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Chapter 7

A categorial theory of structure building

Michael Flynn

0. INTRODUCTION*

In 1901 Bertrand Russell discovered the contradiction that was later to become known as Russell's paradox. It led him to formulate a theory of logical types.[1] Several years later Stanislaw Lesniewski, working in Warsaw, decided that Russell's solution to the paradox was an 'inadequate palliative' and rejected it. He turned to Husserl's theory of meaning and developed what he called a theory of 'semantical categories'. His colleague Kazimierz Ajdukiewicz then formulated an algorithm based on Lesniewski's system to determine the well-formedness of an arbitrary string in certain languages (Ajdukiewicz 1935). It is Ajdukiewicz's idea which forms a major part of the conceptual core of the theory of language proposed in this paper.

To take an example from a propositional calculus, the sentence in (1) with the indicated bracketing could be specified as well formed by the formation rules in (2).

(1) $[_S\ [_{CON}\ \supset]\ \ [_S\ p]\ \ [_S\ [_{CON}\ \wedge]\ \ [_S\ q]\ \ [_S\ r]]]$
or in more familiar notation, $(p\ [\supset]\ (q \wedge r))$

(2)

$S \rightarrow p,q,r, \ldots$	($p,q,r, \ldots$ are sentences in L)
$CON \rightarrow \supset, \wedge$	($\supset, \wedge$ are connectives in L)
$S \rightarrow CON\ S\ S$	(If α, β are sentences in L, then $CON\ \alpha\ \beta$ is a sentence in L)

Notice that the formation rules simultaneously specify the hierarchical organization (i.e. the categorial assignments) of expressions in the language and the order in which the constituents of complex (i.e. branching) categories must appear. In Ajdukiewicz's system, however, the formation rules are replaced by (sometimes fractional) categorial assignments and a method for checking order (called 'cancellation' for obvious reasons) as in (3) and (4).

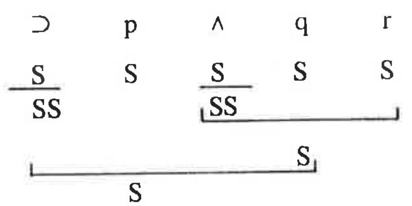
(3) p,q,r, … are each members of category S

$\supset$, $\wedge$ are members of category $\frac{S}{SS}$

(4) Find a combination of categories with a fractional category in the initial position, followed immediately by exactly the same categories that occur in the denominator of the fractional category. If one of these combinations is found, replace it with the category which appears in the numerator of the fractional category.

Thus, (1) represented as (5), will be found to cancel to an S, which is to say that it is a 'syntactically connected' expression of category S.

(5)

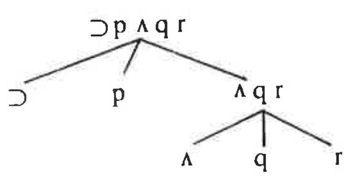


If there is some reason to prefer a generator to a recognizer, (4) can easily be reformulated as (6), which we will call A-concatenation (A for Ajdukiewicz).

(6) If α is an expression of category $\frac{W}{Y_1 \ldots Y_n}$, and $\beta_1 \ldots \beta_n$ are expressions of categories $Y_1 \ldots Y_n$ respectively, then $\alpha \frown \beta_1 \frown \ldots \frown \beta_n$ is of category W.

A-concatenation will generate the tree in (7).

(7)



This way of looking at things has two interesting characteristics. One is that the assignment of expressions to categories suffices to determine the hierarchical organization of phrases in the language, but says nothing about ordering within constituents.[2] In our artificial example, the assignment of a connective like '$\supset$' to the category $\frac{S}{SS}$ says that it will combine

with two sentences to make a sentence. But it does not say how it will combine. A-concatenation tells us that. Thus hierarchical organization can be made independent of left-right order. Secondly, notice that A-concatenation makes 'predictions' about the rest of the syntax of the language. For example, suppose we were to add names like *John* and *Mary* (in, say, category NP) to the language and one-place predicates like *runs* and *walks*, which combine with NPs to form sentences (category $\frac{S}{NP}$). A-concatenation already specifies the order. No new rules need to be added. This, of course, would not be the case for the phrase structure rules in (2), at least in the absence of a theory of phrase structure rules which could make the prediction.

Though Ajdukiewicz clearly intended his system to apply to natural languages, he was well aware that, as it stood, it did not work very well. Nevertheless, it was very useful for logics and was employed by Carnap, Bar-Hillel (see the papers in Bar-Hillel 1964) and more recently, Montague.

In the meantime, it became widely assumed in generative grammar that a set of context-free phrase structure rules was a major subcomponent in grammars of natural languages.[3] As the notion that these rules are universal and extremely simple was discarded, it became necessary to construct a theory of phrase structure rules that incorporated sufficient constraints to permit them to be acquired by learners. The most familiar theory of this sort is the X-bar theory, in its many instantiations. But each of the instantiations that I know of either encounters severe problems, is substantially underspecified, or both. I do not think it would be fair at this point to say that phrase structure rules, or the theories that employ them, should be abandoned, but I do think it makes sense to consider a rather different alternative.[4]

This chapter argues that one attractive alternative is a categorial grammar of the sort proposed by Ajdukiewicz. Phrase structure rules are discarded entirely. Categorial assignment determines hierarchical organization of phrases universally, and specification of precedence relations (for languages which have restrictions) is provided by a single, simple principle, called the word order convention, which operates simultaneously across categories and across levels. Word order conventions are very much like A-concatenation, in that by their very nature they make predictions language wide.

In this chapter, I will adduce word order conventions for three languages, English, Hopi, and Malagasy, concentrating on English for the purposes of illustration. Some of the categorial assignments are adapted from Montague (1973) (hereinafter PTQ). Although a basic familiarity with Montague grammar would be helpful to the reader, I have tried to state the main ideas of the paper using a minimum of Montague's terminology.[5]

Before we turn to details, let me try to articulate the approach from a broader perspective. One goal of theoretical linguistics is to shed some

light on how a child abducts (in Peirce's sense) a rather abstract system which in part regulates linguistic behavior. From the point of view of the X-bar theory, the idea is to constrain the possible sets of phrase structure rules so that insight may be achieved into how a child adduces one set of rules over another equally compatible with the accessible data. Or to put this another way, to give some reason why, say, it so often happens that languages do not have both the phrase structure rules in (8). (This is one way of stating Greenberg's (1963) universal 4.)

(8) VP → NP V
PP → P NP

From the point of view of categorial grammar, the nature of the problem changes somewhat. The goal here is to explain why the child adduces one word order convention over another equally compatible with the accessible data. Or, how are we to construct a theory which yields the prediction that so few word order conventions specify that NP objects precede the verb, but NP objects follow their prepositions?

Serious empirical proposals about universal constraints on word order conventions and the specification of a markedness theory of categories would at this point be little more than hopeful speculation (though we will see an example of the logic of the situation in the final section of this chapter). Consequently, the hope for an illuminating comparison of the categorial theory with phrase structure grammars is premature. The goal of this chapter is more modest. It is to convince the reader that the widespread confidence in phrase structure rules just might be misplaced.

1. We begin by recursively defining a set of categories. This definition is adapted from PTQ.[6]

(9) Let e and t be two fixed objects. The set of categories is the smallest set CAT such that
1. e is in CAT
2. t is in CAT
3. whenever W,Y are in CAT, $\frac{W}{Y}$ is in CAT
4. whenever $\frac{W}{Y}$ is in CAT, $\frac{W}{Y}\alpha$ is in CAT, where α is N, A, or V.

The categories defined by clause 3 of (9) are called *fundamental categories*. Those defined in clause 4 are called *word class projections*. N, A, and V are called *word class markings*. These play a role similar to that played by the multiple slash notation in PTQ. So, for example, intransitive verb phrases are assigned to $\frac{t}{e}$V, intransitive nominal phrases to $\frac{t}{e}$N, and one

place predicate adjectives to $\frac{t}{e}$A (=Siegel's (1976) t///e). There are no expressions in $\frac{t}{e}$ (the fundamental of this category) in English (though there may be in other languages).

As mentioned earlier, we will let the category assignments themselves specify hierarchical organization, while a language particular word order convention will determine left-right order. It is conceptually easier to think of these two interacting specifications in two separate steps. So let us first define categories of sets of expressions:

(10) If α is an expression of category $\frac{W}{Y}$, and β is an expression of category Y, then $\{\alpha, \beta\}$ is of category W.

To see an example of how this works, we will need some expressions. We will follow Montague and assign all noun phrases to the category $\frac{t}{\frac{t}{e}}$

(These will translate to expressions in the logic which denote sets of properties of individual concepts. For discussion, see Lewis (1970), Partee (1975), Dowty, Wall, and Peters (1981)). Notice that the argument category of this category does not have a word class marking. By a general interpretation of word class markings with respect to (10), this means that this category can apply to the fundamental category ($\frac{t}{e}$) and *not* to any of the word class projections of this category ($\frac{t}{e}$N, $\frac{t}{e}$V, $\frac{t}{e}$A). But since, as we mentioned earlier, there will be no items in English in $\frac{t}{e}$, $\frac{t}{\frac{t}{e}}$ will never take any arguments. We will therefore, for the sake of perspicuity, abbreviate this category as 'NP'. The reader should keep in mind that NP is not, technically, a category symbol, but merely an abbreviation of a category symbol.

Intransitive common nouns like *man* will be assigned to the nominal word class projection of $\frac{t}{e}$, namely, $\frac{t}{e}$N. Now we may regard determiners like *every* as being of a category which is a function from common nouns to noun phrases, so determiners must be of category $\frac{NP}{\frac{t}{e}N}$. (10) then says that the set {*every*, *man*} is of category NP.

There are two things worth noting here. One is that the functor category is always uniquely determinable; there is no category which both takes and is taken by another category. This is an essential property of categorial grammar and is what is behind the attempt to use it to resolve Russell's paradox. The second is that we have two ways of determining the category of an expression. One is semantic. We followed PTQ in assigning *man* to a category which guarantees that it will translate to an expression which will denote a one place predicate. The other is syntactic. I doubt that anyone has clear intuitions about the type of the expression *every* translates to,

but we can determine its category by noting that it combines with $\frac{t}{e}$N's to form NP's. The motivation for assigning NP's to $\frac{t}{\frac{t}{e}}$ involves both methods (see Lewis 1970).

For a second example, consider intransitive verbs like *walk*. We will once again follow Montague and assign them to a category which will map onto a type the meaningful expressions of which will denote one place predicates (just like intransitive nouns): $\frac{t}{e}$V. We will also follow a suggestion in Bach (1980b) and treat tenses as being of a category which is a function from intransitive verb phrases to a function from noun phrases to sentences:[7] $\frac{\frac{t}{NP}}{\frac{t}{e}V}$. (10) now says that {PRES, *walk*} is of category $\frac{t}{NP}$. But now we can combine this set with the one from our first example yielding (11).

(11) {{PRES, walk}, {every, man}} is of category t.

Consider a third case. We will regard transitive verbs like *love* as being of a category which takes noun phrases as arguments and results in one place predicates. In other words, *love* is assigned to $\frac{\frac{t}{e}V}{NP}$. Hence, if *Mary* is an NP, (10) specifies that {love, Mary} is a $\frac{t}{e}$V. Analogous to our second example, we then have (12).

(12) {PRES, {love, Mary}} is of category $\frac{t}{NP}$.

Finally, it is clear that we may then have (13).

(13) {PRES, {love, Mary}}, {every, man}} is of category t.

In this way, hierarchical organization is defined universally by the principle in (10).

We can now state the principle in English that determines the left-right order of constituents of phrases. First, it will be useful to introduce some notation, originally due to Lambek (1961).

Consider an expression α which is of category $\frac{W}{Y}$. Suppose that β is an expression of category Y. If α and β are expressions in a language, then three possibilities exist:[8]

(14) L_a: $\alpha^\frown\beta, \beta^\frown\alpha$
L_b: $*\alpha^\frown\beta, \beta^\frown\alpha$
L_c: $\alpha^\frown\beta, *\beta^\frown\alpha$

$*\alpha\frown\beta$, $*\beta\frown\alpha$ is impossible by (10). For language L_a we may write the category of α as $\frac{W}{Y}$. For L_b, we may write the category of α as Y\W. This means that the argument, i.e. β, must appear on the *left* of the expression α in the resulting expression. Another way of saying this is that α is 'leftward-looking'. For L_c, we may write the category of α as W/Y. Here β must appear to the ***right*** of α, or α is 'rightward-looking'.

We also define the notion of ***major category*** as follows:

(15) A major category is any category whose resultant category is t.

Expressions of these categories will always translate to expressions in the logic which denote sets. Thus, so far, we have seen these major categories: $\frac{t}{e}$ (and its word class projections), $\frac{t}{\frac{t}{e}}$ (i.e. NP) $\frac{t}{NP}$ (i.e. tensed verb phrase), and t (sentence).[9] Categories like $\frac{\frac{t}{NP}}{\frac{t}{e}_V}$ (TENSE), and $\frac{NP}{\frac{t}{e}_N}$ are not major categories.

With Lambek's notation and the definition of major category in (15), we can now state the word order convention for English.

(16) Word Order Convention for English

If some phrase φ is of category $\frac{W}{Y}$ and φ contains an expression assigned to a major category, then $\frac{W}{Y}$ is to be interpreted as Y\W. Otherwise, $\frac{W}{Y}$ is to be interpreted as W/Y.

We can think of this procedurally. If, in English, one wants to combine two phrases, the first thing to do is to locate the functor (recall that it is always uniquely determined) and check to make sure that it and its argument are of the proper category. Then if the phrase which is assigned to the functor category contains a major category (we will regard a phrase as containing itself), then the phrase which is of the functor category will appear to the right of the phrase which is of the argument category.[10] In other words, phrases with major categories in them are leftward-looking.

Let us return to our examples above and see how this convention works. Recall that we have the expressions in (17).

(17) $\langle \text{man}, \frac{t}{e}\text{N} \rangle$

$\langle \text{walk}, \frac{t}{e}\text{V} \rangle$

$\langle \text{every}, \dfrac{\text{NP}}{\frac{t}{e}\text{N}} \rangle$

$\langle \text{Mary}, \text{NP} \rangle$

$\langle \text{love}, \dfrac{\frac{t}{e}\text{V}}{\text{NP}} \rangle$

$\langle \text{PRES}, \dfrac{\frac{t}{\text{NP}}}{\frac{t}{e}\text{V}} \rangle$

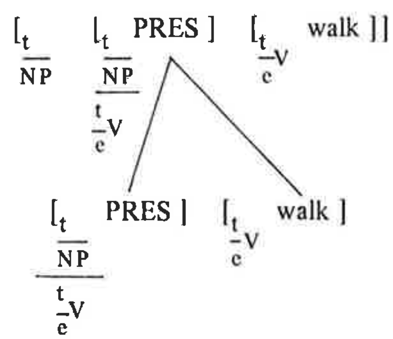
We will follow Partee (1975, 1976b) and assume that expression are bracketed, that brackets are labelled, and that the labelled bracketing is preserved under concatenation (though we will often suppress such bracketings for perspicuity). We can now construct analysis trees as follows.

Since *every* is of category $\dfrac{\text{NP}}{\frac{t}{e}\text{N}}$, and *man* is of category $\frac{t}{e}\text{N}$, (10), as we saw, specifies that {*every*, *man*} is of category NP. The word order convention for English specifies that since *every* does not contain a major category, it will appear to the left of the common noun it applies to. Thus we have the analysis tree in (18).

(18) $[_{\text{NP}}\ [_{\frac{\text{NP}}{\frac{t}{e}\text{N}}}\ \text{every}\ ]\ [_{\frac{t}{e}\text{N}}\ \text{man}\ ]]$

$[_{\frac{\text{NP}}{\frac{t}{e}\text{N}}}\ \text{every}\ ] \qquad [_{\frac{t}{e}\text{N}}\ \text{man}\ ]$

Similarly, since PRES is of category $\dfrac{\frac{t}{\text{NP}}}{\frac{t}{e}\text{V}}$ (not a major category) and *walk* is of category $\frac{t}{e}\text{V}$, we have (19).

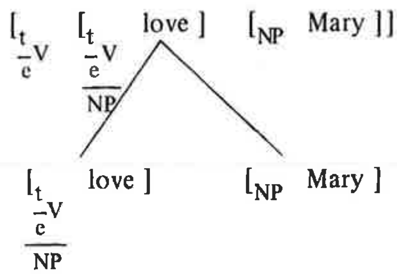
(19) 

Now (19) can combine with (18). But since (19) is of a major category, it will appear to the right of (18).

(20) $[_{t}\ [_{NP}\ \text{every man}\,]\ [_{\frac{t}{NP}}\ \text{PRES walk}\,]]$

Notice that since all tensed verb phrases are of a major category, they will all appear to the right of the subject. Hence, English is subject-initial.

To take the second case we considered, *love* is of category $\frac{\underset{e}{\overset{t}{-}}V}{NP}$ and Mary is an NP. Since *love* does not contain a major category, we have the tree in (21).

(21) 

Leaving verbs with multiple complements aside for the moment, it is plain that all complements of verbs will follow the verb, since no verb which takes a complement will contain a major category. Thus the word order convention specifies that English is S$\frown$V$\frown$Complement.

Returning to our example, PRES may apply to (21) to get (22).

(22) $[_{\frac{t}{NP}}\ [_{\frac{\frac{t}{NP}}{\underset{e}{\overset{t}{-}}V}}\ \text{PRESS}\,]\ [_{\underset{e}{\overset{t}{-}}V}\ \text{love Mary}\,]]$

Of course it makes no difference here that the argument contains a major category, since it is only the composition of the functor category that matters. (22) may then apply to an NP like *every man*. Since it's a major category, it looks left.

(23) $[_t\ [_{NP}$ every man $]\ [_{\frac{t}{NP}}$ PRES love Mary $]]$

We have, so far, shown that the generalizations in (24) are special cases of the word order convention for English.

(24) a. determiners precede the noun
b. verbs precede their complements
c. subjects precede the verb phrase

We noted earlier that word order conventions make predictions language wide. In the next section, we will look at how this convention for English fares in other parts of the language. Then we will examine other word order conventions and sketch a universal theory.

2. $\frac{t}{e}$ is a rather important category in this theory. We might call it the 'pivot' category.[11] Some categories combine with phrases to make $\frac{t}{e}$'s (or, as in English, some of its word class projections). These are phrases that, in a theory which employs a phrase structure grammar, strictly subcategorize nouns, verbs, and adjectives. Thus, the items in (25) each combine with its argument to form a $\frac{t}{e}V$.

(25) $\langle$ refuse, $\frac{\frac{t}{e}V}{NP}$ $\rangle$ as in *refuse the offer*

$\langle$ decide, $\frac{\frac{t}{e}V}{INF}$ $\rangle$ [12] as in *decide to leave*

$\langle$ claim, $\frac{\frac{t}{e}V}{S}$ $\rangle$ as in *claim that ontogeny recapitulates phylogeny*

Since none of the categories in (25) are major categories, all the complements will appear to the right of the verb. The same is true for nouns. Suppose we adopt (mutatis mutandis) the treatment of nominalizations proposed in Chomsky (1970) and modified in Jackendoff (1975). (A detailed exposition of this is given in Flynn (1981b)). We will have the categories in (26).

(26) $\langle \text{refusal}, \frac{\frac{t}{e}N}{NP} \rangle$ as in *refusal (of) the offer*

$\langle \text{decision}, \frac{\frac{t}{e}N}{INF} \rangle$ as in *decision to leave*

$\langle \text{claim}, \frac{\frac{t}{e}V}{\bar{S}} \rangle$ as in *claim that ontogeny recapitulates phylogeny*

Again, since none of the categories in (26) are major categories, the complements appear to the right of the noun. Thus we see how one kind of cross-categorial generalization is captured by the theory. The word order convention cannot tell the difference between verbs and their nominalizations and will treat their complements the same way.

Jackendoff (1977) p. 61 suggests that 'semantically, restrictive modifiers map predicates into predicates of the same number.' We will say something similar: restrictive modifiers map one place predicates into one place predicates. Since the fundamental category for one place predicates is $\frac{t}{e}$, restrictive modifiers must be assigned to the fundamental category $\frac{\frac{t}{e}}{\frac{t}{e}}$.

Consider now prepositional phrases. Jackendoff (1977) notes that they appear as complements to nouns, verbs, and adjectives, and further, the X-bar framework must provide a mechanism to generate an indefinite number of them in the double bar level of these categories. In the categorial theory, these generalizations are captured by assigning prepositional phrases to $\frac{\frac{t}{e}X}{\frac{t}{e}X}$, where X is a variable over N, A, or V.

The internal structure of these phrases is transparent. Prepositions which take noun phrases into prepositional phrases are assigned to $\frac{\frac{\frac{t}{e}X}{\frac{t}{e}X}}{NP}$

We therefore generate the phrases in (27). Notice that since prepositions are assigned to a category which is not major, they will appear to the left of their arguments.

(27) $[_{\frac{\frac{t}{e}X}{\frac{t}{e}X}}\ [_{\frac{\frac{\frac{t}{e}X}{\frac{t}{e}X}}{NP}}\ \text{in}\ ]\ [_{NP}\ \text{the kitchen}\ ]]$

$$[_{\frac{\frac{t}{e}X}{\frac{t}{e}X}}\ [_{\frac{\frac{\frac{t}{e}X}{\frac{t}{e}X}}{NP}}\ \text{with}\ ]\ \ [_{NP}\ \text{Mary}\ ]]$$

The prepositional phrases thus generated apply to all the word class projections of $\frac{t}{e}$. Since these phrases contain a major category (NP), they will appear to the right of their argument.

(28) $$[_{\frac{t}{e}N}\ [_{\frac{t}{e}N}\ \text{child}\ ]\ \ [_{\frac{\frac{t}{e}X}{\frac{t}{e}X}}\ \text{in the kitchen}\ ]]$$

$$[_{\frac{t}{e}V}\ [_{\frac{t}{e}V}\ \text{run}\ ]\ \ [_{\frac{\frac{t}{e}X}{\frac{t}{e}X}}\ \text{with Mary}\ ]]$$

We automatically get the correct relative order between subcategorizing phrases and optional restrictive modifiers because $\frac{\frac{t}{e}X}{\frac{t}{e}X}$ cannot apply to any other category besides $\frac{t}{e}$N,A,V. We generate *kiss every child in the kitchen* as follows.

(29) $$[_{\frac{t}{e}V}\ [_{\frac{t}{e}V}\ [_{\frac{\frac{t}{e}V}{NP}}\ \text{kiss}\ ]\ [_{NP}\ \text{every child}\ ]]\ \ [_{\frac{\frac{t}{e}X}{\frac{t}{e}X}}\ \text{in the kitchen}\ ]]$$

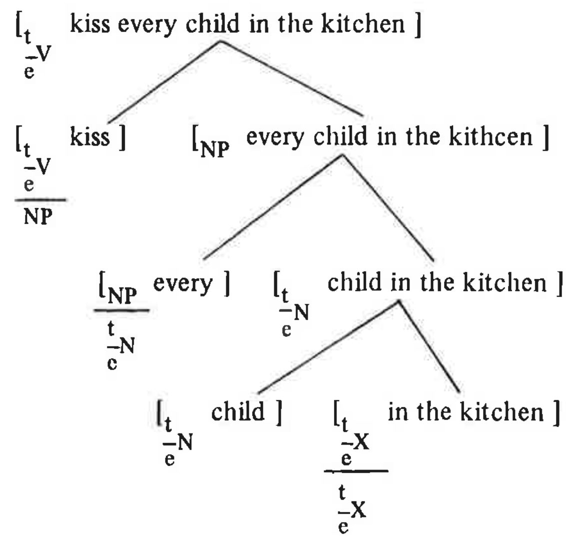
$$[_{\frac{t}{e}V}\ \text{kiss every child}\ ]\qquad [_{\frac{\frac{t}{e}X}{\frac{t}{e}X}}\ \text{in the kitchen}\ ]$$

$$[_{\frac{\frac{t}{e}V}{NP}}\ \text{kiss}\ ]\qquad [_{NP}\ \text{every child}\ ]$$

Notice that *in the kitchen* cannot apply to $[_{\frac{\frac{t}{e}V}{NP}}$ kiss$]$. The prepositional phrase requires that we apply *kiss* to its NP argument before it can apply to the result. The same is true for all categories that take complements; they must apply to their arguments before any restrictive modifiers can apply to them.

We also get the structural ambiguity of *kiss every child in the kitchen* straightforwardly. The reading in (29) is the one that indicates where the kissing is to take place. But the other reading, where *in the kitchen* indicates who is to be kissed, in generable as in (30).[13]

(30)



We could, of course, add another prepositional phrase like *in the living room* to (30) indicating where every child in the kitchen is to be kissed.

(31) $[_{\frac{t}{e}V}\ [_{\frac{t}{e}V}$ kiss every child in the kitchen $]\ [_{\frac{\frac{t}{e}X}{\frac{t}{e}X}}$ in the living room $]]$

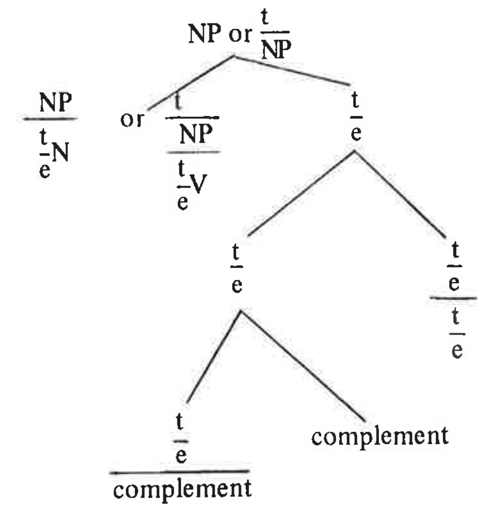
As in the X-bar theory, the grammar will permit prepositional phrases to pile up indefinitely, though in contrast to the X-bar theory, we require no special notation to specify this.[14]

Interesting questions arise about other kinds of prepositional phrases, which we put aside for now. But we are in a position to see that two aspects of the syntax of prepositional phrases are special cases of the word order convention. One is that, regardless of the complement, pre-

positions will appear to the left, since no preposition is of a major category. Thus, English is prepositional. Secondly, prepositional phrases, since they all contain major categories, will follow the phrases they modify.[15]

We can now see why $\frac{t}{e}$ is so central. Some categories take complements to make $\frac{t}{e}$'s. Then other categories apply to $\frac{t}{e}$ to make new $\frac{t}{e}$'s. Then, finally, some categories apply to $\frac{t}{e}$ to make the major phrases of the sentence, 'capping', in effect, the construction of the phrase:

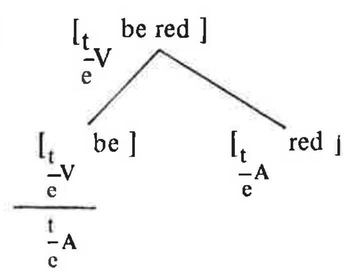
(32)



The position of the phrasal head and of determiners and tensing particles is fixed by the word order convention to the left of the argument. But the position of restrictive modifiers should vary depending on whether or not they contain a major category. Prepositional phrases always have major categories in them and always appear to the right (*pace*, note 15). But adjectives are not so uniform.

Suppose we adopt, with some modifications, the analysis of adjectives in Siegel (1976). Intersective adjactives are in $\frac{t}{e}$A. The copula, in $\frac{\frac{t}{e}V}{\frac{t}{e}A}$, applies to them and appears to the left by the word order convention.

(33)



Some passives and progressives may fall under this case. Now, as Siegel suggested, non-intersective adjectives like *former* are in $\dfrac{\frac{t}{e}N}{\frac{t}{e}N}$. These apply to common nouns, and by the word order convention, appear to the left:

(34) $[_{\frac{t}{e}N}$ former quarterback]

$[_{\frac{\frac{t}{e}N}{\frac{t}{e}N}}$ former] $\qquad [_{\frac{t}{e}N}$ quarterback]

This is so because *former* does not contain a major category. Now, intersective adjectives appear in noun phrases as well. Suppose we posit the following category changing rule. (A more detailed discussion of this rule is given in Flynn (1981a)).

(35) If $\alpha \epsilon \frac{t}{e}A$ and translatates as α', then $\alpha \epsilon \dfrac{\frac{t}{e}N}{\frac{t}{e}N}$ and translates $\lambda P \lambda x\ [\ P\{\ x\ \}\ \hat{}\ \alpha'(x)\ ]$.

This rule can be thought of as having the same effect as a transformation. It applies to anything in $\frac{t}{e}A$ and 'preposes' it, leaving intact its interpretation as a one place predicate. Thus *red* will also be in $\dfrac{\frac{t}{e}N}{\frac{t}{e}N}$, and will appear to the left of the common noun, just like *former*. Notice now that any adjective which contains a major category ought to appear to the right of the common noun. And this is correct:

(36) $[_{NP}$ a $[_{\frac{t}{e}N}$ $[_{\frac{t}{e}N}$ department] $[_{\frac{\frac{t}{e}N}{\frac{t}{e}N}}$ rife with $[_{NP}$ incompetents]]]]

And if some passives and progressives are adjectives, they behave as expected:

(37) $[_{\frac{t}{e}\mathrm{N}}\ [_{\frac{\frac{t}{e}\mathrm{N}}{\frac{t}{e}\mathrm{N}}}\ \text{stolen}\ ]\ [_{\frac{t}{e}\mathrm{N}}\ \text{book}\ ]]$

$[_{\frac{t}{e}\mathrm{N}}\ [_{\frac{t}{e}\mathrm{N}}\ \text{book}\ ]\ [_{\frac{\frac{t}{e}\mathrm{N}}{\frac{t}{e}\mathrm{N}}}\ \text{stolen by}\ [_{\mathrm{NP}}\ \text{John}\ ]]]$

$[_{\frac{t}{e}\mathrm{N}}\ [_{\frac{\frac{t}{e}\mathrm{N}}{\frac{t}{e}\mathrm{N}}}\ \text{sleeping}\ [\ \ [_{\frac{t}{e}\mathrm{N}}\ \text{child}\ ]]$

$[_{\frac{t}{e}\mathrm{N}}\ [_{\frac{t}{e}\mathrm{N}}\ \text{child}\ ]\ [_{\frac{\frac{t}{e}\mathrm{N}}{\frac{t}{e}\mathrm{N}}}\ \text{sleeping in}\ [_{\mathrm{NP}}\ \text{the living room}\ ]]]$

This analysis of adjectives in English, like all analyses of adjectives in English that I know of, is not without its problems. For example, it is unclear how to account for (38).

(38) a brightly shining light
a light brightly shining
*a shining brightly light

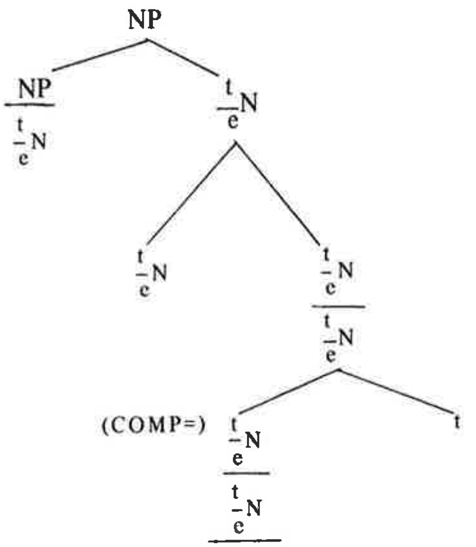
(Thanks to Edwin Williams for this example). And we also require a theory of category changing rules. (For some initial steps, see Dowty (1981) and Flynn (1981b)). But I think the analysis is suggestive, and it shows how the word order convention can distinguish items that behave differently but are of the same category. (For more on adjectives in the categorial framework, see Flynn (1981a) and Barss (1981)).

Of course there is more to say about restrictive modification in English, but I will restrain myself here to mentioning one other case. If relative clauses are restrictive modifiers (as seems natural), they will be in $\frac{\frac{t}{e}\mathrm{N}}{\frac{t}{e}\mathrm{N}}$

Since they always contain major categories, they will appear to the right of the common nouns they modify in English. Further, if we were to analyze the complementizer position as combining with a sentence to make a restrictive modifier, we might also have an explanation for why

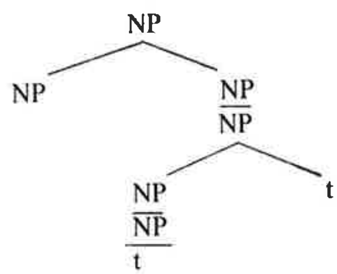
English has a leftward COMP. (We also have to assume either that COMP is empty at the relevant stage of the derivation or that its internal structure is irrelevant to the word order convention.) COMP must be $\dfrac{\frac{\frac{t}{e}N}{\frac{t}{e}N}}{t}$, which is not a major category. Consequently, we have (39).

(39)



It actually is not necessary to assume that relative clauses are in $\dfrac{\frac{t}{e}N}{\frac{t}{e}N}$. They may also be assigned to $\dfrac{NP}{NP}$, giving the structure (40), since $\dfrac{\frac{NP}{NP}}{t}$ for COMP is not a major category.

(40)



Of course, it doesn't matter on either analysis whether or not the phrase to the right of COMP is a t. This category plays no role in the argument, so if further analysis were to show that it should not be regarded as a sentence, the point here would not be affected.[16] It can also be shown, giving some

natural assumptions, that the complementizer in the $\bar{S}$ complement to verbs like ***claim*** is also predicted to be leftward by the word order convention. All that needs to be assumed is that ***that*** clauses are not themselves sentences. Suppose we represent them simply as $\bar{S}$, keeping in mind that $\bar{S} \neq t$. The complementizer, then, is in $\frac{\bar{S}}{t}$, which is not a major category and hence will appear to the left of the sentence.

Before summarizing what we have said so far, it would perhaps be worthwhile to mention one of the principal constituency tests used by Jackendoff (1977): the *do so* test. Jackendoff calls *do so* a pro-V^1 and uses this to test for membership in V^1. Strictly subcategorizing phrases may not follow *do so*:

(41) Ken bought a house last year, and Bob did so last week.
*Ken bought a house last year, and Bob did so a car.

We can say what amounts to the same thing in the categorial theory by assigning *do so* to $\frac{t}{c}V$ (though we will not elaborate here on the anaphoric mechanisms involved). Facts like those in (41) follow immediately, because *buy* is not a $\frac{t}{e}V$, but *buy a house* is.

However, there is a difference between the two theories. There must be some mechanism to move subcategorizing complements around restrictive modifiers (example from Jackendoff):

(42) John said $\left\{\begin{array}{l}\text{in a loud voice}\\ \text{suddenly}\\ \text{at 6:00}\end{array}\right\}$ that smoking was fun.

Said subcategorizes for $\bar{S}$, in this case, ***that smoking was fun***. Notice that we cannot follow (42) by (43):

(43) *but Susan did so $\left\{\begin{array}{l}\text{softly}\\ \text{in jest}\\ \text{at 5:00}\end{array}\right\}$ that it was bad for you

In Jackendoff's theory, (43) must be ruled out by some (unstated)[17] independent mechanism, because the $\bar{S}$ is no longer in V^1. In the categorial theory, the ungrammaticality of (43) is expected. Recall that *do so* is in $\frac{t}{c}V$. Restrictive modifiers are thus possible, but the following $\bar{S}$ is simply ungenerable, because *do so* cannot take any arguments.

Let's summarize what we've said so far. The word order convention for English, repeated here as (44), has as special cases the generalizations in (45).

(44) Word Order Convention for English

If some phrase φ is of category $\frac{W}{Y}$ and φ contains an expression assigned to a major caterogy, then $\frac{W}{Y}$ is to be interpreted as $Y\backslash W$. Otherwise, $\frac{W}{Y}$ is to be interpreted as W/Y.

(45) a. determiners precede nouns
b. verbs precede their complements
c. subjects precede the verb phrase
d. nouns precede their complements
e. English is prepositional
f. prepositional phrases follow the phrases they modify
g. adjective phrases that do not contain major categories precede the noun
h. adjective phrases that contain major categories follow the noun
i. relative clauses follow the nouns they modify
j. English has a leftward COMP

We've also noted that prepositional phrases modify nouns, verbs, and adjectives by virtue of the categorial assignment with a variable over word class markings. The correct order of optional restrictive modifiers with respect to strictly subcategorizing phrases falls out of the method of hierarchical organization. And the *do so* test for constituency is easily formulable in this framework, with perhaps even happier results than in the X-bar theory. We turn now to verbs with multiple complements.

3. In this section, we will consider phrases which are often analyzed as having a non-binary branching structure, such as those in (46).

(46) a. look the number up (V NP PRT)
b. put the pizza into the oven (V NP PP)
c. paint the room blue (V NP ADJ)
d. hammer the metal flat (V NP ADJ)
e. persuade Mary to leave (V NP $\bar{S}$)
f. consider Harry incompetent (V NP ADJ)
g. elect John president (V NP Predicate nominal)
h. consider Harry a friend (V NP NP)
i. promise Sue to leave (V NP $\bar{S}$)
j. strike Sam as crazy (V NP ADJ)

Essentially what we will do here is mimic the treatment of these expressions given in Bach (1979). But since Bach's theory contains rules that build

structure, we cannot use the same mechanism he does. First, let us review his proposal.

Bach's analysis takes advantage of the fact that in Montague's theory of categories there is no distinction between lexical and phrasal categories, and it rests in part on the assumption that passive is a productive rule which applies to all and only those items in category $\frac{\frac{t}{e}V}{NP}$ (in our terms). (For discussion, see Thomason (1976), Partee (1976b), Dowty (1978), and especially Bach (1980a).) Since (46a–h) have good passives, the expressions in (47) must be treated as phrases of category $\frac{\frac{t}{e}V}{NP}$.

(47) a. look up
b. put into the oven
c. paint blue
d. hammer flat
e. persuade to leave
f. consider incompetent
g. elect president
h. consider a friend

So the category of the verbs here may be given as in (48).[18]

(48) a. ⟨look, $\frac{\frac{\frac{t}{e}V}{NP}}{PRT}$⟩
b. ⟨put, $\frac{\frac{\frac{t}{e}V}{NP}}{PP}$⟩
c. ⟨paint, $\frac{\frac{\frac{t}{e}V}{NP}}{ADJ}$⟩
d. ⟨hammer, $\frac{\frac{\frac{t}{e}V}{NP}}{ADJ}$⟩
e. ⟨persuade, $\frac{\frac{\frac{t}{e}V}{NP}}{INF}$⟩

f. $\langle$ consider, $\dfrac{\dfrac{\frac{t}{e}V}{NP}}{ADJ}$ $\rangle$

g. $\langle$ elect, $\dfrac{\dfrac{\frac{t}{e}V}{NP}}{\text{Pred N}}$ $\rangle$

h. $\langle$ consider, $\dfrac{\dfrac{\frac{t}{e}V}{NP}}{NP}$ $\rangle$

We return to (46i,j) in a moment. Two sorts of rules are necessary for the generation of (46a-h) in Bach's theory. First, simple concatenation is needed to combine, say, *look* with its particle *up* to the right (and similarly for the other cases). It appears that several different rules are necessary, one for each category. Notice that in our theory, these phrases behave exactly as expected. None of the categories in (48) are major categories, so these items will appear to the left of their arguments.

The second kind of rule, which combines the phrases in (47) with their argument NP's, makes use of a subfunction RWRAP (Bach (1979) p. 516):

(49) RWRAP: If a is simple, then RWRAP (a,b) is $a^\frown b$. If a has the form $[_{XP}$ X W], then RWRAP (a,b) is $X^\frown b^\frown W$.

The rule for combining transitive verbs with their objects is then given as in (50).[19]

(50) If $\alpha \in \dfrac{\frac{t}{e}V}{NP}$ and $\beta \in$ NP, then RWRAP $(\alpha, \beta) \in \frac{t}{e}V$.

The phrases in (46a-h) are now generable straightforwardly.

(46i,j) do not involve transitive verbs at all. *Promise* and *strike* are assigned to the categories in (51) and the phrases are then generable by rules of simple concatenation.

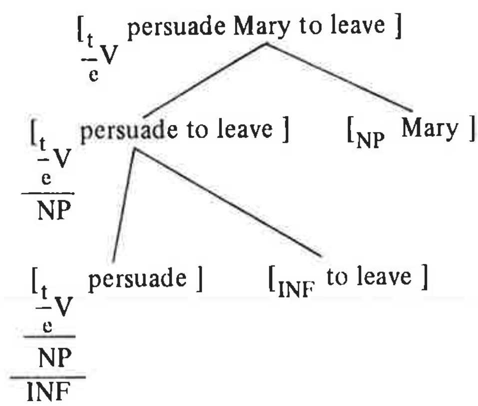
(51) $\langle$ promise, $\dfrac{\dfrac{\frac{t}{e}V}{INF}}{NP}$ $\rangle$ $\langle$ strike, $\dfrac{\dfrac{\frac{t}{e}V}{AP}}{NP}$ $\rangle$

In a theory like the one we are developing, we cannot appeal to subfunctions like simple concatenation and RWRAP because we do not have the right kind of rules. But the effect of RWRAP is easily stateable in the framework by means of the condition on the word order convention stated in (52). (52) is to be regarded as a language particular condition. We leave open for now whether or not it should be stated more generally and also the role played by such conditions across languages.

(52) The WRAP Condition
If α is a phrase of the form $[_{\frac{\frac{t}{e}X}{NP}}\ [\beta]\,[\gamma]]$
then the result of applying α to its argument is $[_{\frac{t}{e}X}\ \beta^\frown NP^\frown\gamma]$.

The phrases of (46a-h) are now straightforwardly generable, as for example, (46e) in (53).

(53)



Turning now to (46i,j), we see that these phrases are a problem for our theory, and we have to treat them in an ad hoc way (like just about everyone else).[20] To see the problem, consider the derivation of (46i). We follow Bach and assign *promise* to $\frac{\frac{\frac{t}{e}V}{INF}}{NP}$, therefore getting (54).

(54) $[_{\frac{\frac{t}{e}V}{INF}}$ promise Sue $]$

$[_{\frac{\frac{\frac{t}{e}V}{INF}}{NP}}$ promise $]$ $[_{NP}$ Sue $]$

But now *promise Sue* takes an INF, and the problem is clear, for *promise Sue* contains an expression which is assigned to a major category (i.e. *Sue*) and thus should appear to the *right* of its argument according to the word order convention. But that would be wrong. We will have to state that *promise Sue* is an exception to the word order convention by assigning *promise* to $\frac{\frac{t}{e}V/INF}{NP}$. (Recall that the right slash '/' indicates that the argument must appear to the right of the functor.) The derivation is as in (55).

(55) $[_{\frac{t}{e}V}$ promise Sue to leave $]$

$[_{\frac{t}{e}V/INF}$ promise Sue $]$ $[_{INF}$ to leave $]$

We can summarize this section as follows. We have shown how verbs with multiple complements can be treated in our framework. The word order convention and the WRAP condition combine to give the correct order for most of the relevant cases. *Promise*, as usual, has to be treated as an exception in the case where it takes an infinitival complement. For some discussion of a related phenomenon, in Irish, see McCloskey's chapter in this volume.

4. In this section, we extend the framework to some other languages and take some tentative steps towards a universal theory of ordering conventions. To recapitulate the basic idea of the theory, hierarchical organization of phrases in natural languages is given by the assignment of lexical items to categories and left-right order is determined by a language particular principle which applies across categories. Thus the child learning the language must discover at least three things: the lexical items in the language with their category assignments, rules that relate categories (such as the adjective rule and the nominalization relations),

and the word order convention. These are by no means independent of each other, since category assignments influence the word order convention and vice versa. Like every other tightly organized theory, an adjustment in one part will have effects in every other. We will see in this section that there are many places in the framework where an analysis is not rigidly specified by the theory. Indeed, there are too many. One goal of this section is to illustrate the framework's flexibility, and then to mention some ways in which this flexibility can be reduced.

As a working hypothesis, we will take an orthodox stance, for the most part, on category assignments and attribute the diversity in word order restrictions that languages exhibit to the adoption of divergent word order conventions. Of course, it is not a logical necessity that this strategy is correct, since different category assignments will give different word orders under the same ordering convention. Though we will regard this as a defeasible first assumption, we will see that it does yield encouraging results.

English, as we saw in the previous sections, is a 'major category sensitive' language, that is, its word order convention makes crucial mention of the notion of 'major category'. Hopi is quite different. Its word order convention does not appear to require reference to major categories at all. Rather, this language relies on the fundamental category $\frac{t}{e}$ to make the relevant distinctions for determining word order. Our proposal for its convention is (56).

(56) Word Order Convention for Hopi
For categories $\frac{W}{Y}$, where $Y = \frac{t}{e}X$ (i.e. one of the word class projections of $\frac{t}{e}$). $\frac{W}{Y}$ is to be interpreted as W/Y. Otherwise, $\frac{W}{Y}$ is to be interpreted as Y\W.

Another way of saying (56) is this: If a category takes a pivot category as its argument, phrases of that category will appear to the *left* of the argument. Otherwise, they will appear to the right.

The basic word order in Hopi is SOV.[21] Verbs take a range of complements:

(57) a. $\frac{\frac{t}{e}V}{NP}$: nɨʔ mit tiyoʔat tiva
I the boy see
'I see the boy'

b. $\frac{\frac{t}{e}V}{PP}$: nɨʔ ʔitaniy ʔaw yori
I our mother her-to see
'I saw our mother'

c. $\frac{\overset{t}{\underset{e}{-}}V}{S}$: nɨ? Hotvel-pe tiikive-ni-qa-t navoti? yta
I Hotevilla-at dance FUT OBV know
'I know that there is going to be a dance at Hotevilla'

d. $\frac{\frac{\overset{t}{\underset{e}{-}}V}{NP}}{PP}$: nɨ? siivat Po?k^y‿yat ?aw maqa
I money Po?k^yaya him-to give
'I gave money to Po?k^yaya'

Since none of the complements are in $\overset{t}{\underset{e}{-}}X$, the word order convention specifies that Hopi will be verb final. (57a) illustrates another property predicted by (56): determiners $\left(\frac{NP}{\overset{t}{\underset{e}{-}}N}\right)$ precede nouns. (57c) shows that Hopi is postpositional, and this, too, follows from (56).

Turning now to the subject phrase, recall that in our analysis of English we departed from PTQ and followed Bach (1980b) and regarded tensed verb phrases as functions from noun phrases to sentences. However, in the case of Hopi it is not so clear whether this kind of analysis is appropriate. I do not have the relevant data on which to base a decision, and for that matter, such data are rather hard to come by, even for English. It works very nicely here, as far as the syntax is concerned, to allow NP's to take verb phrases into sentences, and so we will do it that way to illustrate the alternative. What we may be seeing here is another way languages can vary, though at this stage of research, this idea must be regarded as quite tentative.

At any rate, Hopi verbs are not overtly marked for present or past tense or progressive aspect. They are simply entered in what I suppose might be called the basic form. Jeanne (1978) glosses them variously, sometimes present, sometimes past or progressive. Consider what happens when we adopt an analysis along the lines of PTQ and have NP's make sentences out of $\overset{t}{\underset{e}{-}}V$'s: $\frac{t}{\overset{t}{\underset{e}{-}}V}$. The word order convention then states that subjects will appear to the left of the VP, and we've seen above that this is correct.[22] There are auxiliary elements such as */-ni/* 'FUTURE' and */-n^{w}i/* 'NOMIC'. We can treat these as sentence operators and assign them to , which specifies that they will appear to the right of the sentence. This is correct:

(58) a. nɨ? pɨt nopna-ni
I him feed-FUT
'I will feed him'

b. mi? tiyo warikn^{w}i
the boy run-NOMIC
'the boy runs (habitually)'

Though the tense marker ends up as part of the phonological word that is the predicate, Jeanne gives evidence that these suffixes must be regarded as separate from verbs at some level of representation. Verbs can be 'gapped'[23] in Hopi, leaving the tense marker behind:

(59) a. ?ɨm warikg pɨɨ? nɨ? tɨwat warik-ni
you run then I also run-FUT
'you run and I will run also'
b. ?ɨm warikg pɨɨ? nɨ? tɨwat-ni
you run then I also-FUT
'you run and I will also'

Hence there appears to be some justification in regarding tenses as $\frac{t}{t}$.

Notice also that the word order convention specifies that if the language has common noun modifying adjectives ($\frac{\frac{t}{e}N}{\frac{t}{e}N}$), these will appear to the left of the common noun. I am uncertain about the data on this point. Jeanne (1978) p. 316 remarks that 'the class commonly called "adjective" in other languages is not to be distinguished from the verbal part of speech'. However Whorf (1946) cites the examples in (60) as cases of adjectives.

(60) a. pe-he voyo
new knife
b. qoca voyo
white knife

There may be a dialect difference involved here. At any rate, at least for the data Whorf gives, the word order convention makes the correct prediction.

For our purposes here, we will consider one more example. Hopi makes exuberant use of topicalization or, as Jeanne calls it, the pleonastic structure, as in the following examples. (See also the discussion in Hale, Jeanne, and Platero (1977)).

(61) mi? maana, pam pakɨmɨya
the girl she cry
'the girl, she is crying'

Relative clauses also exhibit this structure:[24]

(62) a. nɨ? tiyo?yat (pam) pakmɨmɨy-qa-t hoona
I boy him cry-qa-OBLIQUE sent-home
'I sent home the boy that is crying'
b. nɨ? tiyo?yat ?ita-nɨ (pit) naawakna-qa-t
I boy our mother him like-qa-OBLIQUE
tɨwɨ yta
know
'I know the boy that our mother likes'

Possessive phrases, postpositional phrases, and verb phrases all have a pleonastic variant:

(63) Possessive: mit tiyo?yat po? ko? at
mit tiyo?yat pɨt po? ko? at
the boy his dog
'the boy's dog'
PP : mit tiyo?yat ?amɨm
mit tiyo?yat pɨt ?amɨm
the boy him him-with
'the boy, with him'
VP : nɨ? mit tiyo?yat tɨwɨ?yta
nɨ? mit tiyo?yat pɨt tɨwɨ?yta
I the boy him know
'I know the boy'

It seems that what's going on here is reminiscent of the 'derived VP rule' proposed in Partee (1976b). In this case, a phrase can have some sort of NP gap, optionally marked with a pronoun, and then add a full NP which controls this position.

We want the pleonastic rule in Hopi to do something like this: if you have a phrase with a pronoun in it, the rule will semantically bind the pronoun with a lambda operator, and form an expression that is 'looking for' an NP to fill the created gap. Consider a simple case like (64).

(64) mi? tiyo?yat, Taqa pɨt tɨwɨ?yta
that boy Taqa him know
'Taqa knows that boy'

Suppose we derive (64) as follows. We first construct the sentence (65).

(65) $[_t$ Taqa pɨt tɨwɨ?yta$]$
translation: $know'(\hat{P}P\{x_7\})(t^*)$
(t^* is the translation of *Taqa*)

Then we make this sentence into a phrase which is looking for an NP to make a sentence.

(66) $[_{\frac{t}{NP}}$ Taqa pɨt tɨwɨʔyta$]$
translation: $\lambda \mathcal{PP} \{ \hat{x}_7 \ (know' \ (\hat{P}P \{ x_7 \}) \ (t^*)) \}$

Now the expression in (66) applies to an NP, which according to the word order convention, appears to the left, giving (67).

(67) miʔ tɨyoʔyat Taqa pɨt tɨwɨʔta
translation (assuming for convenience, but probably contrary to the fact, that *miʔ* translates like *the* in English):
$\bigvee y \ [\bigwedge x \ [\ boy' (x) \leftrightarrow x = y \ ] \wedge (know' \ (\hat{P}P \{ y \}) \ (t^*)) \ ]$

In other words, there is a unique boy such that Taqa knows him. The trick now is to write the rule so that it applies to several categories. We provisionally suggest (68).

(68) The pleonastic rule in Hopi
If α is a phrase with the form
$[_W \ldots PRO \ldots]$
and translates $(\ldots \hat{P}P \{ x_n \} \ldots)$
than α is a phrase of category $\frac{W}{NP}$, where α translates as
$\lambda \mathcal{PP} \{ \hat{x}_n \ (\ldots \hat{P}P \{ x_n \} \ \ldots) \}$

I don't believe I have seen a rule like (68) anywhere in the literature, as it may apply to any expression which has a pronoun in it. But it appears that this is the correct generalization for Hopi. At any rate, I think this rule gives the correct syntax (and semantics, as far as this can be determined at this point) for the pleonastic construction in Hopi.[25]

Let us summarize what we have noted so far in this section. The Hopi word order convention is (56), repeated here.

(56) Word Order Convention for Hopi
For categories $\frac{W}{Y}$, where $Y = \frac{t}{e}X$, $\frac{W}{Y}$ is to be interpreted as W/Y.
Otherwise, $\frac{W}{Y}$ is to be intrepreted as Y\W.

The following generalizations are special cases of (56).

(69) a. complements precede verbs
b. subjects precede the verb phrase (i.e. Hopi is SOV)
c. determiners precede nouns
d. Hopi is postpositional
e. adjectives (if the language has them) precede the noun
f. the pleonastic noun phrase appears to the left of the phrase it is associated with.

There is much more to be said about the syntax of Hopi in the categorial theory (see Flynn (1981a) for a more complete discussion), and I don't want to suggest that this analysis is problem-free. But our principal goal here has been to illustrate the potential of the framework. We have made some initial steps towards finding whatever universal principles may be stateable within the theory. We have proposed that English is a major category sensitive language and verb phrases apply to subjects, while Hopi is a pivot sensitive language and NP's apply to verb phrases to make sentences. Do these characteristics correlate in the world's languages? Are there any other 'sensitivities' that word order conventions may have? It would be premature to attempt to answer these questions conclusively, but at least I believe we have reached the point where they can be asked. In the next few paragraphs, we will briefly survey some other languages.

The categorial theory makes available languages which, in a sense, have the mirror image of Hopi syntax, that is, languages with the word order convention in (70).

(70) For categories $\frac{W}{Y}$, where $Y = \frac{t}{e}X$, $\frac{W}{Y}$ is to be interpreted as $Y\backslash W$. Otherwise, $\frac{W}{Y}$ is to be interpreted as W/Y.

Languages with the word order convention in (70) would have the properties in (71) among others.[26]

(71) a. VP + Subject
b. TVP + Object
c. Prep + NP
d. CNP + ADJ
e; CNP + Relative Clause
f. CNP + DET

As far as I know, there is only one language with all of these characteristics (Batak, cited in Keenan (1978), though this conclusion must be regarded as tentative). There are other which are close. One is Malagasy (also discussed in Keenan (1978)). Its properties are those in (72).

(72) a. VOS
b. DET + CNP
c. Prep + NP
d. Subordinate Conjunction + Subordinate Clause
e. CNP + Relative Clause
f. CNP + ADJ
e. V + ADV

To see one way the theory can accommodate such a language, let us propose a word order convention for it. First, we introduce some terminology from Bar-Hillel (1953). A category $\frac{W}{Y}$ is *endotypic* if W = Y. Otherwise, it is *exotypic*. A word order convention that will account for all of the data in (72) is (73).

(73) Word Order Convention for Malagasy
For categories $\frac{W}{Y}$, if $\frac{W}{Y}$ is exotypic, $\frac{W}{Y}$ is to be interpreted as W/Y. Otherwise, it is to be interpreted as Y\W.

The low-level generalizations for Malagasy in (72) are rather similar to those for English. The differences are those in (74).

(74) English: Subject initial
simple adjective + CNP
CNP + complex adjective
Malagasy: Subject final
CNP + ADJ

If one of the choices that languages are free to make is whether the subject is a function or an argument, then a language with the Malagasy word order convention but with subjects as functions would end up subject initial like English. This language would still, however, have all adjectives following the CNP.

The syntax of adjectives in English is a problem for every other theory that I know of. AP's in English appear on both sides of the head CN as in (75).

(77) a. Word order conventions may be sensitive to only one of the following: pivots, major categories, endo- or exotypicality.

b. VP's take subjects into S's in all languages except some pivot sensitive ones.

c. Only phrases assigned to functor phrases wrap, and wrap only with a phrase on their right. (In other words, there is no operation that takes some phrase α of category $\frac{W}{Y}$, applies it to some phrase $[_Y\ \beta\ \gamma]$ with the result $[_W\ \beta\ \alpha\ \gamma]$.)

d. Sensitivities are defined only on functor categories. For example, there is no word order convention that says 'if the phrase assigned to the argument category contains a major category...'

The constraints in (77) have little empirical content without a markedness theory of categories. Certainly the details of such a theory are very uncertain at this point. But to indicate a chain of inferences that such a theory would make possible, consider (78), regarded as a subcase of a universal theory of categories.

(78) a. All languages have the category $\dfrac{\frac{t}{e}V}{NP}$

(i.e. the category of transitive verbs)[30]

b. All NP's are assigned to $\dfrac{t}{\frac{t}{e}(V)}$. (V is in parentheses because only languages in which NP's take VP's to sentences will have it.)

Suppose the language acquisition device is equipped with (77) and (78) and further suppose that the child adduces that the language to be learned is VSO. Here is what follows immediately, with no further evidence necessary:

(79) VP's apply to NP's to make sentences (i.e. NP = $\dfrac{t}{\frac{t}{e}}$ with no word class marking) This follows directly from (77c).

From (79), (80) is deducible.

(80) The language is not a major category sensitive language. (There is no way to write a word order convention meeting (77) to yield a major category sensitive VSO language.)

Hence,

(81) The language is either

a. exotypic categories leftward

(i.e. $\frac{W}{Y}$, exotypic => W/Y), or

b. pivot initial

(i.e. $\frac{W}{Y}$, $Y = \frac{t}{e}X$ => Y\W).

If (81a) is true, then DET + N. If (81b), then N + DET. In this way two pieces of information (VSO and the order of determiners with respect to the noun) are sufficient to uniquely determine a word order convention.

The preceding remarks are, of course, quite speculative, but I hope the method of our explanation of Greenberg's generalizations is clear. The reason why, say, there are no VSO postpositional languages is that there is no word order convention which allows this combination.

FOOTNOTES

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1. See Russell (1908). Some elaborations on the remarks in these introductory paragraphs can be found under the relevant entries in the *Encyclopedia of Philosophy*.

2. Dowty (1981), recalling the terminology introduced in Curry (1963), refers to this distinction as that between the tectogrammatics (i.e. what we might think of the dominance relations which hold in the language) and the phenogrammatics (i.e. left-right order). As we will propose below, Dowty suggests that the tectogrammatics are essentially universal. For the deployment of this idea within a phrase structure framework, see Gazdar and Pullum (1981).

3. Bar-Hillel, Gaifman and Shamir (1960) showed that categorial grammars and context-free phrase structure grammars are weakly equivalent in generative capacity. Categorial grammars have been reintroduced as tools for linguistic description from time to time (Lyons (1966), Lewis (1970), Geach (1972)) but most of the proposals I am aware of do not attempt to exploit the notation to achieve explanation in syntax. The work of Bartsch and Vennemann (Bartsch and Vennemann (1972), Vennemann (1973, 1975)) appears to share a similar sort of intuition about the structure of languages that I will deploy here. However, the systems are quite different.

A detailed comparison would take us too far afield, but see Koster (1975) for remarks about the Bartsch-Vennemann theory that do not apply to the one in this paper. More recently there have been several studies which use a categorial syntax to explain syntactic phenomena. See Steedman and Ades (1981), Contreras (1981) and van der Zee (to appear).

4. For an interesting recent modification of the theory of phrase structure, see Stowell (1981). Some of the ideas presented there are quite similar in spirit to the theory in these pages, but they are deployed in a substantially different framework. A thorough-going comparison of the two approaches is beyond the scope of this chapter.

5. The theory I will explicate here departs, in a number of places and in varying degrees, from common practice in Montague grammar. I will not pause to identify each innovation. For a discussion of the Montague framework, see Dowty, Wall, and Peters (1981).

6. Categories have direct and universal semantic import. I am assuming that each category is mapped in a uniform way onto a type in an interpreted logic, along the lines specified in PTQ. For further discussion, see Flynn (1981a).

7. Actually, Bach (1980b) follows Lapointe (1980) in regarding the tensed forms of verbs as given directly by the lexicon, eliminating the need for abstract items like PRES in the syntax. I believe that our framework is reformulable along these lines. *Walks*, then, would be in $\frac{t}{NP}$, *loves* in $\frac{\frac{t}{NP}}{NP}$. There is no effect on the points made here, though we will continue to assume items like PRES for the sake of discussion.

8. This is not quite right, but we will assume it here for the sake of exposition. We will introduce a modification in section 3 that will account for discontinuous constituents.

9. We will regard the category t to fall under this definition, though I do not know of any cases where it makes a crucial difference.

10. It is unclear whether this convention is to be thought of as a rule for the construction of phrases or as an output condition. For the present purposes, the distinction will play no role and readers may have it as they wish. I believe that the word order convention may also be formulable in terms of node admissibility conditions in the sense of Gazdar (1982). Thus we may interpret (16) as an instruction to admit a node W under the conditions specified in the convention.

11. The terminology here was suggested to me by what I think is a similarly revealing metaphor in the technical vocabulary of basketball and baseball. The notion should not be confused with that of Braine (1963).

12. We beg the question of what categories INF and $\bar{S}$ abbreviate. Their exact specification, though an interesting problem, is irrelevant to the point under discussion here.

13. It is possible to formulate the principles of sentence parsing proposed in Frazier (1978) in a rather natural way within the categorial framwork. Her late closure principle can be stated as in (i) and her minimal attachment principle as in (ii).

(i) If the parser encounters a word which is ambiguous with respect lexical category, it will select a category which is a possible functor.

(ii) The parser checks the next item before making a category assignment. If the next item has a category assignment that allows phrasal packaging of already encountered items, that category assignment will be selected.

These principles predict that the reading in (29) is the preferred reading to that in (30) just as Frazier's principles do. For details and further discussion, see Epstein (1980).

14. In fact, any restrictive modifier that does not iterate is a problem for the theory. Ewan Klein has suggested to me that manner adverbs may be such a case.

15. Here we see one potential problem with our analysis: 'bare' prepositions as in *John walked in* and *the people here*. If *in* and *here* are assigned to the prepositional phrase category $\frac{\frac{t}{e}X}{\frac{t}{e}X}$, the word order convention predicts **John in walked* and **the here people*. I am uncertain right now what to say about this.

16. I want to make explicit the very tentative status of this treatment of COMP in relative clauses. The relevant research on unbounded dependencies in a categorial framework is only beginning, and hence the compatibility of the theory with others such as that in Gazdar (1982) and Chomsky (1981) is unclear. See Steedman and Ades (1981) and note 25 below.

17. He suggests it has something to do with the trace left by the extraposed constituent.

18. Notice that if we regard transitive verbs as being just those verbs in $\frac{\frac{t}{e}V}{NP}$ we do not encounter the problems noted and discussed in Gazdar (1982). We put aside the category specifications of PRT, INF, ADJ, and Pred N. Phrases such as *hammer flat* may be regarded as basic expressions. For discussion of this point, see Dowty (1976). The important point here is that *hammer flat* has an internal structure like

$$[_{\frac{\frac{t}{e}V}{NP}} [_{\frac{\frac{\frac{t}{e}V}{NP}}{ADJ}} \text{hammer}] \; [_{ADJ} \text{ flat}]]$$

regardless of whether or not this phrase is generated by a productive syntactic rule.

19. We have reformulated this rule slightly to make Bach's notation similar to our own. The point involved is not affected. Other writers who have appealed to a rule like RWRAP include Thomason (1976) and Dowty (1978).

20. Bach's treatment is ad hoc because there is no independent motivation for the failure of phrases like *promise Sue* to wrap like *persuade to leave*. That is to say, we need an explanation for why the category $\frac{\frac{t}{e}V}{INF}$ combines with its argument by simple concatenation, while $\frac{\frac{t}{e}V}{NP}$ calls the subfunction RWRAP.

21. Parts of the analysis and all of the data (except where noted) come from Jeanne (1978). I would like to express my thanks to Ken Hale for bringing Jeanne's work to my attention.

22. The reader can easily verify that Hopi would also be predicted to be subject initial if tensed VP's were assigned to $\frac{t}{NP}$ as we did for English.

23. The term here is Jeanne's. It is unclear from the examples she cites whether the rule involved is gapping or some sort of VP anaphora.

24. The relative clause marker *-qa* has very interesting properties which we won't go into here. For discussion, see Jeanne (1978). Flynn (1981a) suggests a treatment in categorial grammar that makes those properties special cases of the Hopi word order convention proposed here.

25. No doubt the reader will notice the provocative similarity between the Hopi pleonastic rule and other rules which set up unbounded dependencies. What to make of this is not clear yet.
26. We will assume that VP's take subjects into sentences unless otherwise noted.
27. There are some instances where adjectives not containing major categories may follow the noun, but these have a rather poetic feel:

(i) a melody sweet
the beer refreshing
the lion dying (from Shakespeare R2 5.1.29)
a dozen healthy infants well formed (from Watson's famous boast about behaviorism)

Cases of resistance to the word order convention show up in several places in English. The 'transportability' of adverbs ($\frac{\frac{t}{e}V}{\frac{t}{e}V}$ and $\frac{t}{t}$) may be related to this as well as object inversion in poetry (see Austin (1977) for discussion).

(ii) the lonely man's despair hunger overcame (Keats, 'Adonais')
When I a fat and bean-fed horse bequile (Shakespeare, MND 2.1.45)

28. One interesting question that we will not consider here is exactly how this wrap convention is to be stated and why VSO languages are much more common than VOS languages like Malagasy.
29. Notice that it is possible that a word order convention for a language may not have an 'otherwise case'. For example, suppose we had the convention in (i).

(i) For categories $\frac{W}{Y}$, if $Y = \frac{t}{e}X$, then $\frac{W}{Y}$ is to be interpreted as $Y\backslash W$.

This would give us a language where all restrictive modifiers and determiners (in that order) follow the head. But the distribution of NP's would be free, since (i) does not apply to categories which take NP arguments. Makua might be such a language. (See Stucky's chapter in this volume for discussion.) There are several ways to treat languages with free or partially free order in this framework, but the pertinent research has not been attempted yet.
30. Given other assumptions that we have made, this is equivalent to the claim that all languages have a VP.