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In this paper the author attempts to show that the relational network approach is adequate to handle the relationship between interrogative and declarative word order, the gramatically determined "do," "not," and the order of morphemes in the verbal auxiliary. He feels that this is one step toward demonstrating that the relational network approach is a viable alternative way of formalizing our knowledge of English grammar. (See relate" document AL 001 634.) (Author/DO)

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# THE ENGLISH AUXILIARIES:

# A RELATIONAL NETWORK DESCRIPTION

Peter A. Reich

November 1968

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Linguistic Automation Project

YALE UNIVERSITY

New Haven, Connecticut

AL 001 636

# THE ENGLISH AUXILIARIES: A RELATIONAL NETWORK DESCRIPTION

Peter A. Reich

The paper, "Symbols, Relations, and Structural Complexity" (Reich, 1968b), discusses an alternate formalism for context-free phrase structure grammar (Chomsky and Schützenburger, 1963). This formalism consists of networks of relationships, a slightly refined version of the networks proposed by Lamb (1966a; 1966b). Three types of relations are needed to achieve a formalism equivalent in power to context-free phrase structure grammars: downward concatenation (downward ordered and), downward disjunction (downward unordered or), and upward disjunction (upward unordered or). Two additional nodes are introduced which do not add to the power of the system, but do contribute to simplicity of the structure and its formal properties; namely, downward ordered and-or, and downward optional. These networks of relationships have certain formal properties; among them are associativity, bypass representation, commutivity, distributivity, coincidence, and reduction. The formal properties define equivalence relationships among different networks. Figure 1 summarizes these relationships.

All of the discussion in that paper is limited to grammatical structure essentially equivalent to context-free phrase structure grammar. Chomsky and his followers have argued, and we heartily agree, that this is not enough. Chomsky (1957:68) writes:

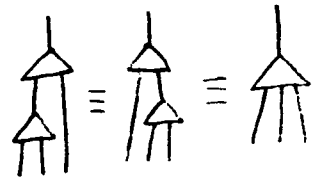
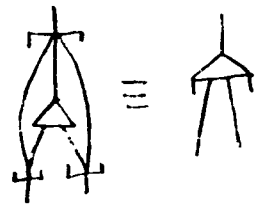
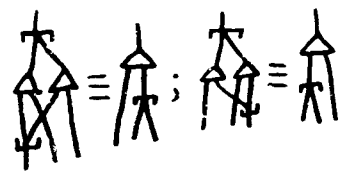
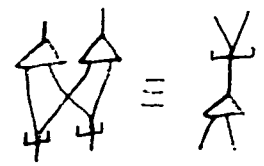
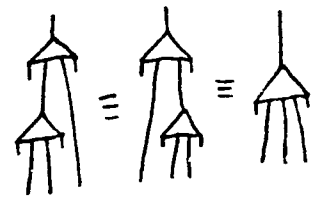
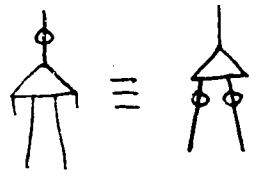
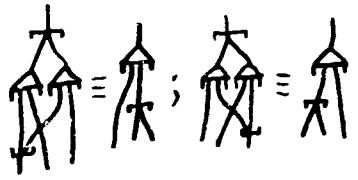
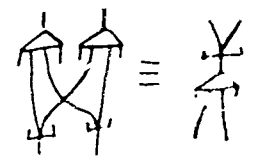
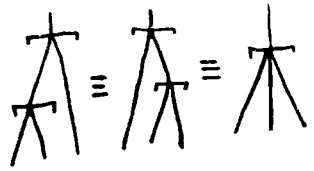
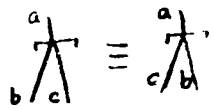
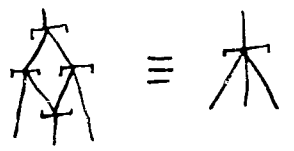
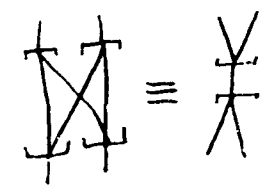
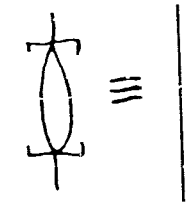
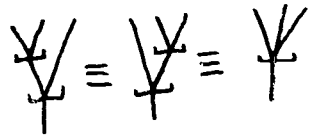
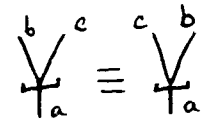
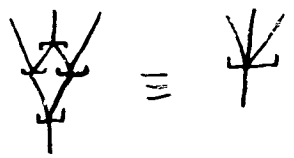
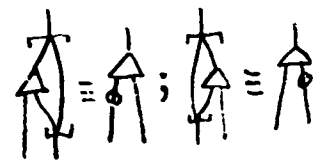
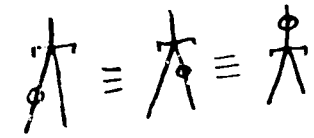
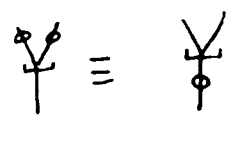
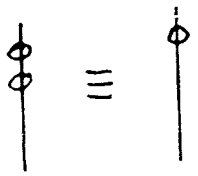
| SYMBOL | NAME | A<br>ASSOCIATIVITY | B<br>BYPASS REPRESENTATION | C<br>COMMUTIVITY | D<br>DISTRIBUTIVITY | E<br>COINCIDENCE | R<br>REDUCTION |
|---|---|---|---|---|---|---|---|
|  | downward concatenation (downward ordered and) |  |  | No |  |  | — |
|  | downward ordered and-or |  |  | No |  |  |  |
|  | downward disjunction (downward unordered or) |  | — |  |  |  |  |
|  | upward disjunction (upward unordered or) |  | — |  |  | | |
|  | downward optional | — |  | — |  |  |  |

Figure 1: Summary of formal properties

We have seen that a wide variety of apparently distinct phenomena all fall into place in a very simple and natural way when we adopt the viewpoint of transformation analysis and that, consequently, the grammar of English becomes much more simple and orderly. This is the basic requirement that any conception of linguistic structure (i.e., any model for the form of grammars) must meet. I think that these considerations give ample justification for our earlier contention that the conceptions of phrase structure are fundamentally inadequate and that the theory of linguistic structure must be elaborated along the lines suggested in this discussion of transformational analysis.

Many have concluded from this and other such statements that the only grammars which are adequate are grammars that contain transformations. While we agree that phrase structure is fundamentally inadequate, we do not therefore agree that the theory of linguistic structure must be elaborated in terms of transformations. There can be no doubt that a theory consisting of phrase structure plus transformations is considerably superior to phrase structure alone. But, we find, 'As the depth of the analysis increases, problems...mount to the point where they indicate a serious inadequacy in a grammar that consists only of rewriting rules. Nor is this particular difficulty overcome, as many others are, when we add transformational rules to the grammar.' (Chomsky, 1965:80). It is certainly possible that phrase structure plus transformations plus distinctive features plus projection rules plus...will bring us closer and closer to an adequate theory. But it is also possible that another theory could do the job easier, faster, and

with considerably less theoretical structure. It is with this aim in mind that the relational network approach is being developed.

In order for one model to be shown superior to another model, it is necessary to show that it handles all of the data at least as well as the other theory, and some of the data considerably better, or else some data not covered at all by the other theory. In linguistics this is an unending task, especially since the different models are continually being modified. Thus in the attempt to promote our model here, we can only make a small dent in the subject matter that needs to be discussed. We choose to discuss the English 'auxiliary verbs', because Chomsky believes that 'The study of these auxiliary verbs turns out to be quite crucial in the development of English grammar' (Chomsky, 1957:38). We hope to show that we can obtain the same kinds of insights as can the transformationalist.

The problem of the English auxiliaries is that such constructions as has been taking are most efficiently described as consisting of discontinuous constituents. A phrase structure grammar would produce (s) (have en) (be ing) (take), and a transformation rule would reorder the constituents -- have s be en take ing. (Chomsky, 1957:38-40; Klima, 1964: 253)

In order to handle this construction, we must include some features in our model beyond those given in figure 1. We want to do so without adversely affecting some of the nice features we have developed, such as the simple complexity count and the formal operations which give us equivalence sets. What we need is simply some new nodes. In particular, we need upward conjunction, diagrammed as shown in the top row of

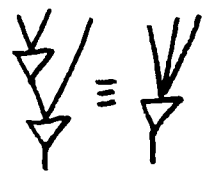
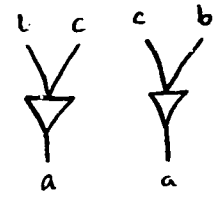
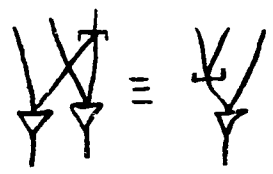
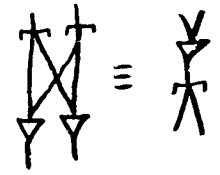
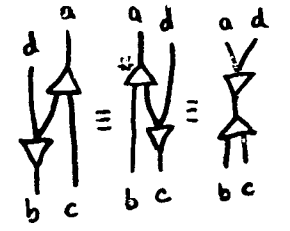
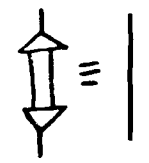
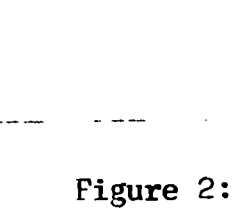
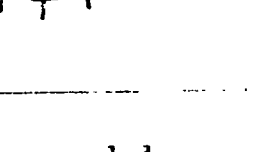
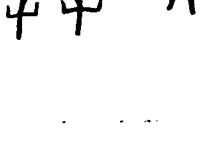
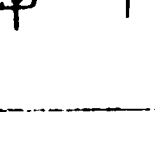
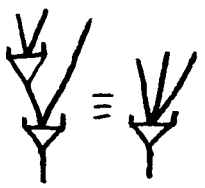
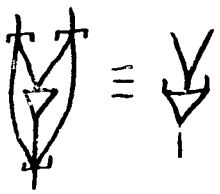
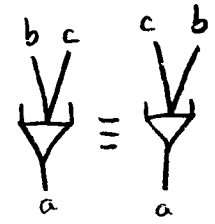
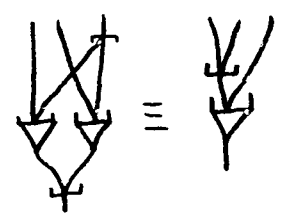
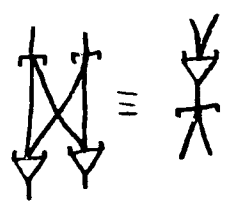
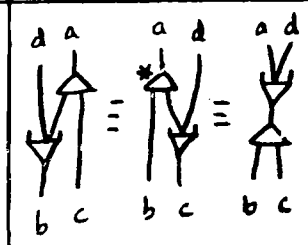
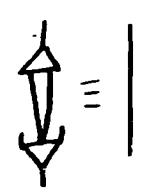
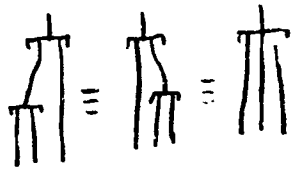
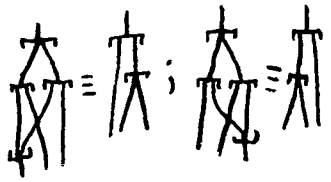
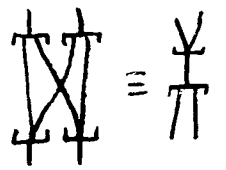
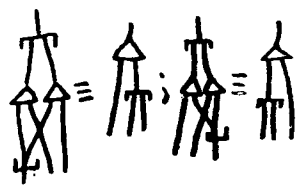
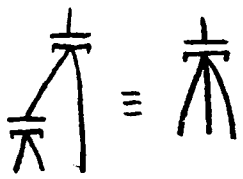
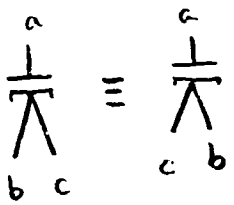
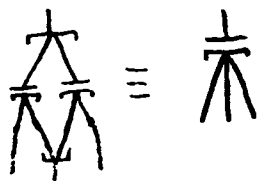
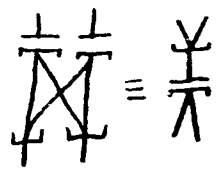
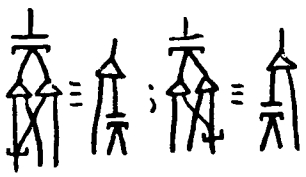
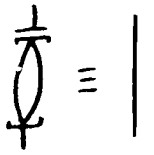
| symbol | name | A associativity | B bypass representation | C commutivity | D distributivity | E coincidence | F distribution over concatenation | R reduction |
|---|---|---|---|---|---|---|---|---|
| UCJ  | upward conjunction (upward unordered and) |  | — |  |  |  |  |  |
| UOP  | upward optional | — |  | — |  |  | No |  |
| UAO  | upward and-or |  |  |  |  |  |  |  |
| DPD  | downward precedence disjunction (downward ordered or) |  | — | No |  |  |  |  |
| FVD  | free variation disjunction |  | — |  |  |  |  |  |

Figure 2: Some additional nodes needed

figure 2.[1] What this node means is that two conditions, b and c, both must be satisfied before a is produced. For example, both go and past must be present in order to get went, and both bad and comparative must be present in order to get worse. In terms of signals, signals must come down both b and c, not necessarily simultaneously. A signal is sent down a immediately after b or c comes down, whichever comes later. Feedback which goes up a travels up b and c simultaneously. In terms of formal properties, they are similar to concatentation, except that the relation is commutative. There is an additional property, distribution over concatenation (see figure 2). This says that if condition d is required before a can be realized as b followed by c, the requirement (i.e., the upward conjunction) can be placed on the a, b, or c lines of the concatenation element. For the same reasons that we introduced the downward optional element and the downward ordered and-or in Reich, 1968b, we introduce the upward optional[2] and the upward unordered and-or.

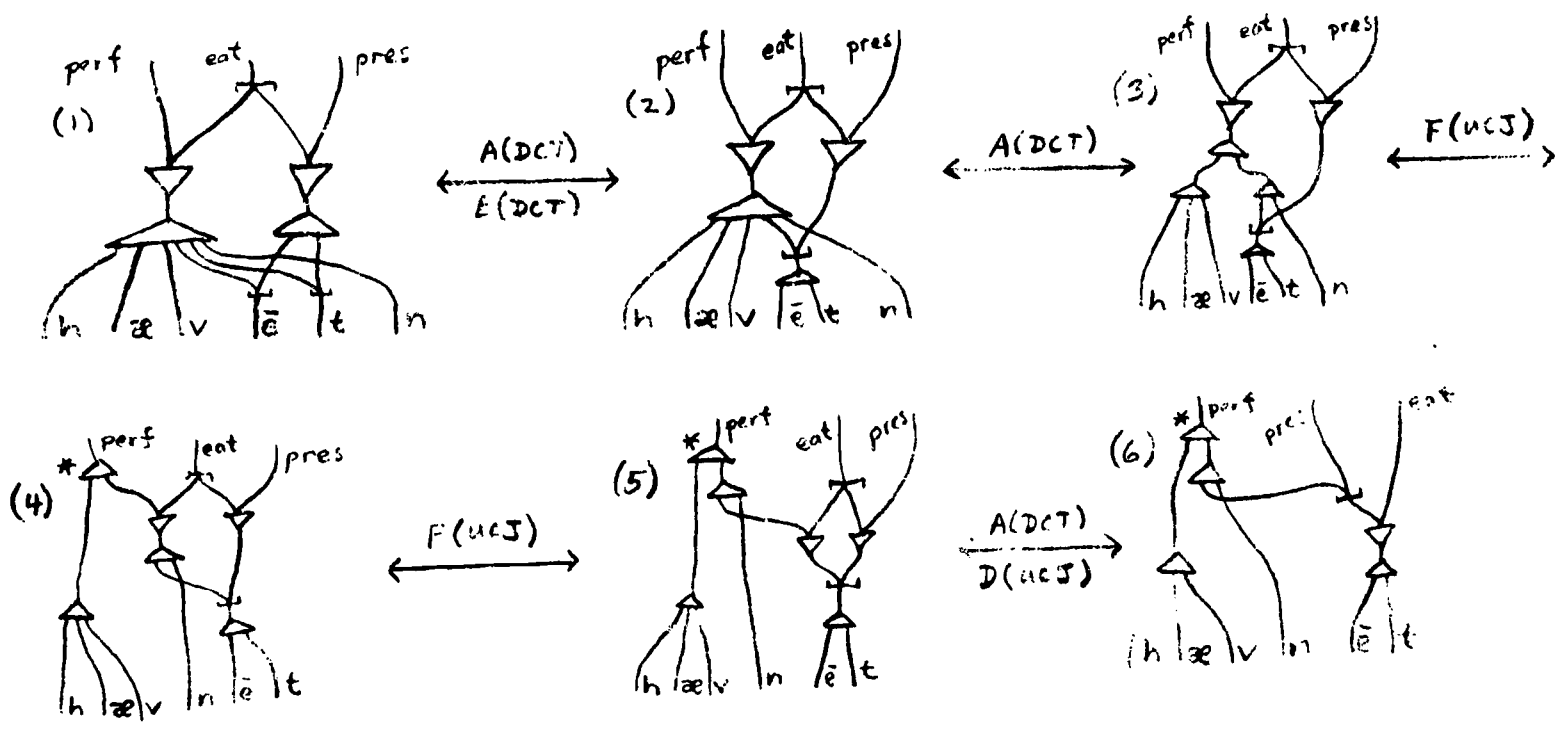



Figure 3: Simplification leading to identification of discontinous constituent.

Figure 3 shows the role of upward conjunction in the simplification process. It is highly suggestive as a model of the process by which a child learning his language learns to discriminate its parts, even if they are noncontiguous. Network (1) would represent the condition in which the child learned that the concept of eating conjoined with the concept of perfect tense is expressed by h æ v e t n, while the concept of eating together with the concept of present tense is expressed by ēt. We see that by applying the formal properties, we can move step by step to the simplest equivalent network (6). This network expresses the generalization that perfect tense is realized as the discontinuous constituent h æ v n, and the concept of eating is realized in both the perfect and present tenses as ēt. We see that the initial information we represent in our networks is not just the form, or expression, but also the meaning, or content. This represents a major difference between our approach and that of many transformationalists. The production of discourse consists not in moving from abstract to concrete, but rather in a transduction process between content and expression (Gleason, 1964; Lamb, 1966c: 562ff). In this we follow Hjelmslev (1943:47-60) and agree with Chafe (1967: 84-89).

In order to understand the English auxiliaries, therefore, we not only need to know the patterns of English expression, but we must have a model of the patterns of English content. The model we shall use is that of Halliday (1967). According to this model, there are three basic tenses in English: past, present and future.[3] Complex tenses can be built up by concatenation of the simple ones. For example, future past (as in I will have finished it ...) means that whatever event we are talking about will in the future have taken place in the past. Halliday

calls this past in future. In this framework the form of the verb in such examples as I am lithping, which as been called progressive (e.g., Palmer, 1965:59), temporary aspect (e.g., Jocs, 1964:106), and various other things, is present present, or present in present. Similarly, the form of the verb in such examples as I have died is represented in this framework as present past, or past in present, and I had died is represented as past past, or past in past. Halliday has recorded examples of the concatenation of up to five tenses. For example, He had been going to have been taking... would be an example of past past future past present. According to this framework, each basic tense has two realizations. Present is realized as either nothing (∅), or be-ing. Past is realized as either ed or have-en. Future is realized as either will or be-going-to. Of course, most of these in turn have alternate realizations -- e.g., be is realized in portmanteaus as am, is, are, etc. We shall refer to the first of the two alternate of realizations of basic tense as type I, and the second as type II. Type I realizations occur in simple tenses and as the first tense in all finite constructions. Type II realizations occur in non-finite constructions and in complex tenses.

We shall first consider the nonfinite constructions. These are the only constructions that are permitted when verbal constructions are nominalized, as in:

To publish the journal on time
Publishing the journal on time } was difficult.

The nonfinite does not include the full verb phrase. One cannot say:

*To can avoid the draft is his goal.

*Wenting to Vietnam cost him his life.

Halliday finds twelve tenses available to nonfinite constructions, as shown in figure 4 (d = past, f = future, p = present, s = passive). To each of these twelve tenses can be added a passive, which gives us

| | |
|---|---|
| ∅ | to take |
| d | to have taken |
| p | to be taking |
| f | to be going to take |
| fd | to be going to have taken |
| dp | to have been taking |
| fp | to be going to be taking |
| df | to have been going to take |
| dfd | to have been going to have taken |
| fdp | to be going to have been taking |
| dfp | to have been going to be taking |
| dfdp | to have been going to have been taking |

Figure 4: The twelve nonfinite tenses

such constructions as (s) to be taken, (fds) to be going to have been taken, (dfs) to have been going to be taken, and (dfdps) to have been going to have been being taken. It will be granted that some of these constructions require fairly uncommon contexts in order to be produced, but Halliday has examples of many of these from natural conversation recorded on tape, so we shall take his word about the data. If we diagram all these and simplify, we get figure 5, which was first proposed by Newell (1966:82).

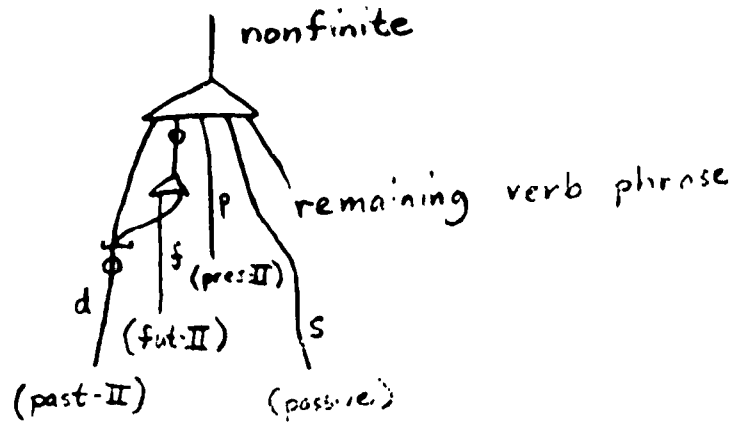



Figure 5: Phrase structure component of nonfinite construction

The finite consists of a modal auxiliary, or <u>past</u>, <u>present</u> or <u>future</u>, concatenated with the nonfinite system. If we include this in our diagram, we get figure 6. But the tenses in the nonfinite part are type II, while the initial tense is type I. The fact that they have

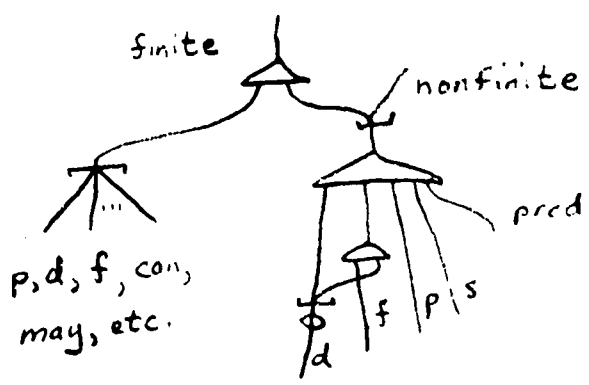



Figure 6: Phrase structure component including finite construction

the same meaning indicates they are brought together by a disjunction above this point.[4] We now have two independent factors controlling our grammatical decisions -- whether the tense is <u>past</u>, <u>present</u>, or <u>future</u>,

and whether we are in the nonfinite portion of the predicate construction or not. Thus we need upward conjunction to indicate that both factors must be combined. This is diagrammed in figure 7. We have also included the top portion of the structure which realizes the type II tenses. In the diagram we analyze the type II future, be going to as (be ing) go to, where be ing is the same construction as the type II present. The be is the same as the be of the passive be en, and the en of the passive is the same as the en of have en. What I mean by this is that no matter whether the be came from be en or from be ing, it will be realized a particular way, depending upon person, type I tense, and number (e.g. am, is, are, etc.), but not depending on what construction it came from. Similarly, en has many alternate

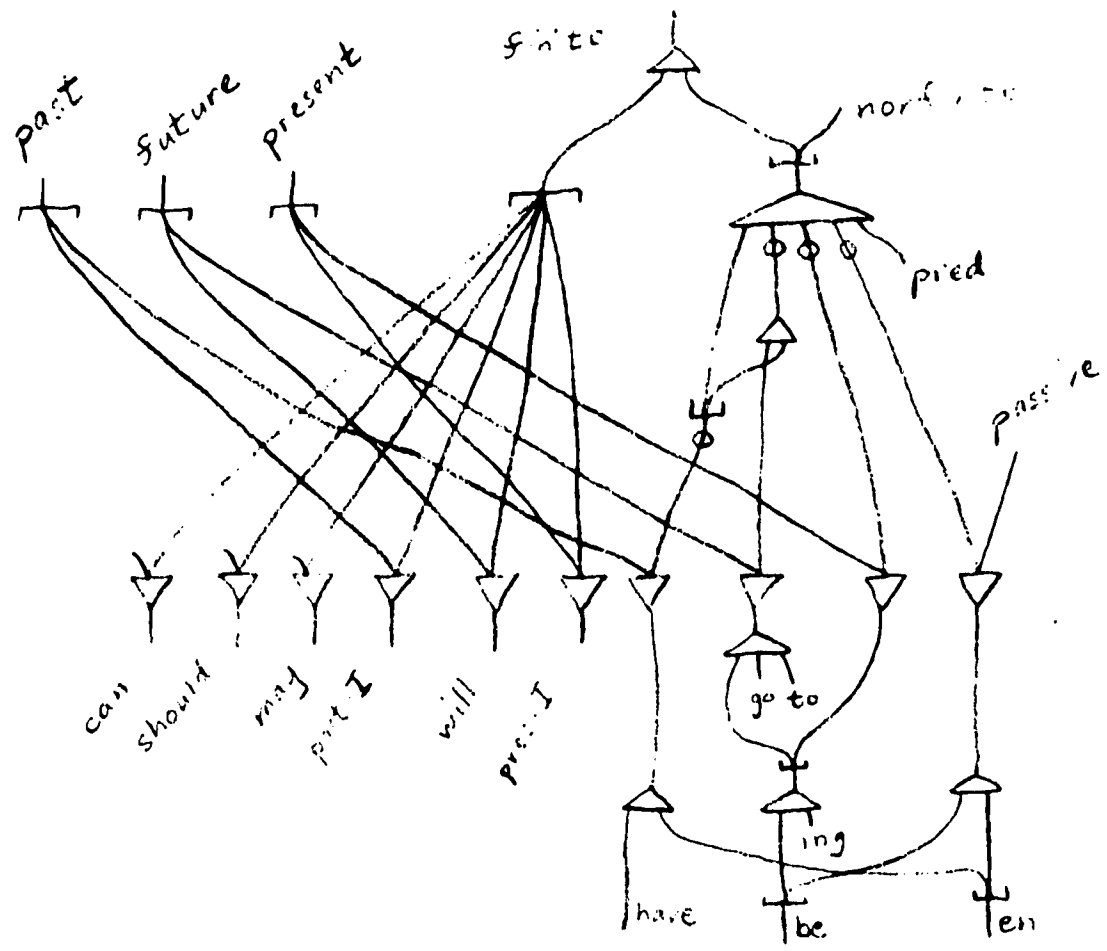



Figure 7: Grammar with Type I - Type II tense disjunction added

realizations, depending on what verb it is to be associated with, but not depending upon whether it came from be en or have en.

Let us now consider what happens when negation is present. nt is affixed to be, have, will, or any of the modals, whichever comes first. If none are present, a do is inserted. Thus they have gone combined with negation yields they haven't gone, but they went yields they didn't go. Figure 8 shows the grammar for figure 7 with this additional information added. The structure we have added corresponds closely to the way we described the facts in English. We have added concatenations saying that after have, be, or the modals including will we insert nt if we have a negation signal from content. In the case of simple past or present, none of these occur. In this event nt is realized following do.[5]

We have at this point used a type of element which we have not previously discussed -- the downward precedence disjunction (downward ordered or). In order to understand this we shall have to look at the meaning of disjunction in our system more closely. When we were dealing with context-free phrase structure grammars, we defined disjunction by saying that a signal coming in a would go down either b or c; the choice was a random one (Reich, 1968b: figure 8). Thus we would generate one of the set of possible sentences at random. But of course we don't generate sentences at random. In reality we generate (barring errors) just that sentence which we want to generate. Our system is selectively generative; it is generative under content control. This notion is probably one of the most important contributions Lamb has made. In terms of our network structures this means that each

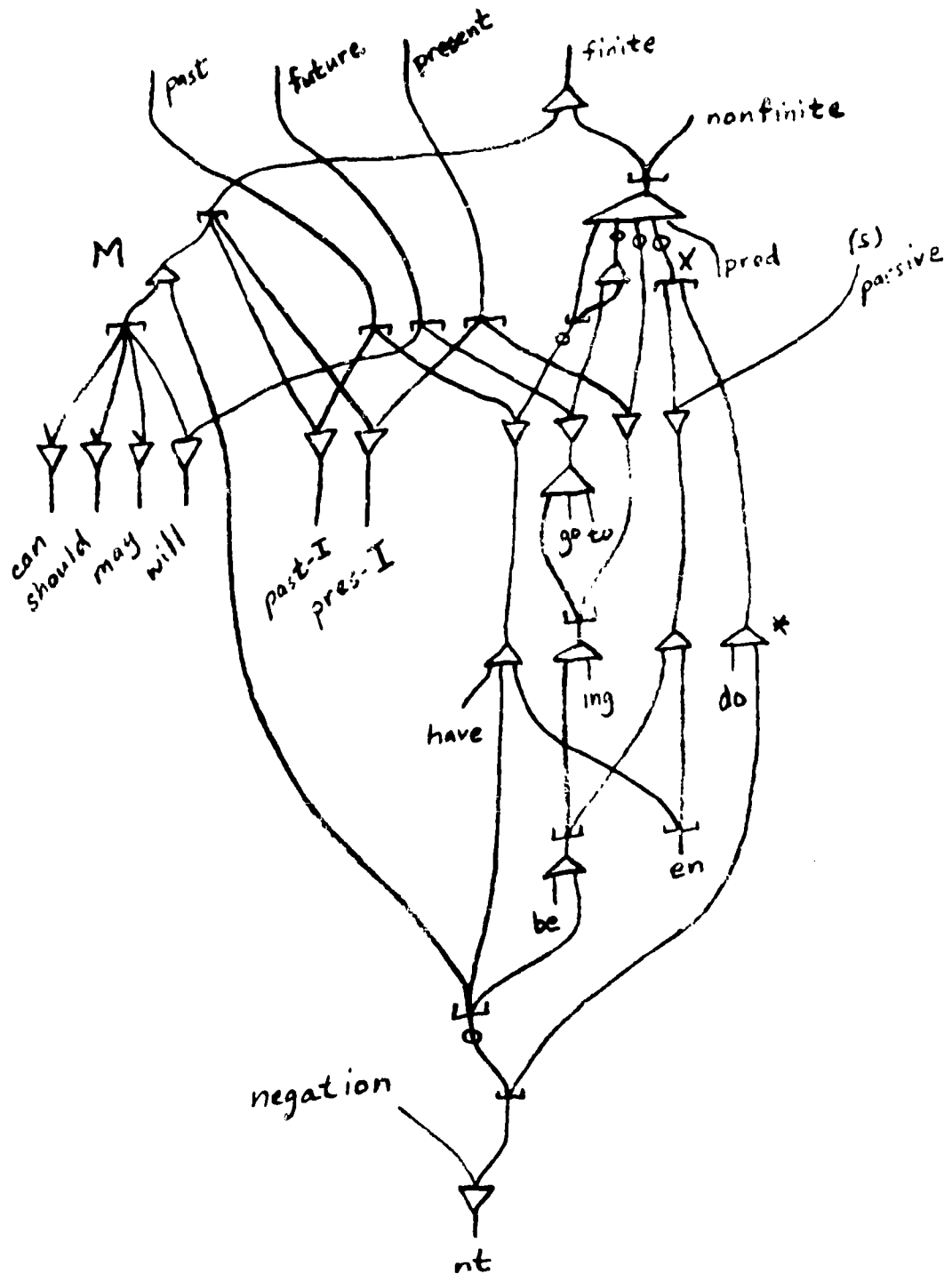



Figure 8: Grammar with negation added

disjunction leads down to one or more upward conjunctions which determine which one of the possibilities is realized. Thus in 9(1) for a given segement s may signal or t may signal, but it will never happen that both s and t signal. (The zig-zag line means there may be additional nodes between the nodes referred to.)

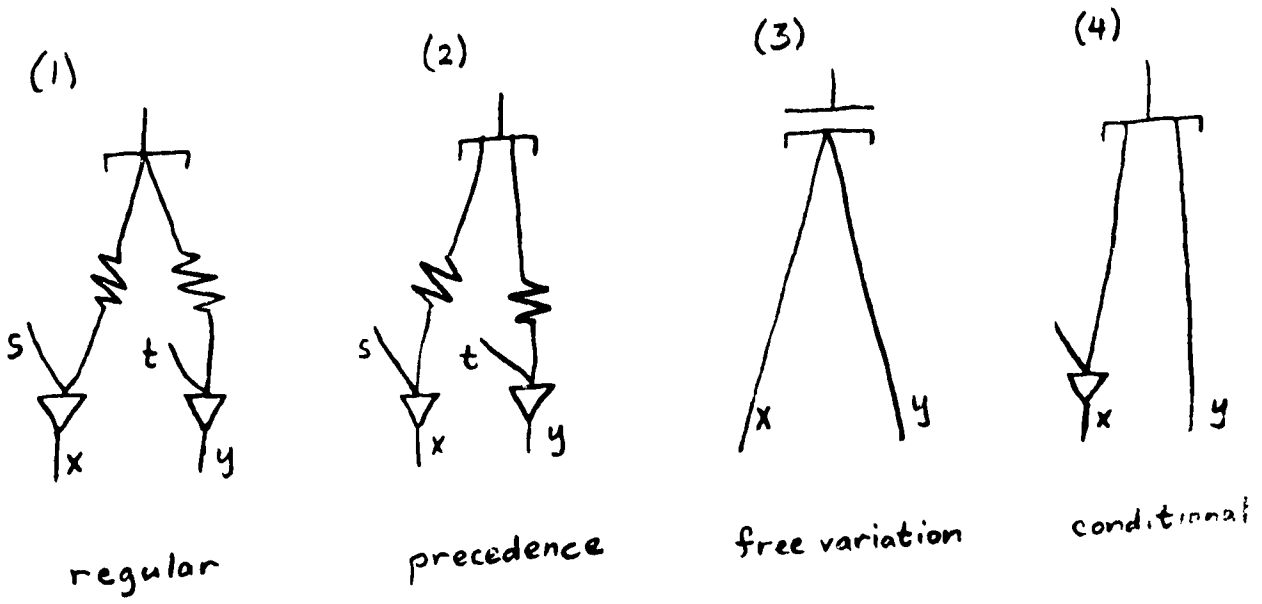



Figure 9: Types of disjunction

This is the condition that we place on regular disjunction, but we do not want to limit ourselves to this situation. Figure 9(2) describes another situation. Here s or t may signal, but it is also possible that both s and t may signal. In this situation we must define what we want the grammar to produce. We may decide that when both signal, s is to be realized, and t is to fail. Thus s takes precedence over t. We shall call this precedence disjunction. An example of this is used in figure 8 at point X in the diagram. If passive (s) and negation both occur, the passive construction is realized, and do is not needed.

In some situations we don't know what the variables are that determine why an informant makes one choice over another. They appear to us to be random. This is the case of free variation. We can indicate this with another disjunction node, this one to make its decision

at random. We shall call it the free variation disjunction, shown in 9(3). As our object is to specify as completely as possible the conditions which determine precisely the expression that a particular content produces, one of our goals is to have as few free variation disjunctions in our grammar as possible. However, in any practical study of grammar, we shall have to have these around. The formal properties of precedence and free variation disjunctions are given in figure 2.

Still another disjunction situation arises. We shall term this the conditional disjunction, after the conditional statements in LISP and Algol-like computer programming languages. This is the situation in which of the two possibilities, one has a condition on it (leads to an upward conjunction), and the other does not, as shown in 9(4). If the condition s is satisfied, the former possibility is taken, otherwise the latter path is chosen. This is very similar to the precedence disjunction, although logically distinct from it. In this paper the two situations will not be distinguished. It is possible that certain behavioral models of behavior may require that the two situations be kept distinct.

A similar differentiation of concatentation into four separate cases is also useful in defining the performance characteristics of the relational elements. The differentiation into four cases is based on the conditions under which the concatenation element can fail. The four logically distinct possibilities are pictured in figure 10. The first possibility, 10(1),is simply that if a signal comes in a, the concatenation will never fail to be realized. This possibility is common in the tactic and sign patterns of linguistic structure.

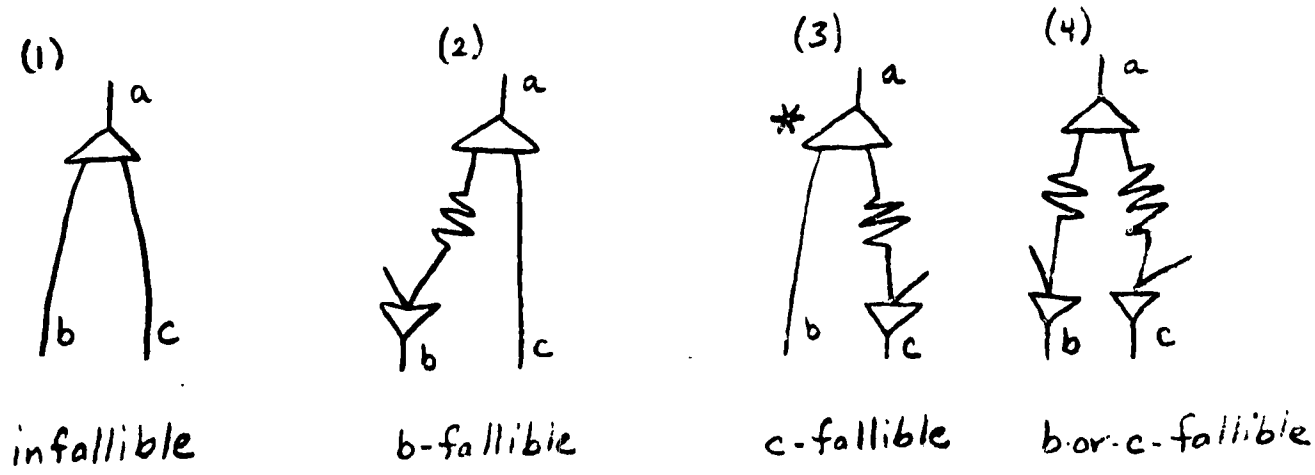



Figure 10: Types of concatenation

All concatenation elements in figure 8 except the two discussed below are of type (1). In the case of the concatenation above the modals, labelled M in figure 8, we have an example of a type (2) concatenation. The b wire may succeed or fail, depending upon whether or not the higher stratum signals the presence of a modal or will, but the c wire will always succeed.

A third possibility, 10(3), is that the concatenation may fail as a result of a condition on the c wire, but the b wire will always succeed if a signal is sent down it. These are considerably rarer, but occasionally occur in tactic patterns. An example appears in figure 8. In the case of the concatenation element above the do (starred in figure 8), it is the success or failure of the c wire which determines whether the concatenation will succeed. That is, it is the presence of negation (and other things which we will add below) that determines the presence of do in the utterance. This,

then, is a type (3) concatenation element.

A fourth possibility would be that both conditions on the b wire and conditions on the c wire could independently cause the failure of the concatenation element. This is pictured in 10(4). I have not yet come across this possibility in grammars attempting to describe fragments of natural language.

Ideally, all four possibilities should be realized by a single type of node. However, in the current encoding model (see appendix to Reich, 1968a) we have not been able to accomplish this. Two different concatenation elements have been defined, type (2) and type (3). Type (1) can be considered as a subcase of either (2) or (3). We have arbitrarily considered it a case of type (2). In the figures of this paper, type (3) concatenation is starred, otherwise we shall not be concerned with the difference between these two types of concatenation.

One of the 'apparently distinct phenomena' that Chomsky finds falls into place is the yes-no question. What appears in the declarative form as Meredith has dropped acid becomes in the interrogative Has Meredith dropped acid? When no auxiliary is present, do is added, as it is in the case of negation. Thus the declarative Julia Child eats TV dinners becomes Does Julia Child eat TV dinners? Chomsky says (1957:64):

> The crucial fact about the question transformation $T_q$ is that almost nothing must be added to the grammar in order to describe it. Since both the subdivision of the sentence that it imposes and the rule for appearance of do were required independently for negation, we need only describe the inversion

> effected by $T_q$ in extending the grammar to account for yes-or-no questions. Putting it differently, transformational analysis brings out the fact that negatives and interrogatives have fundamentally the same 'structure,'and it can make use of this fact to simplify the description of English syntax.

We shall see that relational network analysis also brings out these facts. Figure 11 contains the additional structure necessary to account for yes-or-no questions. Let us see what we have added. First we have added the information that a declarative consists of the subject followed by the finite. The only structure necessary to include the interrogative construction is the addition of interrog, a line coming from content which attaches to the finite construction, and the addition of an and-or at Y which attaches to the subject line at Z. The result of the former connection is that in the case of a yes-no interrogative the sentence begins immediately with the finite construction. The result of the latter connection is that the subject, if it hasn't already occurred, occurs in the same place as the nt, and has the same effect of adding the do when other auxiliaries are not present as does the negation. If the negation also occurs, the order is nt followed by the subject. Thus we have added the interrogative with very little additional mechanism, just as Chomsky does.

We have made two additional small changes to the grammar of figure 8. In figure 11 we have added the copulative, be, in the same place as the passive (indicated by s). This has the effect of adding

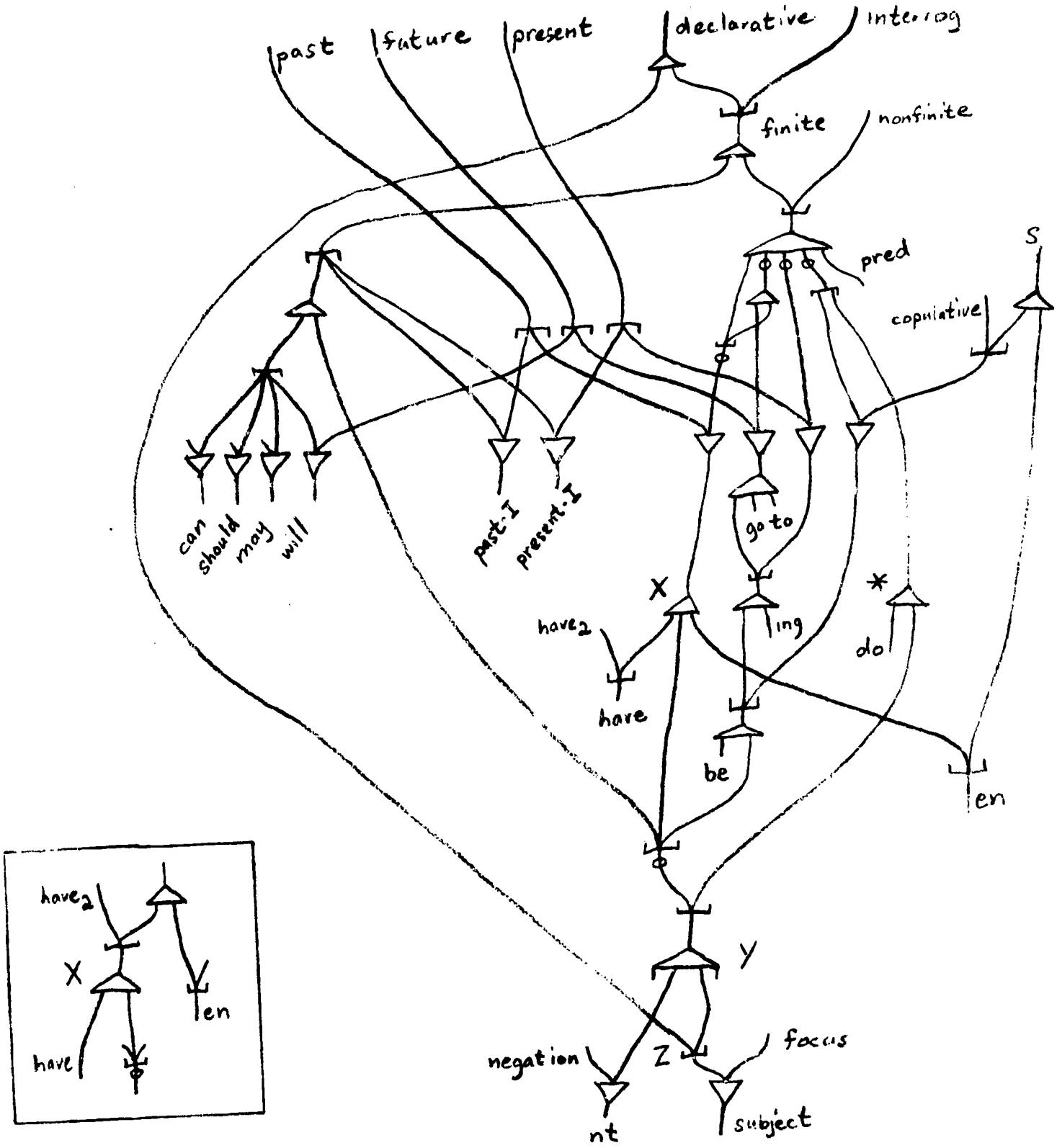



Figure 11: Grammar with interrogative added

the copulative be to the list of words which don't get do in interrogative and negative, accounting for the fact that Chomsky is another Freud in the negative is Chomsky isn't another Freud rather than *Chomsky doesn't be another Freud, and similarly in the interrogative. The same

is not true when have is the main verb, at least in American English. Thus Americans would say Don't you have an electric toothbrush? rather than *Haven't you an electric toothbrush? This means that the main verb $have_2$ combines with the auxiliary have below point X. Both haves become had in the past and has in the 3rd person singular present, so we know they come together above the structure which handles this. In those dialects in which Haven't you an electric toothbrush? is acceptable, the line from the main verb have would come in above X but below the concatenation with en, as shown in the insert of figure 11.

So far, we have developed our grammar to the point where it can produce a good portion of what we can find in the auxiliary system. However, the segments are coming out in the wrong order. I was going to have been finished with my income tax by now, but... would come out of our grammar I $d_1$ be ing go to have en be en finish with ... Chomsky finds that transformational rules make the necessary reordering very simple. Affix followed by verb is to be rewritten as verb followed by affix, where verb includes modals, have, be, etc., and affix includes past, en, ing, etc. After this rule is appled there is a large number of rules of the form: do past→did, do en→dən, do neg→dönt, do singular→daz, etc. (Chomsky, 1957: 39-40).[6] We could, if we wanted to, represent these rules in our network. However, there is a simpler way. First of all, all of the modals and have[7], be, and do are irregular; that is, they have alternate phonological realization depending upon morphemic context. Why take two steps to go from past do to do past to did when it is just as easy to state the rule past do→did? In our system this course seems simpler. And what about the generalization

that no matter what the morphemic context of do, the initial phoneme is always d? The structure I propose allows one to make such generalizations. Although such generalizations are relatively trivial and uninteresting, the formalism developed to describe linguistic structure should be flexible enough to allow such statements. We shall see how they can be made within the relational network framework.

Let us first look at the structure which will account for regular verbs, shown in figure 12. We see that following the regular verb there

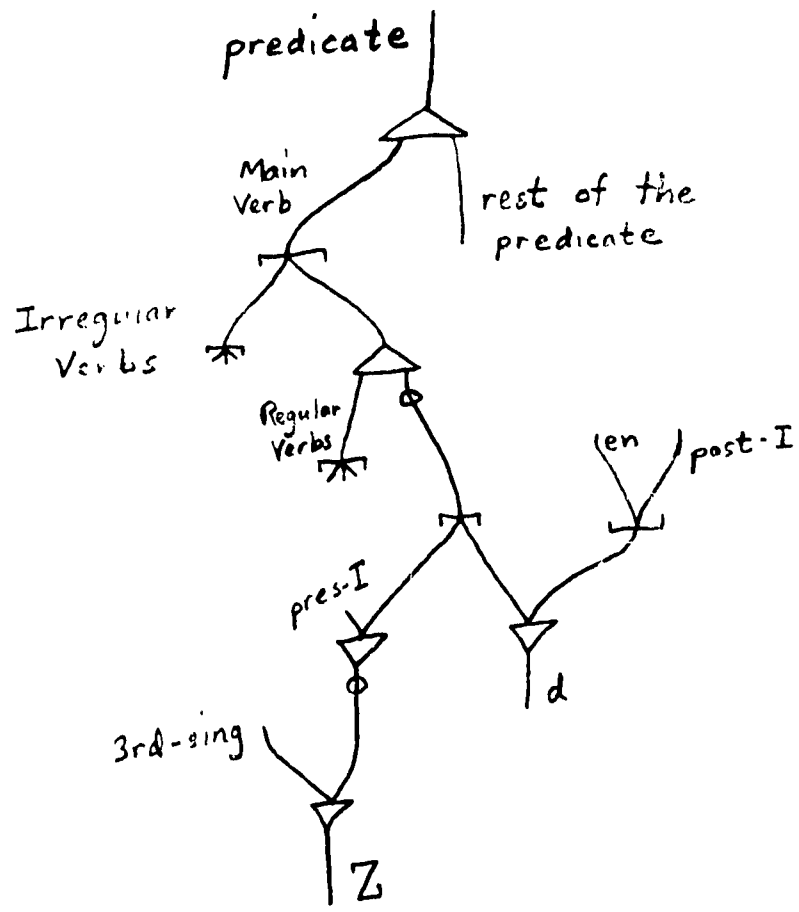



Figure 12: Structure for regular verbs

is the possibility of three different endings. In the environment of past I or en, the ending is d. In the environment of present I there are two possibilities: if additionally the environment includes 3rd

person and singular, the ending is z; otherwise there is no ending (or ing - we shall see how this is produced later). In the event that neither past I or en nor present I occur, the verb is realized without an ending.

Although the diagram is a straightforward representation of the facts, it does not fit into the patterns proposed by Lamb (1966b). Specifically, it appears to put into one stratum information that Lamb preferred to split into two strata, lexemic and morphemic. It is my feeling that if the requirements for what is allowed in the realizational portion of linguistic structure are relaxed slightly, the information formerly described in these two strata can be combined into one stratum. This is a rather involved empirical and theoretical question, the discussion of which I shall save for a future paper. For the purposes of this paper the reader should simply be warned not to expect the diagrams in this paper to conform completely with all of Lamb's 1966 hypotheses.[8]

Let us now turn to the structure of some irregular verbs, to see how they can be handled. Figure 13 shows the structure I propose for do. The initial consonant is d no matter what the environment is. There are two sets of environments to be considered. The first choice is based on whether do occurs with present I, past I, or en. If it is past I the vowel is i and the final consonant is d. If it is en the vowel is ə and the final consonant is n. Note that the concatenation is type 3; the choice of vowel is determined by what follows. If do occurs together with present I, then a second set of contexts determines the vowel. In the environment 3rd-person singular the vowel is ə

and the final consonant is Z. If not (precedence disjunction), but if the context includes neg (negation), the vowel is ō. Otherwise, (conditional disjunction) the vowel is o͞o.

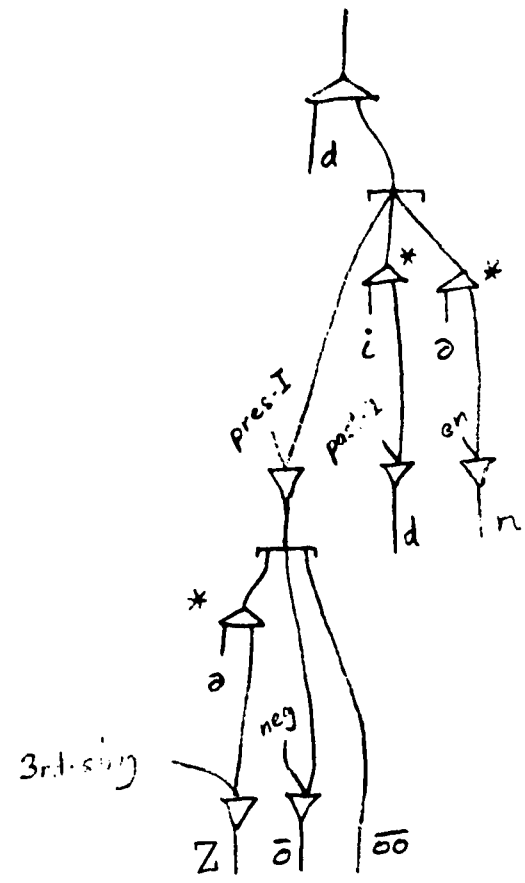



Figure 13: Structure for do.

The structure of go and will, showr in figure 14, is similar to the structure of do. In the case of go the same three contexts determine which form is realized, but this time one form, wenD, which is realized in the environment past I is entirely distinct from the other two forms, which begin with g. The fact that the other two forms differ in their vowel can be described either morphophonemically, that is, as being determined by the environments en or present I as the case

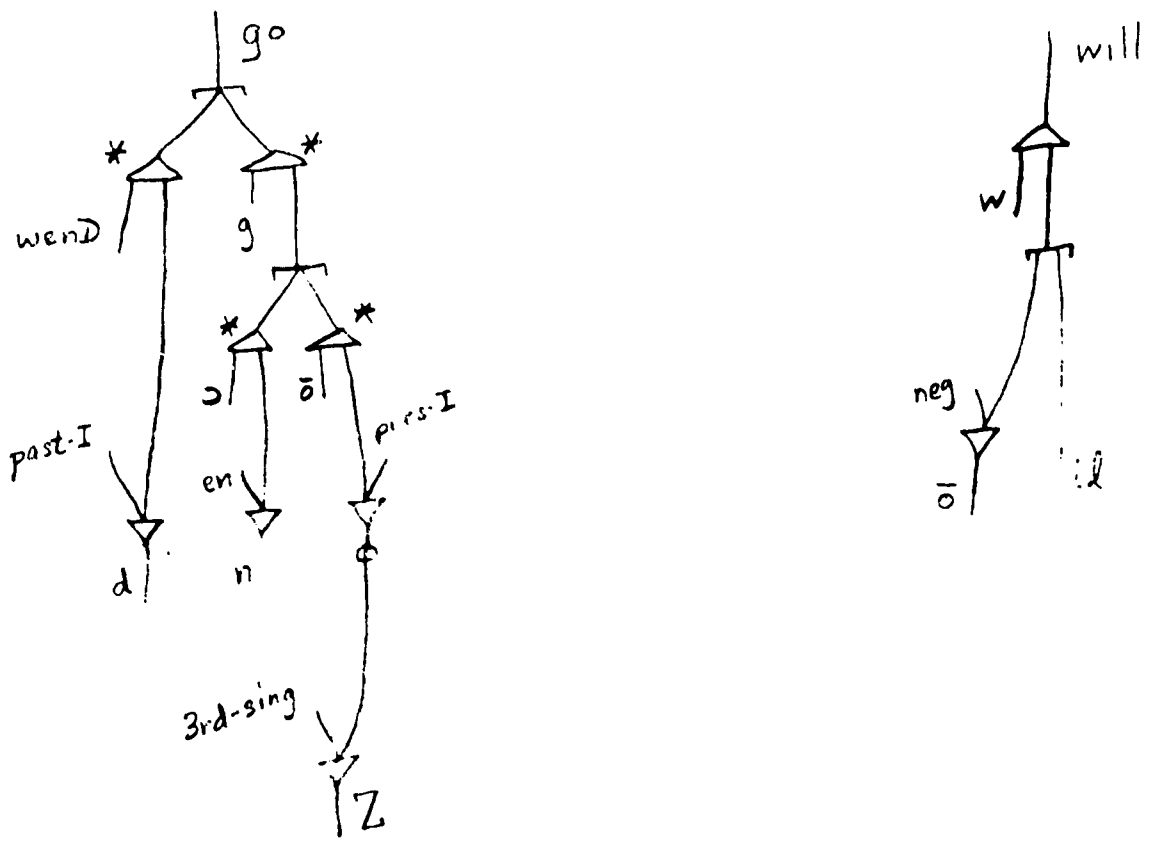



Figure 14: Structure for go and will

may be, or phonemically by the presence of a following n or some such rule. The representation shown in figure 14 is the morphophonemic one. The D in wenD is a special morphon which devoices a following d, so that $^{MN}$/Dd/ is realized as $^{P}$/t/. Otherwise $^{MN}$/D/ is realized as d. Thus $^{MN}$/benDd/ is realized as $^{P}$/bent/. Similarly with send, sent, and lend, lent. Will is realized as wō in the environment neg, otherwise as wil.

Figure 15 gives a possible description of one of the most complicated morphological structures, namely that of be. Here again we find two levels of choices. The first is unique in that there are four choices. In all other verbs the infinitive and ing form of the verb is the same as that of present I, so that these lines come together (at

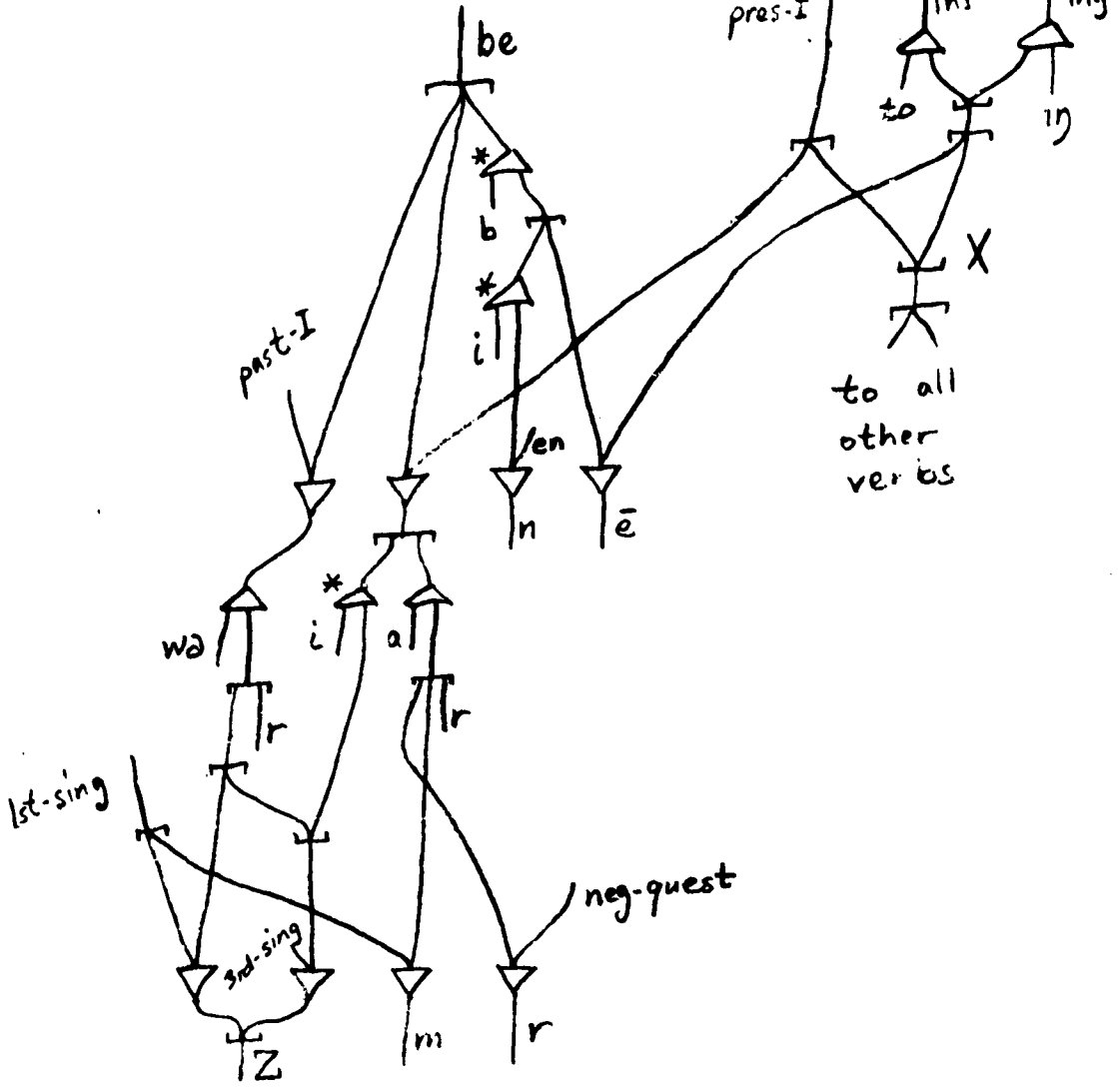



Figure 15: Structure for be

the upward disjunction marked X in the figure) and act as a single conditioning environment, labelled present I in figures 12, 13, and 14. In the verb be the forms are distinct, as shown in figure 15. In the second level of choices we find the familiar 3rd-sing, but in addition we also find neg-quest (which will be discussed in detail below) and 1st-sing as conditioning environments. I will leave it to the reader to check out that the diagram does indeed produce am, is, are, was, were, be, being, and been when appropriate.

Thus far I have described the realizational structure of various

verbs as if they were separate and completely ideosyncratic. This is, however, not the case. Go and do (and all the irregular non-modal verbs) behave like regular verbs with respect to 3rd-sing in having the ending z. Other facts can be generalized over fewer verbs, such as en being realized as n in been, done, gone, taken, etc. Still other facts apply to as few as two verbs, such as the ō for the vowel of the verb in the presence of neg which is only true for won't and don't. This is no particular problem for a network grammar. The descriptions given in figures 12 through 15 are easily combined and simplified to represent identical structures only once, and to identify specifically the class of items for which the structure applies. The resulting structure is shown in figure 16. For example, the upward disjunction at X in the center of the figure defines the class of verbs that take n as the realization of en.

Again I wish to emphasize that this diagram is not necessarily the optimal way of representing this grammatical information within a relational framework. That is beside the point. Representing these facts as a network seems superior to transformational grammar alternatives. If one represents these facts in a lexicon; that is, a list of separate lexical items, one is not able to state the partial generalizations that occur. One is condemned to inefficiently repeat the rules over and over again in each item for which they apply. If one writes transformational rules to describe the partially generalizable structures, one is faced with the problem of how to specify when a transformation is applicable. There is another problem one encounters with this approach. Notice that while the realization of, for example, do

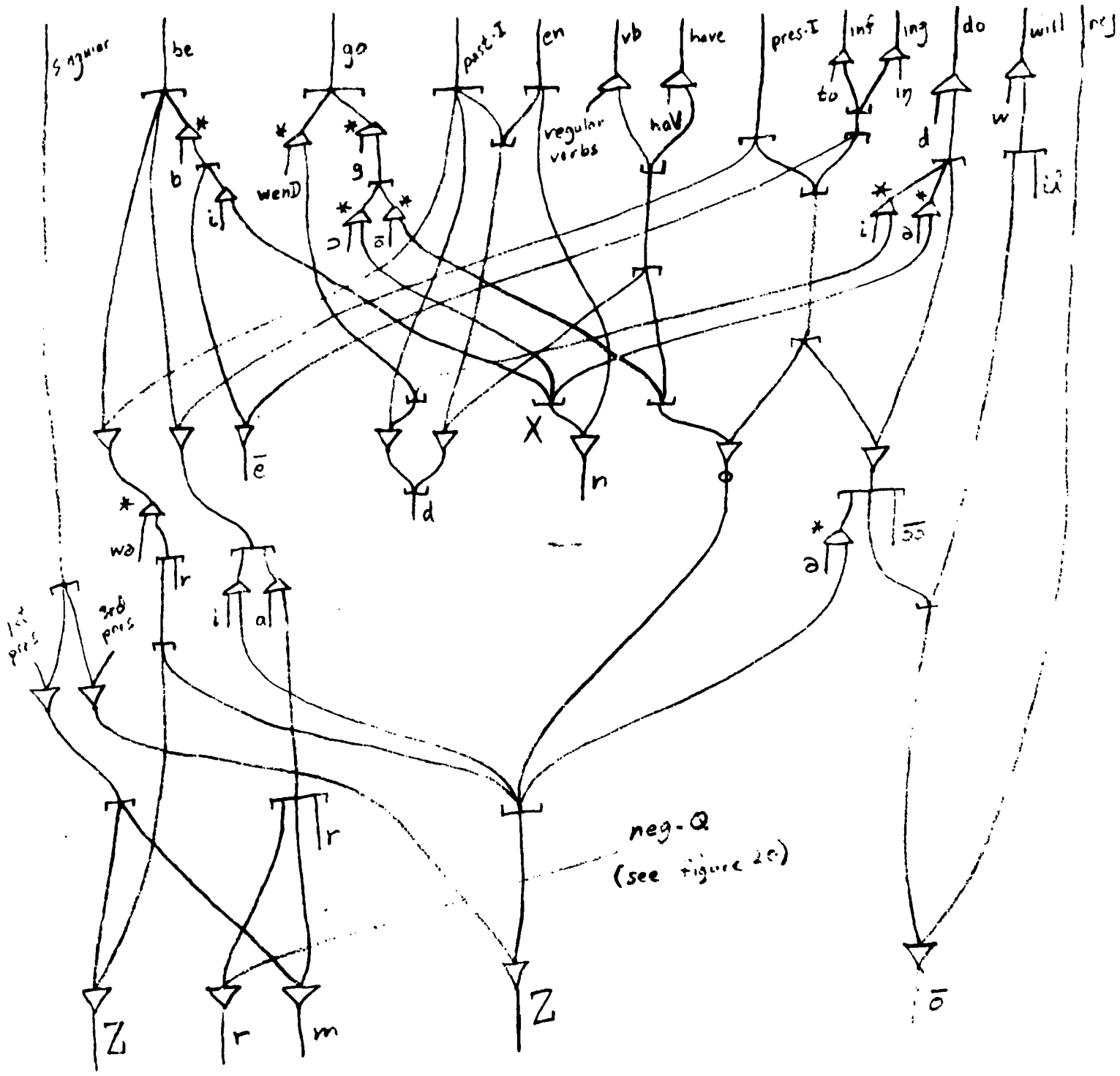



Figure 16: A fragment of realizational structure

is determined by the environment of en, it is also true that the realization of en is determined by do. In a rewrite rule framework, one could

express these facts with rules of the form:

$$(\alpha)\ a \rightarrow x\ /\ \_\_b \qquad \text{and} \qquad (\beta)\ b \rightarrow y\ /\ a\ \_\_$$

The problem is that these rules in a rewrite framework must be ordered. We want ab to be realized as xy. But if we order the rules $\alpha, \beta$ ab would be realized xb, and if we order the rules $\beta, \alpha$ ab would be realized ay. One can always get around this problem in a rewrite framework by means of a special rule of the form ab→xy, but this has the disadvantage that within the grammar a is not related to x and b is not related to y. But do and də are certainly related and en and n are certainly related. One might propose a rule do→də/__n, except that this would result in don't being realized as dənt. This can be avoided by inserting an initial rule do→dō/__neg, so that our rules are ordered:

do→dō/__neg

en→n/do__

do→də/__n

neg→nt

This has the disadvantage of separating the two rules for do. It also forces an ordering between a rule concerning neg and a rule concerning en, which seems ad hoc since they never occur in the same word. It seems to me that the best solution is to allow simultaneous application of rules, if one must use rules at all.[9]

We now turn to the problem of order disparity in relational networks. If we put together the networks of figures 11 and 16, we notice that the original ordering of elements is not the one that is ultimately realized. Figure 17 shows an example. We notice that the grammar above the dashed line produces have en be ing. But the network below the

dashed line specifies that the order should be bi n rather than en be. If we are not interested in a performance model we can simply state the general principle that lower level orderings take priority over higher level orderings.

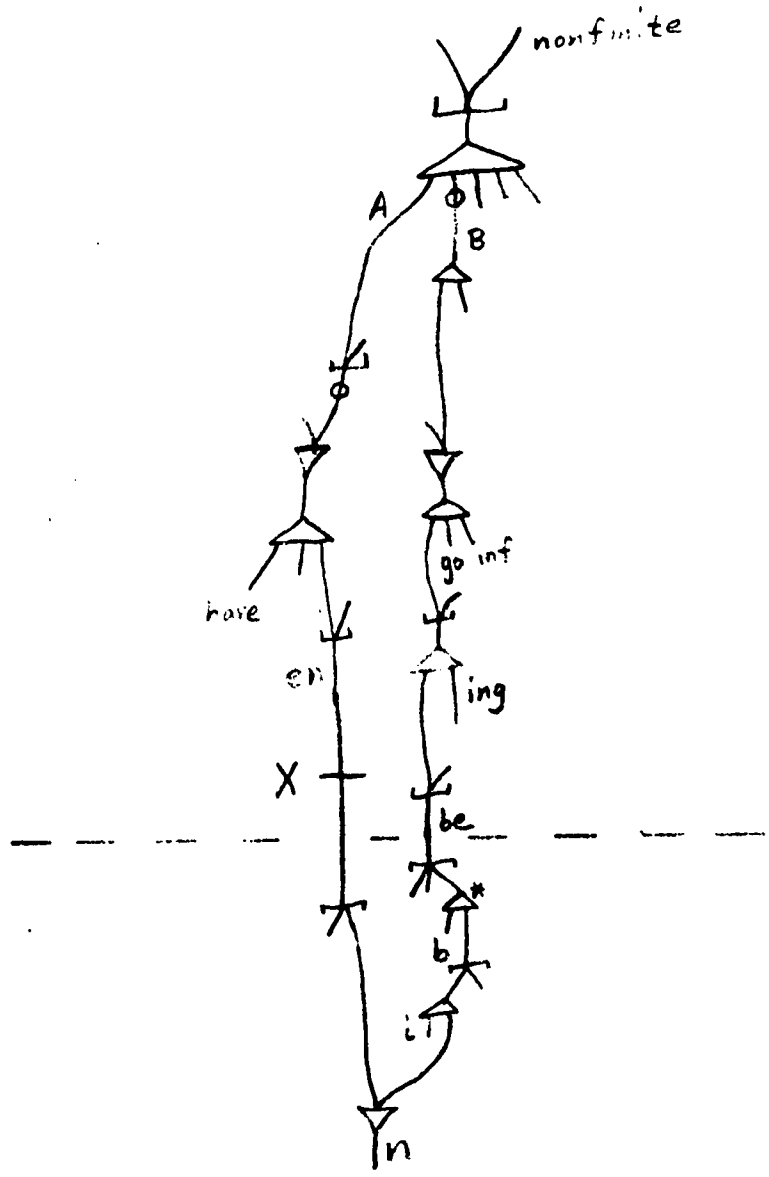



Figure 17: Example of order disparity in relational networks

How can such a principle be realized in a performance model? In earlier papers (Reich, 1968a:2-7; Reich, 1968b: 11-14) it was explained that concatenation ordering works by means of a feedback signal. Thus a signal does not start down B in figure 17 until a feedback signal

comes up A, in effect signalling that the entire structure emanating down from A has been successfully realized. But en can't be realized until after a signal is sent down B. The conflict is easily resolved by adding a node of a new type, a 'feedback reflector' at X. When a signal comes down to a feedback reflector, it continues to send the signal down the wire, but it also sends feedback up the wire immediately. When feedback finally does come up to the feedback reflector, it simply stops, since feedback has already been sent up from there.

In the grammar of English auxiliaries discussed in this paper, the feedback reflector must be added at four places, present-I, past-I, en, and ing. This simple addition to the theory allows one to handle both anataxis and discontinous constituents.

The last area we shall discuss is the problem of negation. The problem arises because of the missing amn't in English. In my normal speaking dialect I say I'm not when the subject appears before the auxiliary, and aren't I in interrogatives where the pattern is first auxiliary before subject. The question is why aren't I rather than am I not. This question leads to the problem of meaning in negation. Of the three accounts of negation I looked at (Klima, 1964; Palmer, 1965; and Joos, 1964) two offered suggestions as to the meaning of not. Palmer (1965:43) suggests that of the two forms of not, n't modifies the modal auxiliary and not modifies the non-finite form that follows it, and that n't should be considered to precede the auxiliary to which it is affixed. Both of these suggestions seem overly simplified. Consider the sentences in figure 18 (the apostrophe indicates emphasis, probably realized by intonation). We see that what is emphasized is

| | | |
|---|---|---|
| 18a. | Zellig didn't stay at the 'hotel. | (He stayed at the 'inn.) |
| 18b. | Zellig didn't 'stay at the hotel. | (He moved into a 'flat.) |
| 18c. | 'Zellig didn't stay at the hotel. | (but 'Rulon did.) |
| 18d. | Zellig didn't stay 'at the hotel. | (He stayed 'in it.) |
| 18e. | Zellig 'didn't stay at the hotel. | (He commuted daily from home.) |
| 18f. | Zellig did 'not stay at the hotel. | (contrary to what you thought.) |
| 18g. | Zellig 'did not stay at the hotel. | (as you had suspected.) |
| 18h. | 'Didn't Zellig stay at the hotel? | (No, he didn't.) |
| 18i. | Did Zellig 'not stay at the hotel? | (Yes, he did not.) |

Figure 18

what is negated. In 18a hotel is negated, but the rest of the sentence is not. In 18b stay is negated. In 18c Zellig is negated. In 18d at is negated. In 18e the entire predicate seems to be negated, and in 18f only the polarity of the sentence seems to be negated. But 18e and 18f can both mean either; the difference seems to be only a tendency. Thus in the fifth previous sentence in this paragraph, I prefer is not to isn't, but would accept either. In 18g not modifies stay at the hotel, but the predicate is considered a positive act. This is best seen in 18i, which is the interrogative of 18e. In general, the parenthesized phrases or clauses to the right of each of the examples cannot be concatenated with examples other than the one they are with. Thus, for example, 'Zellig didn't stay at the hotel; he moved into a 'flat. is less acceptable, if not ungrammatical.[10]

Neither Palmer's nor Joos' suggestions can account for the variety shown in examples 18a through 18g. Nor do they account for the difference between 18h and 18i, since do in these sentences has no meaning.

Moreover, we find that not cannot occur anywhere in the verb phrase; it can occur immediately after the first auxiliary in the form n't or not, and it can occur immediately before the main verb.[11] Thus 19a, 19b, and 19d are grammatical, but 19c is not. Based on these examples

---

19a. She wasn't going to have typed the thesis.

19b. She was not going to have typed the thesis.

19c. *She was going to not have typed the thesis.

19d. She was going to have not typed the thesis.

Figure 19

---

we conclude that there are two types of negation: indefinite negation, which is realized immediately after the first auxiliary, and which has as its range that part of the sentence which is emphasized, and definite negation, which indicates a positive act not to do something, and which occurs immediately before the main verb. These two negations are independent of one another; they can both occur in the same sentence: Zellig didn't not stay at the hotel. When there is only one auxiliary the two slots occur at the same place in the sentence, resulting in ambiguity in the written, but not in the oral, forms, as in 18f versus 18g.

Given this description of not, we can understand why in the indicative I say I'm not, while in the interrogative I say aren't I. The missing amn't, corresponding to 18e is not a problem because of the existence of the alternate form I'm not, corresponding to 18f. But am I not doesn't work, because this is definite negation, and means something different. Thus a contracted form must be used, and the one

that was chosen by people who disdain to say ain't is aren't.

The structure which describes the two types of negation at this level is shown in figure 20, where Y indicates the node corresponding

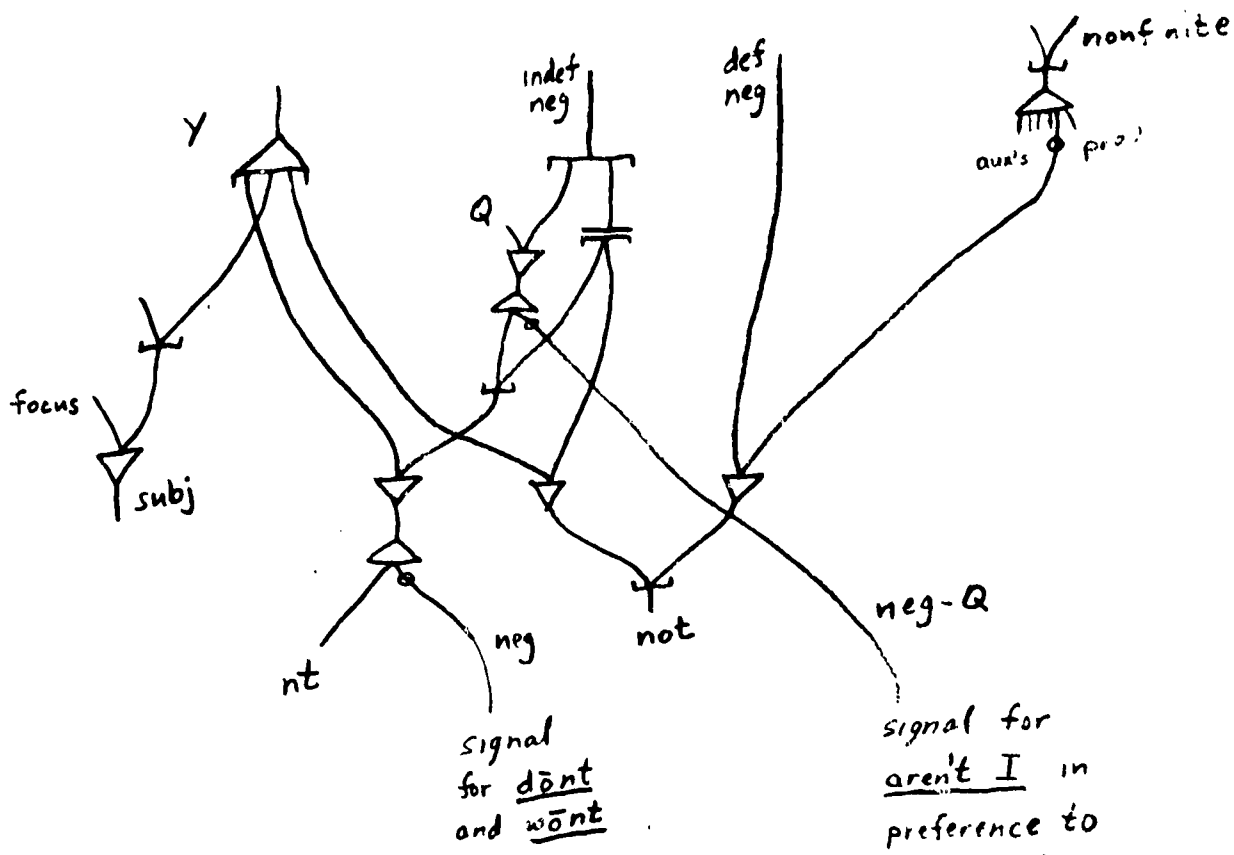



Figure 20. Structure of negation

to the node labelled Y in figure 11. Y, it will be recalled, leads to all the features which require the realization of the empty do if modals, have, or be are not present. Another feature which has this property is polarity emphasis. This also is trivially added to our grammar. Another feature is a juncture that results after the subject if it is needed to account for the difference in the number of syllables in 21a

versus 21b. This example was pointed out by Palmer (1965:33). It is

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21a. Now I have gone. [aiv]

21b. Should I have gone [ai əv]

Figure 20

---

an example of a place where syntax affects phonology. This is no particular problem for the relational network approach. When we need a syntax connected feature in phonology, we send a signal down to the phonology from the appropriate place in syntax. There seems to be some confusion on this point. Postal (1968:118) states: "The stratificational rejection of phonological or morphophonemic rules which refer to Surface constituents is..among the clearest evidence of the extent to which this theory fails to be descriptive of human language." We do not carry into the phonology <u>all</u> of the information about the 'surface structure ' because we don't <u>need</u> all of it. But, of course, we bring down any information that is needed. Where these lines enter the phonology, we call them phonological features, because in general they come from more than one place in the syntax, or go to more than one place in phonology, or both. That is, they go through an alternation pattern. For example, the juncture needed to account for the sentences in figure 21 also occurs after noun phrases which are not simple pronouns, as evidenced by the minimal pair in figure 22 where Shei is a nickname for Sheila (Palmer, 1965:33).

22a. Shei'll be there. [ i: əl]

22b. She'll be there. [ i: l]

Figure 22

Postal seems to be objecting both to calling such features phonological and to the fact that we bring down only the necessary features, rather than all features. He feels our approach is ad hoc. However, Chomsky (1967:108) has pointed out that evaluative notions such as simplicity are theory specific - the same argument applies to notions of ad hoc. From the point of view of stratificational grammar, to send all syntactic information to the phonology when only a few junctures are needed is like killing a mosquito by dropping an H-bomb on it. Of course, in order to complete the argument, it is necessary to demonstrate that the transformational cycle is unnecessary to account for stress in English. This would be a paper in itself (at least), but a sketch of the argument is given in Reich, forthcoming, and so it will not be pursued further here.

Figure 23 gives our final tentative sketch of the grammar for the English auxiliaries, with negation, polarity emphasis, and the above-mentioned juncture.

The grammar described by figure 23 attached to figure 16 differs from Newell's (1966) stratificational treatment in two ways. The first is that it does not follow the 1966 stratificational format. This has resulted in reducing a certain amount of redundancy that existed in the earlier treatment. The second difference is that Newell's treatment causes problems in defining a performance model to fit his

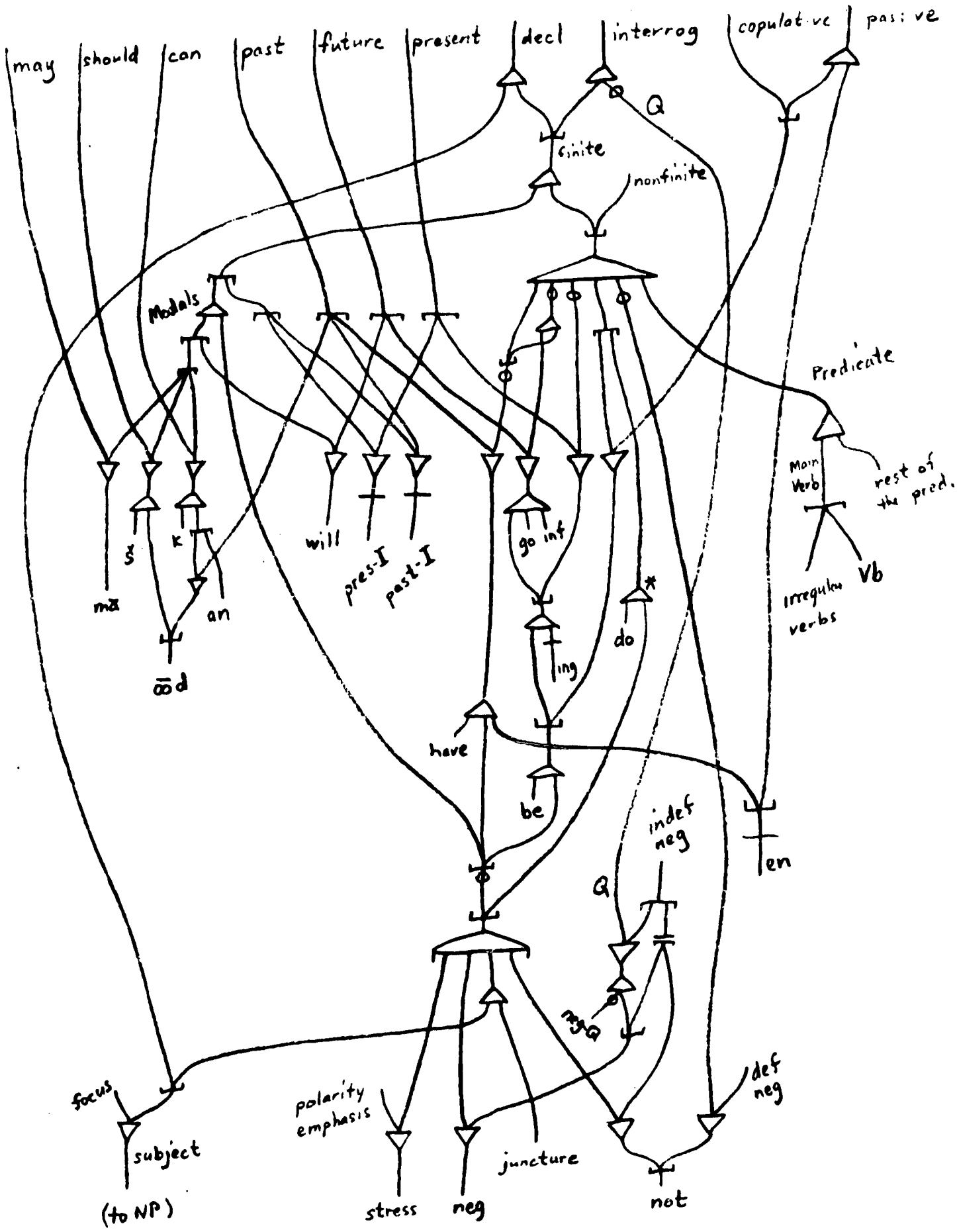


Figure 23: Tentative grammar for the auxiliaries

formulation. The morphemic system needs to 'look ahead' to see what is going to come down from the lexemic stratum before it actually comes down, in order to handle the insertion of the grammatically determined do properly. This can be avoided by adding some additional structure to the morphotactics but it increases bistratal redundancy, as this additional structure is already in the lexotactics. In order to demonstrate that my formulation does not suffer from such performance problems, which can be very difficult to spot, I have tested it on the computer, using the Relational Network Simulator (Reich, 1968). Sample output of a slightly earlier version appears in the appendix to that paper. The definition of the nodes used in running this network is also given in the appendix. The network produced as required in all samples tested.

In this paper we have shown that the relational network approach is adequate to handle the relationship between interrogative and declarative word order, the grammatically determined do, not, and the order of morphemes in the verbal auxiliary. This is one step toward demonstrating that the relational network approach is a viable alternative way of formalizing our knowledge of English grammar.

## Footnotes

[1]In his recent work, Lamb sometimes uses diamonds where I am going to use upward unordered ands (upward conjunction). This is based on two considerations. One is that if upward unordered ands are used as I use them in this paper, they cannot be defined in the same way as downward unordered ands. I prefer not to be bound by a constraint requiring that upward and downward nodes with identical logical function need necessarily be defined identically. The other consideration is that he is trying to solve the problem of both language production (encoding) and language perception (decoding). In some versions of decoding it appears that these nodes behave differently with respect to their two upward wires. If this is the case, then the node cannot be commutative and should be represented differently. I have limited myself in these papers to the problem of encoding, and in this domain I have found no reason to depart from Lamb's (1966b) earlier notation.

[2]Both optional nodes are indicated with a circle on the optional line. A downward optional is put near the node above it on the line, and an upward optional is put near the node below it on the line. In situations where this does not make the difference clear, I indicate the upward optional by adding a line immediately below the circle, as shown in figure 2, and the downward optional by adding a line immediately above the circle, as shown in figure 1.

[3]I have chosen this model merely for purposes of explicitness. A two tense description such as that described by Huddleston, Hudson, Winter and Henrici (1968) has much to recommend it, although I personally don't agree with all their examples (this is probably a

dialect difference). David Bennett and Geoffrey Sampson, working at Yale, have both found additional evidence for a two tense system. Since most of the difference would appear in the networks which would describe English semology, and since this paper is concerned exclusively with lexemic and morphemic structure, it is not important to the arguments in this paper how the issue is ultimately resolved.

[4]This is the point in the grammar which would have to be modified if the semology is better described in terms of a two tense system. See footnote 3.

[5]This design assumes the signal for negation is one of the first signals sent down by the semology. Otherwise such non-English strings as *I will haven't gone instead of I won't have gone might be produced.

[6]This is one place in which extensive changes have taken place in transformational theory since 1957. In my opinion these changes have only made matters worse, at least with respect to morphophonemic structure. I have never seen in print how transformationalists propose to handle this structure within their current formulation, although Wall (personal communication) has indicated how he thinks it might be done. In this paper I will refer only to the 1957 version of transformational grammar, and save discussion of the newer formulation and the reason I dislike it, for a future paper.

[7]The irregularity of have can be handled completely in the phonology by spelling it haV where V is a consonant which is realized as v only in syllable final position. Thus $^{MN}$/haVd/ is realized as $^{P}$/h æ d/ and $^{MN}$/haVZ/ is realized as $^{P}$/hæ z/.

[8]After this paper was written Lamb modified his position so that it might be relatively close to mine. However, it is too early to tell exactly what the correspondence will be.

[9]For more discussion on this issue see Lamb, 1964:111ff, Chomsky, 1962c:97, and Lamb's description of the same data in Lamb, 1966b:39.

[10]One must not confuse this example with 'Zellig didn't stay at the hotel; 'he moved into a 'flat., which is grammatical in an appropriate context.

[11]Except in the case of the copulative be, where it occurs after the main verb.

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