTC, along with their alternative proposal, pretty much marked the end of DTC, which was already the subject of considerable skepticism, particularly in light of recent revisions within linguistic theory (Chomsky, 1965). One important consequence of all this was to resurrect the question of the relationship between a grammar formulated according to linguistic guidelines and the process models required by psychological theories. The Fodor and Garrett (1966) proposal on the reality of structural descriptions hardly clarified matters, as it was open to several interpretations. One of these is incomprehensible in that, strictly speaking, structural descriptions cannot be divorced from the rules that generate them. In all likelihood what they were suggesting is that only certain of the structural descriptions generated by a grammar were of psychological interest; in particular, features of the base and surface structures. But this is to suggest that much of a grammar, G, is irrelevant for a psychological model of sentence processing and that any notation capturing the appropriate relationship between the phonetic representations of a sentence and its interpretations will suffice to provide the necessary empirical constraints upon a process model of interpretation. A similar conclusion was reached earlier by Katz and Postal (1964) in their evaluation of analysis by synthesis models of recognition.

It would be inaccurate to conclude that the early studies involving syntactic variables had no positive results. Of immense importance is the fact that psychology no longer could treat language as a collection of words or names for things. Structure among words now meant more than associative overlap, and syntax was more than an autoclitic response. Sentences were recognized as a major unit in language behavior, having complex rule-governed hierarchical structure.

Process models of syntactic analysis. In his discussion of sentence comprehension, Garrett (1974) points out that there are two major lines of attack on the question of how listeners assign structural analyses to sentences. One approach has been to investigate sentence comprehension experimentally, in the hope of establishing a set of constraints on the character of information processing routines that accomplish the task. The other has been to attempt to specify in detail computational routines or process models that will take as input the information represented in a string of lexical items and yield a syntactic description of the string.

Algorithms that appropriately interpret a string of symbols in accord with the syntax of the language are, by definition, a necessary component of any computer programming language. The early work in machine translation quickly revealed extraordinary differences between artificial computer languages and natural human languages.

These efforts at machine translation foundered in large part upon the onmipresent ambiguity of natural languages, not to mention the semantic problems (Bar Hillel, 1964; Yngve, 1964). It comes as no surprise then that lexical, structural, and coreferential ambiguities, which abound in every day speech (Garrett, 1974), also plague models of human sentence processing. As listeners we only occasionally become aware of an ambiguous utterance; yet any algorithm for the syntactic analysis of sentences (i.e. any parsing procedure of recognition grammar) must contend with alternative analyses at many points within each sentence. For example, in the DTC era, much was made of the fact that in a number of experimental paradigms, passive sentences proved more difficult than their active counterpart. This was taken as evidence for the DTC since passive sentences had additional steps in their grammatical derivations. Yet from the perspective of any processing model of English, passive sentences have a local ambiguity or choice point at the by NP phrase. The algorithm must be able to decide whether that phrase indicates a passive agent or one of the other vexing prepositional phrases in English. In many cases these local ambiguities may be disambiguated by nearby context. But in many others the local ambiguity translates into a global ambiguity; that is, each alternative will result in a valid analysis for the input string, as in (1). Notice that this

(1) The stolen gems were found by the fence.

particular complexity of passive sentences is simply a coincidence, as far as any grammatical rules are concerned. The complexity of (1) indexed, say, by response latency to a question about it, is a function of the ambiguous structures permitted by the by NP (passive vs. locative) and by the close associations among the words gems, steal, and one sense of the ambiguous fence.

The passive example reiterates a general point made above with regard to DTC. Complexities attendant to the syntactic processing of a sentence may be wholely unpredictable from the grammar, G. Instead complexities are a function of the particular decision procedures and priorities implemented in the syntactic processor.[2] A processor that awaits all input from a sentence before beginning analysis will behave quite differently from a processor that begins an immediate left to right analysis. A depth-first processor that follows only one path at a choice point will behave differently from a breadth-first one that attempts to compute all paths encountered simultaneously.

It is evident that certain of the many possible realizations of a grammar will be more in line with a psychological model of the listener than others. Th early developers of syntactic analyzers for natural language had little concern for the psychological implications of their

[2] There is much more to it than this. Computational complexity depends ultimately on the actual method and mechanism by which the computations are effected. Any inference from a logical analysis of a computation to the values of physical indices of complexity must not overlook this fact. Consider estimates about the relative complexity of common arithmetic computations, e.g. addition vs. division, without knowledge of whether an abacus, electronic calculator, or slide rule is employed.

programs: they were concerned with efficiency in such endeavors as machine translation, testing grammars, or man-machine communication within very restrictive subsets of language. A program devised by Thorne, Bratley, and Dewar (1968) was perhaps the first program specifically intended to model the syntactic analyses required of a listener.[3] Their program analyzes an input sentence word by word, left to right, in a single pass. One of the more interesting features of that program is that it does not require accesses to a complete dictionary of English. Instead it successfully analyzes the structure of a wide variety of English sentences on the basis of a representation of a grammar in the form of a directed graph and a closed class dictionary of several thousand grammatical formatives, including inflections, along with a small number of verb classes. Obviously this is not offered as a complete model of sentence interpretation, but only as a model for syntactic analysis of a surface string into its base structure (Chomsky, 1965).

Thorne et al. (1968) reject a dictionary lookup for every work for pragmatic and theoretical reasons. It is their argument that looking up each word individually complicates the analytic process rather than simplifying it since nearly all content words are ambiguous as to form class, not to mention their multiple senses within a class. One implication of their proposal is that listeners use syntactic information in order to obtain the appropriate sense of a content word such as run, iron, or play. In other words, a listener does not retrieve the appropriate information for a given phonological form as an isolated unit, but under a specific syntactic description computed from the syntactic context. A further implication of this proposal is that an individual learning a language can use the syntactic analysis to derive meaningful information about a previously unknown word form from its syntactic context. This is consonant with the fact that there is frequently a non-negligible correlation between syntactic distribution and meaning (Limber, 1969) and also with the observation that children have difficulty interpreting sentences with words such as easy, promise, or ask, which in certain constructions go against well established syntactic generalizations regarding grammatical relationships (Limber, 1973).

Their analysis procedure constructs a diverging tree structure with nodes labeled in terms of "syntactic relations", e.g. subject, passive verb, complement, and important high level grammatical categories, e.g. statement, question, infinitive clause, etc. This construction process is predictive in that all options possible at any point are investigated. A completed path through this tree is essentially the recognition and analysis of a given sentence in terms of its base structures and associated lexical items. At an ambiguous choice point all paths are computed simultaneously. The relationship between the transformational grammar on which Thorne et al. based their analyzer and the analyzer program itself is not an obvious one. For instance, grammatical relations are not defined in terms of constituent structure but as labels on nodes associated with certain surface formatives. Similarly the effects of certain transformations in the grammar appear to be represented by labeled nodes; directly entailed by specific surface configurations (e.g., passive verb). What is preserved from the grammar is primarily the base structure information associated with particular surface structures. The intermediate structures, even much of phrase structure within major constituents, are not expressed.[4]

For the most part, the Thorne et al. program is an explicit realization of the Fodor and Garrett (1966) proposal. Only base structure information from a grammar is psychologically

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[3] It is clear that Yngve had given the matter considerable thought in connection with his machine translation work. Hockett (1961) proposed writing a grammar from a listener's perspective. The countless syntactic analysis programs written in the 1960's were to my knowledge, not explicitly devised as psychological models.

[4] The significance of such structures, including surface constituent structures, is unclear. Linguists appear to assign structures within major constituents; e.g., S, NP, VP, on the basis of their theories, rather than on a direct empirical basis. Experiments purporting to demonstrate surface constituent structure are hardly unequivocal within clause boundaries.

relevant. It is only a superficial difference that Fodor and Garrett (1966) emphasized the importance of lexical information associated with verbs since the Thorne, et al. program also includes complement-taking verbs in its dictionary.

Hence, it is somewhat surprising that the Thorne, et al. syntactic analyzer did not receive more attention with psycholinguistics. Recent texts for example, Fodor, Bever, and Gaarrett, 1975; Glucksberg and Danks, 1975; make no mention of that work. Their basic notions have been kept alive, however, within the artificial intelligence community. Bobrow and Fraser (1969) and later Kaplan (1972), in particular, presented a model intended to capture a number of generalizations about human syntactic analysis (cf. Bever, 1970). Kaplan's model, an augmented recursive transition network (ATN) based on that presented in Woods (1970), has several objectives. Like the models discussed thus far, it seeks to analyze an input sentence in terms of its base structure components. Kaplan also suggests that an adequate model must process strings in an amount of time proportional to that required by human speakers and that any model should discover and process anomalies and ambiguities as listeners do. In its psychological implications, Kaplan's model differs from the Thorne, Bratley, and Dewar model in that it conducts depth-first analysis, and, consequently, has different predictions for the analysisof ambiguous sentences. It also seems that the Kaplan model requires much more lexical subcategory information than the Thorne et at. model. Unfortunately, from their respective program descriptions, it is difficult to determine the consequences of this different data base with respect to either performance or psychological significance.

One of the most important features of ATN and related program models is that they provide a medium for representing and explaining a wide variety of facts about the psychological processes of sentence comprehension, particularly the consequences of the interaction of a number of factors. Many generalizations about performance can only be captured in a model of performance in contrast to the objectives of a grammatical description. For example, both the Thorne et al . and the Kaplan programs provide an index of complexity in terms of the number of nodes constructed (arcs attempted, in ATN jargon). Recently Wanner, Kaplan, and Shiner (1976) reported several experiments reasonably in accord with complexity predictions from Kaplan's ATN program. Those predictions derive basically from the path choice made at certain local ambiguities in a depth—first, backup analysis. Clearly the number of arcs attempted—and consequent predicted complexity—will be greater for those sentences where the first choice was a deadend garden path.

There are other computer models frequently mentioned in connection with psychological models of comprehension, particularly those of Winograd (1972) and Schank (1972). Most of these appear to be of little interest here. The Schank model explicitly denies the importance of syntax and need detain us no longer. The Winograd model, on the other hand, is explicitly concerned with syntax, yet makes no discernible psychologically relevant claims beyond the well taken point that ultimately syntax must be linked to a semantic and cognitive system. Yet the simple block world to which Winograd's system is coupled, along with its corresponding simple syntax has few implications for human sentence processing (cf. Petrick, 1974).

Interpreting Complex Sentences

One can achieve considerable insight into the various problems surrounding a theory of sentence interpretation by going directly to the complex sentences of a language. These multi-clause structures, typically having two or more verbs in their surface structure, provide most of the hurdles for current linguistic and psycholinguistic theories. There are a number of very good reasons for focusing on complex sentences rather than simple sentences. First off, the projective or creative aspect of human language is reflected in our ability to formulate new and appropriate linguistic expressions for concepts that we previously may have never experienced. This is accomplished in English primarily through the use of complex nominalizations (Lees, 1960), particularly complement clauses and relative clauses. Complex sentences of all varieties, complement, relative, and assorted conjunctions, are common features of everyday speech. Even in the most informal interpersonal communication situations, where the need for referential power is at a minimum, 20 to 30% of all sentences may be complex. Similarly between 5 to 15% of all sentences produced by children between 2 and 4 are likely to be complex (Limber, 1976). Many of the things we talk about daily cannot generally be referenced other than by using complex expressions.

Interpreting complex sentences is generally a routine affair, accomplished with no conscious effort. It is perhaps instructive to take a look at a nonroutine complex sentence. Consider the example (2) which, I submit, is a

(2) The player kicked the ball kicked him.

perfectly good English sentence. In fact (2) represents at least two sentences. Despite the fact that (2) is only a two clause sentence, fewer than 3 of a hundred fluent English speakers are likely to interpret it correctly.[5] Close to 40% or more will report—with puzzlement—upon hearing that sentence in isolation, that they heard something to the effect that "The player kicked the ball and the ball kicked him." Another 20% may report hearing "The player who kicked the ball, kicked him." The remainder of the one hundred will report a variety of related fragments or incomprehensible paraphrases. What is it about (2) that precludes its correct interpretation, when its structurally identical and semantically similar counterparts (3) and (4) are accurately

(3) The player thrown the ball kicked him.

(4) The player kicked the ball thrown him.

paraphrased by at least several times as many listeners? Furthermore, when the structure is explained to listeners, (3) and (4) are comprehended immediately while (2) continues to puzzle many of them.

On almost anyone's theory of sentence processing there are reasons to expect (2) to be complex. The basic difficulty is that much of the normal redundancy as to the grammatical organization of the sentence has been removed. Although the listener can easily assign the correct grammatical categories to the input string as <u>NP VP NP VP NP</u>, segmenting those constituents into the proper clauses and determining the relationship between the clauses presents a problem. A primary source of the difficulty of (2), in contrast to (3) and (4), is the ambiguity of the –<u>ed</u> inflection, which may indicate either a passive verb or a past active form. Notice that in (3) and (4) the verbs of the main and subordinate clauses can be discriminated by the contrast between the –<u>en</u> and –<u>ed</u> inflections. The perceptual consequence of the ambiguous –<u>ed</u> is to eliminate a crucial discriminative cue to the relationship among the clauses. The failure of many listeners to get (3) and (4) correctly appears in part due to a failure to perceive the nasal inflection.

Another source of difficulty in the perception of (2) stems from the fact it contains a reduced relative clause. The usual complexity (Fodor and Garrett, 1967) resulting from the loss of the relative pronoun is amplified enormously in (2) since its loss also prevents the discrimination of the subordinate clause verb from the main verb. In contrast to (2), the unreduced versions in (5) and (6) are perceived accurately by over half of the listeners. But

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[5] These sentences were recorded at a slow to normal speaking rate and played to varying numbers of listeners seated in a classroom. Each listener heard only one sentence and was required to paraphrase it and rate his/her confidence in that paraphrase on a 13 point scale.

something more than ambiguity of –ed and loss of the relative pronoun also seems at work. Compare the

(5) The player that was kicked the ball kicked him.

(6) The player kicked the ball that was kicked him.

complexity of (2) with (7), which listeners find even easier than (3) or (4). Note that (7) has both the ambiguous –ed and

(7) The player kicked in the head kicked him.

missing relative pronoun. The phrase in the head apparently not only aids in segmentation of the clauses, but also does not present the segmentation problem that the ball presents in (2) where it may be locally interpreted as either an object NP to the first VP or subject NP to the second VP, and as both by some listeners! Additionally there may be a number of other factors including the type of passive sentence, and the repetition of the verb kicked may marginally contribute to the difficulty of (2).

The incorrect and often fragmented, ungrammatical paraphrases reveal the efforts of the listeners to cope with the uncertainty of (2). The most common paraphrase takes both instances of kicked as active verbs and fabricates a conjunction and extra NP linking two independent clauses (…kicked the ball and the ball kicked…) or a relative pronoun linking an independent and dependent clause (…player who kicked the ball…). A substantial number of incomplete paraphrases include portions of the passive the ball was hit by the player without being able to integrate that fragment with the other portions of the sentence. It would be of interest to know how the various syntactic analyzers, such as Kaplan's ATN model, deal with such sentences. It is not obvious how that model or any such model would block the interpretation of (2). The constraint on explanatory simulations that they must not exceed the ability of humans is easily overlooked amidst the problems of simulating even a fragment of human language behavior. Nonetheless, models cannot be perfect if they are to be models of human behavior.

On the use of prosodic, lexical, and structural information. The above example illustrates the fundamental syntactic tasks facing a listener: assign lexical items to constituents, assign the constituents to their clauses, and determine the relationships among the clauses. To accomplish these tasks, a skilled listener has three major sources of grammatical information concerning the syntactic organization of sentences: the lexical information associated with each word in the listener's vocabulary, structural or syntactic information concerning the permissible configurations of grammatical categories, and prosodic features or suprasegmental information (Lehiste, 1970), including intonation contour, juncture, and stress or accent. Prosodic phenomena are mostly inevitably neglected in considerations of syntactic analysis, simply because they are subtle and fleeting, not to mention difficult to incorporate into a syntactic analysis program. I cannot say much about prosodics other than to suggest that prosodic phenomena might facilitate the processing of sentences such as (2) by providing suprasegmental information about subsequent structures as yet unheard. Thus in the version of (2) corresponding to (3), it may be that speakers can signal the subordinate nature of the first clause by a rising intonation contour over ball and perhaps by using other cues. I must say however that my own efforts to facilitate the interpretation of (2) using intonation have as yet been unsuccessful.

It is apparent that the most important source of information, lexical and structural, bear an intimate relationship to one another. While the structure of a sentence is defined in terms of grammatical patterns of grammatical categories, the listener encounters only strings of words. Yet suppose—if only to reveal its defects and the nature of English—that every skilled listener has developed a kind of canonical sentence template or expected syntactic structure against which all input sentences are evaluated. Learning to understand English is to learn the template, its use, and the necessary amendments to it, signaled by specific lexical items and syntactic patterns. As a beginning, assume that all English sentences follow the general format of alternating NP and VP; that is, …NP VP NP VP NP VP NP… Declarative sentences typically are signalled by an initial NP while questions and imperatives an initial VP. Among the many structures deviating from this simple pattern are those with relative clauses, verbs taking more than one object NP, prepositional phrases, adverbials, and conjunctions. This is hardly a trivial list of exceptions; nevertheless there are English sentences which do fit this description; e.g. (8) however implausible those with more than three VPs may be. To use the template we assume the first NP encountered is the subject of the sentence and the

(8) The lady believed the man thought she knew the liar…

main verb is the last VP "paired" with it, where "pairing" is a procedure described below in the discussion of relative clauses. For the moment, consider "pairing" as simply taking the first VP following a subject NP as the main verb. The object NP of the sentence is the following NP and any VP NP… that goes with it. Thus the object NP of (8) is taken as the man thought she knew…

Notice what happens if these rules are used to interpret a sentence like (2). We get the utter nonsense that kicked is the main verb with a complex object NP, the ball kicked him. If, however, we interpret (9) similarly, we get just what the great majority of listeners report.

(9) The player believed the ball kicked him.

This sentence is reported with greater confidence and accuracy than (3) and (4) and even (5) and (6). This suggests there is yet another reason for the difficulty of (2), namely that its initial structural description fits the format of an object complement sentence, a sentence type having priority over a relative clause, independently of lexical content.[6] Of course, it is just to filter out such interpretations that Fodor and Gararett (1967) emphasized the importance of the lexical information associated with the verbs, and Thorne, Bratley, and Dewar (1968) put complement taking verbs in their closed class dictionary. By the syntactic rules suggested here both (2) and (9) will receive the same structural description; only the semantic homunculus can reject (2) as nonsense.

Space limitations fortunately prevent me from having to discuss all of the exceptions to the model. It is necessary however, to consider at least the first two, double object verbs and relative clauses. One implication of the template is that all verbs have one object NP, though it may be a complex sentential object. While verbs with no objects do not pose a serious problem, those with the potential for double objects, e.g. kick, give, believe, require special treatment. The Thorne, Bratley, and Dewar analyzer operates on the breadth first assumption that zero, one or two objects may follow any verb and constructs potential nodes for all three. Kaplan does not mention the matter explicitly, but in any depth-first analysis one path of three must be selected first. A compromise third alternative might just utilize verb category information to alert the listener to the possibility of a subsequent double object, but make no decisions about assigning the first NP encountered to either indirect or direct object position until all the data are available. A similar issue arises in the analysis of relative clauses discussed below. Verbs like believe,

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[6] Wanner, Kaplan, and Shiner, in their as yet unpublished work, test very much the same proposal in their studies of sentences like They told the girl that Bill liked the story. Over a variety of lexical material, their listeners overwhelmingly interpret that structure as double object VP with a simple NP (the girl) and a sentential NP (Bill liked the story). This is in contrast to a nested relative clause interpretation (that Bill liked (the girl).

which may take both a simple abstract NP such as fact or claim and a sentencial complex object as in (10), also must be considered as exceptions. Predictably there are sentences, like (11), that

(10) The professor believed the claim the earth was flat.

(11) The professor told the woman the tale that the earth was flat.

combine the worst of (9) and (10) and have essentially a triple object NP.

Massive disruptions of the standard template occur in the analysis of restrictive relative clauses, which may occur in any NP position of the sentence. In order to interpret a relative clause the listener must recognize the linguistic environments signaling a relative clause, postulate a secondary sentence template, be able to assign the constituents of the entire string to their respective clause templates, and in the process reconstruct any implicit or transformed constituents. It is worthwhile to consider several examples in detail. First let me briefly describe, quite informally, a typical linguistic analysis of relative clauses.

The structure of a relative clause. A common relative clause like (12) is constructed from two clauses, the main, or matrix, and the subordinate, or constituent, clauses. In (12) these correspond to the dog bit Bill and Bill bought the dog, respectively. One might think of relative clause formation as a process of attaching the constituent clause to the head NP in the matrix clause, in this example the dog. A condition on that attachment is that an NP in the constituent

(12) The dog that Bill bought bit him.

clause must be coreferent with the head NP to which it is attached. Coreference is a grammatical relationship among NPs indicating they refer to the same entity. The attachment process involves forming an appropriate relative pronoun—that, who, which, whom, whose—marking the coreferent NP in the constituent, and then moving the pronoun to the front of the constituent clause, e.g. that Bill bought the dog. Finally the constituent clause is attached immediately following the lead NP in the main clause, and the coreferent NP in the constituent clause is deleted, leaving no trace. The complete structure is indicated in (13).

(13) The dog that Bill bought (the dog) bit him.

A primary function of relative clauses in communication is to describe a referent such that the listener will be able to identify that referent, a kind of indirect reference whereby the speaker uses information already presumed available to the listener in order to single out some individual—a dog in (12)—about which the speaker is making some additional comment. There are undoubtedly many other uses of such clauses. The important point here is that all of them require that the listener reconstruct the grammatical relationship, e.g. subject, object, indirect object, subject of object complement, object of a preposition, etc., of the new deleted NP within the relative clause. The task of a listener finding herself in a relative clause environment may be functionally outlined as seeking to replace the NP corresponding to the relative pronoun as she proceeds through the string of words coming to her from left to right. While the listener does know that the NP must be coreferential to the head NP, she cannot know without analysis of the sentence, what grammatical relationship that NP played in the constituent clause.

Some common relative clause environments. The characteristic indicator of a relative clause is one of the several relative pronouns. Just in case the relative pronoun is coreferent to an object NP in the constituent sentence, the relative pronoun itself may be omitted. Thus the that in (12) may be deleted giving (14). In the resulting surface structure typically remaining the

(14) The dog Bill bought bit him.

occurrence of two consecutive NPs itself serves as a cue of high validity that the listener is entering a relative clause. Notice that the back to back NPs violate the NP-VP alternations of our canonical sentence format. Almost never does this imply that a deleted VP must be recovered, as in I ordered ham and eggs and Kita beans and weenies. When the object relative pronoun is deleted but contiguous NPs do not result, we may predict trouble for the listener. Of course they have it cases like (2) and even (3) and (4), where the constituent clause was a passive, with subject and object NPs interchanged. Now when the object NP of the constituent clause is deleted in normal relative clause formation, and if the relative pronoun is deleted (along with the auxiliary), the passivized verb in the constituent clause immediately follows the head NP and is liable to be taken as the main verb of the matrix sentence. Thus the interpretive process breaks down.

A schematic outline of the more frequent relative clause environments is presented in Figure 1 on the following page. A listener encountering a noun phrase, NP_n, may find himself in a relative clause if any of the constituents indicated in that outline follow the NP. Also exemplified in Figure 1 are some of the constructions in which those constituents may not indicate a relative clause environment. I have indicated in the third and fifth branch examples of certain postnominal modifiers which seem to overlap the traditional relative clause in function; yet have a differing syntactic form, even though a number of the generalizations about the analysis of relative clauses are valid for those constructions. It may or may not be coincidental that the same morphemes marking complement clauses (Rosenbaum, 1967), that, -ing, and to turn up indicating postnominal modification, e.g. (16) and (21) below, along with –ing adjuncts as Anyone losing Humphrey gets a reward. Consider, for example, a listener encountering (15). He hears an initial NP followed by a relative pronoun, which, and he can be assured that he is into a relative clause. On the other hand if he heard (16) which differs only in choice of pronoun, he could not be so sure since the noun fact is one of the many abstract NPs which may take an

(16) The fact that Otto knew the answer surprised everyone.

adjunct complement clause (cf. examples (10) and (11)). Thus The fact that is locally ambiguous in a way that The fact which is not. In the former, the listener requires further information to eliminate the relative interpretation and, not surprisingly, in some cases (e.g. (17)), the sentence will be globally ambiguous between the relative and the complement

(17) The fact that Otto knew was surprising.

interpretation…. It should be clear to the reader why (17) but not (16) is ambiguous; if not, it soon will be.

Reconstructing the relative clause. Upon encountering a potential relative clause environment a listener knows he is now dealing with at least two clauses and that he must sort out the constituents and reconstruct both the matrix and constituent clauses. Following the above account of relative clause formation, this entails replacing an NP which is coreferential to the head NP somewhere down inside the relative clause. Essentially the listener is looking for a gap in the structure of the clause caused by the previously described deletion process. In this way the listener may ascertain the grammatical relationship of the deleted NP corresponding to the relative pronoun.

Recalling example (12), one can imagine a listener, upon the valid hypothesis that that marks a relative clause, beginning to search for a potential source for the relative pronoun. He knows, inversing my description of relative clause formation, that the relative is coreferent with its left adjacent NP, the dog, and that this NP is one of the constellation of NPs around the verb brought in the constituent clause. He takes out another sentence template for the constituent clause and begins to fill it out from left to right. The first NP in the constituent clause is Bill, which he interprets correctly as the subject of the clause. Next he expects and finds a VP bought, which he correctly assumes is the main verb of the clause. Now he predicts but does not find an object NP but instead finds another VP, bit. Just as two consecutive NPs signal an embedding, so two consecutive VPs signal a change from one clause to another. The listener has a number of alternatives. The simplest is to assume that unfilled object NP of bought is the source of the deleted NP coreferent with the dog, i.e. that the relative pronoun is coreferent with the direct object of bought. At this point the relative clause is reconstructed but the listener has an "unpaired" VP, bit to assign somewhere. Again the simplest solution is to pop back to the first sentence template which only has its initial NP filled (with The dog) and still needs a VP paired with it as main verb of the matrix clause. The listener correctly assigns bit as that main VP and the following NP, him, as object NP to bit. The sentence is thus syntactically analyzed, to the extent of sorting out the clauses, reconstructing deleted constituents, and assigning the several constituents into their proper grammatical relationships.

These general interpretative principles can be extended to reconstruct relative clauses of extraordinary complexity. For those who did not figure it out at the time, we can now explain why (17) but not (16) is ambiguous. In (16) there is just no NP in the putative constituent template to be the source of the deleted NP coreferent to that and, subsequently, to the fact. The object position is already taken by the answer, and nothing about the verb knew lets us postulate a secondary object NP, in contrast to (18), where a secondary object NP, governed by the verb told

(18) The fact that Otto told the teacher surprised everyone.

is possible. Example (18) is, of course, ambiguous precisely for the same reason as (17).

An even more complex relative is (19). Initially the analysis follows exactly along the

(19) The professor that the students believed was arrested died.

path for the analysis given above for (12). Upon encountering the VP was arrested our listener might well do as before and assign the relative pronoun that as the coreferent object NP to believed, as if the constitutent clause were the students believed the professor. He now pops back to the main clause template and pairs off was arrested with the initial NP, the professor as if it were the main VP in the matrix sentence. To his dismay, the next constituent is also a VP, namely died. He has another unpaired VP and no higher clause to pop up to. It should be apparent where that line of analysis went astray. It was back in the constituent template, when the relative pronoun was taken as a direct object NP to believed and was arrested was taken as the matrix VP. Our listener had another choice at that point, which was to assign was arrested as a secondary verb in the constituent template, i.e. as the verb in complex sentential object to believe. There is now a gap at the subject NP position within that complex object NP. That is the true source of the deleted NP coreferent with that and the professor. Now when died is encountered, the listener can appropriately pop back into the main clause and pair off died with the professor in the main clause. Thus the main clause is The professor died and the constituent clause is the students believe (the professor) was arrested.

Sentences such as (19) raise a number of familiar questions about the actual process of interpretation. I described the analysis of (19) as a depth first back up analysis. That was primarily for expository reasons and to parallel its analysis with that given earlier for (12). Yet many listeners have no difficulty with (19) and do not report any conscious back up process. If listeners always tried to complete the analysis of a clause or phrase and immediately move to a higher level of analysis as Chapin, Smith, and Abrahamson (1972) proposed, some of them should report it. Perhaps some in fact do; but there are other alternatives that deserve careful experimental inquiry. Can listeners use prosodic information to avoid making a decision of premature closure? Do they compute more than one alternative path as Thorne, Bratley, and Dewar's (1968) analyzer does, or as Garrett (1974) has suggested? Or is there simply some sort of time delay or buffer between input and analysis that operates to prevent incorrect constituent assignment when immediately following constituents will eliminate one or another alternative path?

I would like to consider one final example relative clause type that illustrates how the relative clause analysis interacts with the interpretation of infinitival complement sentences like those in (20). Those examples illustrate a quite general rule in English; namely, that for most verbs in their infinitive form, the leftmost antecedent NP should be interpreted as the "subject"

(20) a. I want to leave.
b. I want the taxman to leave.
c. The farmer expected the cow to eat old hay.
d. The farmer expected the cow to eat.

NP of the infinitive. Although linguists may debate whether infinitives can have subject NPs, it is clear that in (20a), it is the speaker of sentence that will leave, just as it is clear in (20b) that it is the taxman who will leave. The same is true for those relative clause-like infinitival modifiers as in (21), although here the interpretation is complicated when the subject of <u>see</u> is implicit as in

(21) The doctor for you to see is Mucus Welby.

(22) The doctor to see is Mucus Welby.

(22). Suppose one forms a relative clause using (20c) as the constituent and (23) as the matrix.

(23) The cow was purple with rage.

The resultant sentence is that shown in (24). But now substitute (20d) as the constituent sentence in place of (20c).

(24) The cow that the farmer expected ( ) to eat old hay was purple with rage.

The resulting complex sentence is (25), which is ambiguous precisely because of the interaction of the relative clause reconstruction

(25) The cow that the farmer expected ( ) to eat was purple with rage.

process and the rule of interpreting a subject of an infinitive. One interpretation has the sense of the farmer expecting to eat a cow that is purple with rage, while the other has the sense of the farmer expecting the purple cow to eat something. The reason for the ambiguity should be evident. The verb <u>eat</u> is a transitive verb that does not always require an explicit object NP. The difference between (20c) and (20d) is just that in (20c) there is an explicit object NP whereas in (20d) there is not. Yet in (20d) surely the farmer expected the cow to eat something, hence an implicit object NP. Now in the reconstruction of the relative clause in (25) there are two possible sources for the deleted NP. One is <u>the cow</u> from the constituent clause <u>the farmer expected the cow to eat</u> but the other is <u>the cow</u> from a constituent clause we have not yet considered, <u>the farmer expected to eat the cow</u>. Thus in contrast to the structures in (24), we have the structures in (26), both of which result in the identical surface structure. Thus, as the listener goes along at the level of his second sentence template,

(26) The cow that the farmer expected to eat ( ) was purple with rage.

seeking the source of the deleted NP in the relative clause, he finds two potential sources, one after the other. That is, he might decide that the cow is coreferent with the subject of eat as in (25) or with the object of eat as in (26), with the infinitive interpretation rule supplying the farmer as the subject of eat. Notice that if I am correct about the syntactic ambiguity of (25) and (26), it considerably weakens the proposal that listeners take the first opportunity they come to in order to decide the coreferent of the head NP of a relative clause. In order for those sentences to have two interpretations, the listener must not yet have made a final decision when the second gap becomes known to him. There are, of course, a number of different interpretative schemes that would give this result. Perhaps the NP (pronoun NP configuration biases the listener for an object NP interpretation regardless of options occurring before the object NP position in the constituent clause is reached. Perhaps the subject NP interpretation rule for infinitives "protects" that position from interpretation as coreferent to the head NP except as a last resort. These and other alternatives require empirical evaluation.

The primarily heuristic analysis of relative clause reconstruction I have presented here can be summarized as a process of expecting English sentences to follow an alternating pattern of NPs and VPs, along with procedures for dealing with exceptions signalled structurally and lexically. Relative clauses are identified by such cues, and another sentence template is put into play. The analysis continues on a left to right basis with every NP position being interpreted according to a complex of coreference rules governed to some extent by specific verbs. Consecutive verbs, as in (19), (27), and (28), signal an important choice point for the clausal recognition process. Does the first verb dominate the second as a complement in the constituent

(27) The workers that appeared tired after 5 days.

(28) The workers that appeared tired quit after 5 days.

clause, e.g. believed was arrested in (19) and appeared tired in (28) or is the second in fact a verb from a higher sentence, e.g. tired in (27)? These matters are discussed further in Limber (1970). Readers will profit greatly from working out some examples for themselves. To that end, some interesting examples are given in (29).

(29) a. The boy students believed the professor expected to win lost.
b. The dog that bit the boy who knew the man who bought it died.
c. The dog that the girl knew the man bought barked continually.
d. The man who everyone knew hired the workers that just arrived tired.
e. The lion who saw the gorilla chased it.
f. The lion who saw the gorilla chased laughed.
g. The lion who saw the gorilla chase it laughed.

Some Neglected Issues

Here I should like to no more than mention several of the important issues facing further developments in the area of sentence interpretation. Each of these deserves far more discussion and analysis than I can offer here; nevertheless it is important not to overlook them.

Beyond syntax. Surely there is more to interpreting a sentence than organizing its constituents into the proper clauses. The content words of a sentence do far more than serve as filters to exclude meaningless structures, which is the function to which most syntactic analyzers put them. If the meaning of a word is viewed as the contribution which that word makes to the interpretation of its sentences, it is also clear that word meaning is more than a static set of semantic mediators, markers, or features that are put together by simple combinatorial rules. In many cases it would appear that word meanings must be construed as not only carriers of semantic material but much like active functions or subroutines that take linguistic and context parameters as inputs and whose outputs are the inferences typically made by listeners. Consider the sentences in (30). Now look at the corresponding interpretations in (31) that might

(30) a. This water is warm enough to swim in.
b. Bob is fast.
c. Chess is easy.
d. Merrill suggested a goose for the secretary.

have been extracted by a listener from a specific conversation in which the examples in (30) were used. It takes no more than the examination of the protocols from a few listeners asked to

(31) a. According to state law, the water in the outdoor pool is
is suitable for swimming in.
b. Bob is fast at solving two move chess problems.
c. Chess is easy to learn.
d. Merrill suggested that we might purchase a plump Christmas
goose as a gift for the secretary.

interpret such sentences as in (30) to see that something beyond syntactic analysis is necessary to explain those interpretations.

Why syntax? This is a question that certainly deserves far more attention than it has ever received. As I suggested above, syntax has in large part been treated as a kind of nuisance variable by many psychologists; something that gets in the way of the business of studying meaning. Yet why should something as complex as the syntax of human language have evolved? Several speculative answers come to mind. The corresponding examples in (30) and (31) suggest one of them. Syntax serves to economically package thoughts in a fashion suitable for vocal transmission and subsequent interpretation. It is hardly a coincidence that in transformational grammars the surface structure is generally considerably reduced in structure from the base structure, not to mention from any attempt at representing semantic structure. Probably not unrelated to the notion of economical packaging is the fact that a simple sentence or single clause is typically no more than seven syllables in length and of one to two seconds duration. That figure is perfectly in accord with the requirements of short term auditory memory on one hand, and the requirements of the production system on the other.

It may be more accurate to consider syntax as directing, controlling, or structuring thought rather than packaging. Thus in (30d) the surface structure follows a simple NP VP NP format yet the meaning of suggest entails a propositional object rather than the simple object NP goose. It remains for the listener to construct a proposition compatible both with the linguistic context, goose in particular, and the extralinguistic context. Much the same phenomenon can be observed in the language of two and three year olds where a single morpheme represents an entire proposition yet in context is sufficient to convey the intention.

Syntax and language development. There are several perspectives one may take here. In terms of the function of syntax, it serves to structure the perceptual inputs for the child much as it does for the mature individual. As I have suggested elsewhere (Limber, 1973), given the kinds of verbs that young children first acquire, syntax is of even more value to the child since there is a much more direct correspondence in their structures between surface structure format and the grammatical-semantic relationship of the initial and final NPs. For the mature listener, however, relatively few syntactic formats are pressed into service to carry a much larger variety of grammatical-semantic relationships. It is no surprise at all, therefore, that when children encounter those exceptional lexical forms such as easy, ask, promise, and a comparatively few others, they interpret those sentences incorrectly. They simply are using well-established syntactic interpretation rules concerning grammatical relationships and the assignment of coreference. Why should those syntactic overgeneralizations be thought any different from the inevitable morphological overgeneralizations involving verb inflections? It is not unlikely that the comparative regularity of the young child's syntax greatly facilitates its acquisition of new structures and, in particular, vocabulary items.

From quite another perspective it is important to keep in mind that whatever procedures the mature listener uses in sentence processing, those procedures must be learnable. Hence it is sensible to look toward the earliest syntactic structures for potential evidence concerning the mature processing routines. The overgeneralizations of easy and other similar forms indicates that indeed syntactic patterns do play an important role in the interpretive process, contrary to occasional suggestions that semantic processes are primary in young children. An examination of the speech patterns of children during their third year suggests that important features of the interpretive process already underlie speech production at that age. For example, alternating NP VP sequences are common; e.g. ,Watch me hit ball. Similarly, young children perhaps never overtly express an NP in an object complement clause; e.g., Me want mommy read book but not me want me read book. Far more likely is Me want read book. To a considerable extent the productive structures of children apparent between two and six years make a good beginning toward establishing the interpretive strategies discussed here.

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