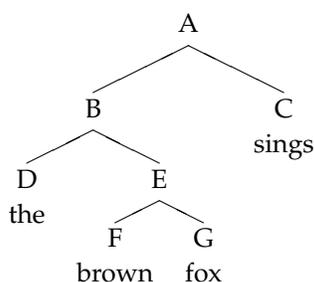


## Phrase Structure Rules, Tree Rewriting, and Recursion

### Hierarchical Structure: Complements and Adjuncts

#### 1 Trees

- (1) a tree for 'the brown fox sings'



- Linguistic trees have **nodes**. The nodes in (1) are A, B, C, D, E, F, and G.
- There are two kinds of nodes: internal nodes and terminal nodes. The internal nodes in (1) are A, B, and E. The terminal nodes are C, D, F, and G. Terminal nodes are so called because they are not expanded into anything further. The tree ends there. Terminal nodes are also called **leaf** nodes. The leaves of (1) are really the words that constitute the sentence 'the brown fox sings' i.e. 'the', 'brown', 'fox', and 'sings'.

- (2) a. A set of nodes form a **constituent** iff they are exhaustively dominated by a common node.
- b. X is a **constituent** of Y iff X is dominated by Y.
- c. X is an **immediate constituent** of Y iff X is immediately dominated by Y.

Notions such as subject, object, prepositional object etc. can be defined structurally. So a subject is the NP immediately dominated by S and an object is an NP immediately dominated by VP etc.

- (3) a. If a node X immediately dominates a node Y, then X is the **mother** of Y, and Y is the **daughter** of X.
- b. A set of nodes are sisters if they are all immediately dominated by the same (mother) node.

We can now define a host of relationships on trees - grandmother, granddaughter, descendant, ancestor etc.

Another important relationship that is defined in purely structural terms is c-command.

(4) A c-commands B:

if and only if A does not dominate B and the node that immediately dominates A dominates B.

if and only if B is either a sister of A or dominated by a sister of A.

*c-command* is used in the formulation of **Condition C**, a principle used to determine what a pronoun may not refer to.

- **CONDITION C**

(5) A pronoun cannot refer to a proper name it c-commands.

In general, if a pronoun cannot refer to a proper name (despite agreeing in gender and number and being in the same sentence), you can conclude that the pronoun c-commands the proper name.

Note that Condition C is a negative condition. It never tells you what a particular pronoun must refer to. It only tells you what it cannot refer to.

- **The NO CROSSING BRANCHES CONSTRAINT**

(6) If one node X precedes another node Y, then all descendants of X must also precede Y and all descendants of Y.

Where do the trees that we use to analyze linguistic structure come from?

In a way, they are just representations of facts that exist out in the world - the facts that we can discover using constituency test. So one way to make trees is by doing empirical work - taking a sentence, applying various constituency tests to the words in the sentence, and then drawing a tree based on the results of our tests.

This empirical method is ultimately the only correct way to deduce 'tree structure'. However, in most cases, we can simplify things considerably by using **Phrase Structure Rules** or **Tree Rewriting Systems**.

## 1.1 Phrase Structure Rules

**Phrase Structure Rules** are rules of the sort

$X \rightarrow YZ$

This rule says 'take the node X and expand it into the nodes Y and Z'. Alternately, going from right to left (or from below), it says 'if you have a Y and a Z next to each other, you can combine them to make an X'.<sup>1</sup>

Phrase structure rules can be categorial i.e. rules that expand categories into other categories, or they can also be lexical i.e. rules that expand category labels by word (lexical items).

---

<sup>1</sup>Such phrase structure rules are called Context Free Grammars (CFG) and were invented by Noam Chomsky in 1956. A closely related model was used by Pāṇini to describe the grammar of Sanskrit in around 500 B.C.

- A grammar can then be thought of as a set of phrase structure rules (categorial rules plus lexical rules).

The categorial rules can be thought of as (part of) the syntax and the lexical rules as (part of) the lexicon.

- Some Phrase Structure Rules for English

(7) Categorial Rules

- $S \rightarrow NP \text{ Modal VP}$
- $VP \rightarrow V \text{ AP PP}$
- $AP \rightarrow \text{ADVP A}$
- $\text{ADVP} \rightarrow \text{ADV}$
- $PP \rightarrow P \text{ NP}$
- $NP \rightarrow D \text{ N}$

(8) Lexical Rules

- $N \rightarrow \text{girl}$
- $N \rightarrow \text{boy}$
- $\text{Adv} \rightarrow \text{incredibly}$
- $A \rightarrow \text{conceited}$
- $V \rightarrow \text{seem}$
- $\text{Modal} \rightarrow \text{must}$
- $P \rightarrow \text{to}$
- $D \rightarrow \text{that}$
- $D \rightarrow \text{this}$

Some sentences these rules will **generate**:

- (9)
- This boy must seem incredibly conceited to that girl.
  - This boy must seem incredibly conceited to this girl.
  - This boy must seem incredibly conceited to that boy.
  - This boy must seem incredibly conceited to this boy.
  - This girl must seem incredibly conceited to that girl.
  - This girl must seem incredibly conceited to this girl.
  - This girl must seem incredibly conceited to that boy.
  - This girl must seem incredibly conceited to this boy.

How many more sentences will these rules generate?

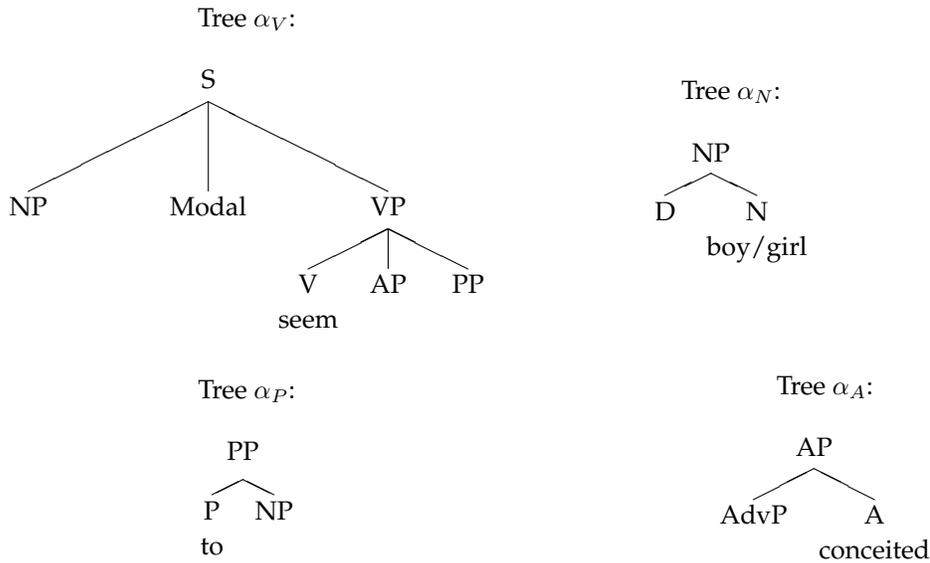
- Optional constituents

How do we handle cases like:

- (10) This boy must seem incredibly stupid.

## 1.2 Tree Rewriting Systems

Another way of generating trees is to start from small trees corresponding to *kernel* sentences and then combine these trees to build bigger trees.



The simplest kind of Tree Rewriting System is a Tree Substitution Grammar. It is equivalent in most respects to Context Free Grammars. The only operation in a Tree Substitution Grammar is **tree substitution**.

## 1.3 Introducing infinity

We know that human languages can contain sentences of arbitrary length. Consider (11) which stands for an infinite number of sentences.

(11) He believes that he believes that he believes that he believes that . . . he ate pizza.

So if all of human language is to be generated by a set of phrase structure rules, the relevant set of phrase structure rules should generate an infinite number of sentences.

How can that be done?

Let us try to analyze (11), starting with a more manageable (12).

(12) He believes that he ate pizza.

We start with the following categorial rules:

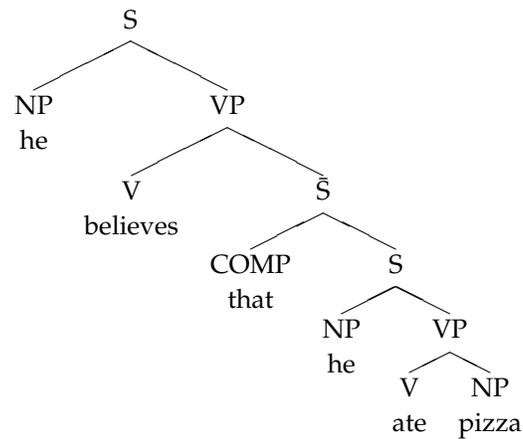
- (13)
- $S \rightarrow NP VP$
  - $VP \rightarrow V \bar{S}$
  - $\bar{S} \rightarrow COMP S$
  - $VP \rightarrow V NP$

We need the following lexical rules:

- (14) a. NP  $\rightarrow$  he  
 b. NP  $\rightarrow$  pizza  
 c. V  $\rightarrow$  ate  
 d. V  $\rightarrow$  believes  
 e. COMP  $\rightarrow$  that

Now we can generate (12). This is shown in (15).

(15)



But is (12) all that the rules in (13) and (14) will generate?

How many sentences will (13) and (14) generate?

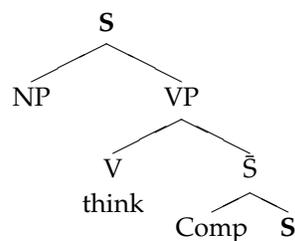
The source of all infinity in natural language is **recursion**. Sometimes the recursion is directly visible:

- (16) VP  $\rightarrow$  AdvP VP

And sometimes the recursion is only visible by following a sequence of steps.

- (17) a. S  $\rightarrow$  NP VP  
 b. VP  $\rightarrow$  V S̄  
 c. S̄  $\rightarrow$  COMP S

CFG/PSRs can't always make recursion explicit. Tree Substitution Grammars allow us to do this. We can **factorize recursion** out of the grammar by using *kernel trees* like the following:

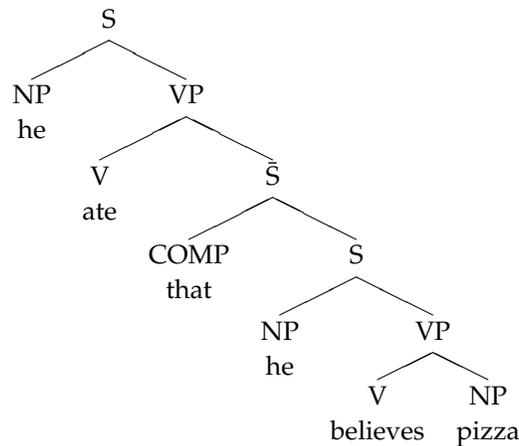


Tree Substitution Grammars are related to the richer and more powerful formalism of Tree Adjoining Grammars. Tree Adjoining Grammars have an additional operation of Tree Adjunction, which is distinct from ordinary adjunction. This operation provides additional expressive power which can be used for handling a variety of syntactic phenomena across languages. Tree Adjoining Grammars correspond to the Mildly Context Sensitive Languages (MCSLs), a class of formal languages that is strictly bigger than the class of Context Free Languages but strictly smaller than the class of Context Sensitive Languages.

## 1.4 Overgeneration

The rules in (13) and (14) will also generate sentences (see the structure below) like:

(18) \*He ate that he believes pizza.



How can we constrain phrase structure rules so that such overgeneration does not take place?

## 1.5 Constraints on Rules

Phrase Structure Rules by themselves are very unrestricted. For example, the following would be well-formed phrase structure rules:

- (19) a.  $WP \rightarrow XP ZP$   
 b.  $W \rightarrow YP WP$

In fact such rules are not attested. They are blocked crosslinguistically by the principle of **Endocentricity** (A phrase must have a head of the same kind) and by assumptions about what XP/X means.

- (20) a. An XP must have an  $X^0$  as a head.  
 b. The projection of XP starts at  $X^0$  i.e.  $X^0$  is the minimal projection.

For now, we will be able to do with just  $X^0$  and XP. Later we will have occasion to bring in the X-bar level.

## 2 Structure within the VP

So far, we have seen two kinds of categories:

word-level categories such as N, V, A, P etc. (somewhat imprecisely, words) and phrase-level categories such as NP/DP, VP, AP, PP etc. (somewhat imprecisely, sequences of words which can 'stand on their own').

We will now investigate if these two kinds of categories are all we need or whether we need to postulate more structure. If there is additional structure, what are the properties of this intermediate structure?

Intuitively, the bracketed constituents below are VPs.

- (21) a. Sam [saw Bill].  
b. Sam will [see Bill].  
c. Sam has [seen Bill].  
d. Sam is [seeing Bill].

But they do not pattern alike with respect to most syntactic tests - we cannot co-ordinate one with the other; *saw Bill* in (21a) cannot be topicalized. We can rescue the intuition by noting that each case contains a VP: *see Bill*.

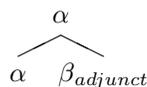
Now let us compare VPs of the following kind:

- (22) a. Sam will [dance].  
b. Sam will [see Bill].  
c. Sam will [give me a hug].  
d. Sam will [rely on Bill].  
e. Sam will [say that he is tired].

with the following VPs.

- (23) a. Sam will [dance [*in the garden*] [*with Kate*]].  
b. Sam will [see Bill [*for coffee*] [*in downtown Amherst*]].  
c. Sam will [give me a hug [*before the exam*]].  
d. Sam will [rely on Bill [*to solve the problem*]].  
e. Sam will [*often*] say that he is tired [*when he feels lazy*]].

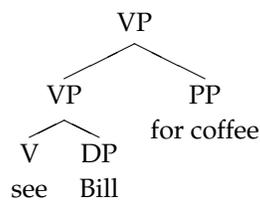
• The VPs in (23) have the same distribution as the VPs in (22). The additional constituents in (23) leave the VPs 'unchanged' in a certain sense - in this sense, they are optional. We will call such elements adjuncts. They will obey the following phrase structure schema:



- The VP internal elements in (22b-e) are, however, not optional. We will call such elements complements. Complements can be DPs, PPs, or CPs. DPs will typically enter into case and agreement relationships. Adjuncts are typically AdvPs, PPs or CPs, but some DPs like *yesterday* can also appear as adjuncts.

- Complements tend to precede adjuncts:

- (24) a. Sam will see for coffee Bill.  
 b. \*Sam will give me before the exam a hug.



→ the ordering restriction follow from the structural assumptions concerning how complements and adjuncts combine with the head.

A potential confound:

- (25) Adjuncts don't always follow complements:
- a. Sam will see *for coffee today* the new student who arrived from Harbin last night.
  - b. Sam will say *today* that he was tired yesterday.
  - c. Sam relies *implicitly* on Bill.

Two strategies:

→ movement operations

→ question complementhood!

- (26) A semantic intuition
- a. Complements (i.e. Arguments) combine via function application.
  - b. Adjuncts combine via modification i.e. set intersection.
- but this intuition can be slippery. Since we do not have privileged access to the semantic entry of the head, we cannot determine how an XP is combining with a head.

How do we handle the combination of intransitive verbs with adjuncts?

### 3 The structure of NP

Before we proceed, I will make the assumption that what we called Noun Phrases earlier in the handout are actually Determiner Phrases i.e. they are headed by D. Henceforth I will treat nominal expressions like *the king of France*, *red balloons*, *you*, and *Sweden* as DPs.

Consider the following DP:

(27) the king of England

We feel quite confident saying that ‘the king of England’ is an DP. What else can we say about its structure?

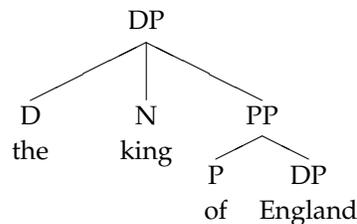
There seems to be a lot of evidence that **of England** is a PP. It can be co-ordinated, shared in **shared constituent** co-ordination. It can also function as a sentence fragment and be preposed.

- (28) a. the king [<sub>PP</sub> of England] and [<sub>PP</sub> of the empire]. (coordination)  
 b. He is the king, and she is the queen, [<sub>PP</sub> of England]. (shared constituent coordination)  
 c. A: Was he the king of Livonia?  
 B: No, [<sub>PP</sub> of England]. (sentence fragment)  
 d. [<sub>PP</sub> Of which country] was he the king?

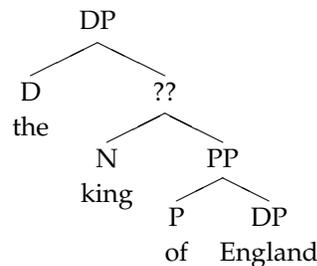
#### 3.1 Binary Branching

At this point we have two options:

(29)



(30)



There is evidence from constituency tests that the sequence of words ‘king of England’ forms a constituent.

- ‘king of England’ can undergo co-ordination with another similar sequence.

(31) Vivian dared defy the [king of England] and [ruler of the Empire]?

- ‘king of England’ can serve as the **shared constituent** in **shared constituent co-ordination**.

(32) Edward was the last, and some people say the best, [king of England].

- There is a proform that replaces sequences like ‘king of England’.

(33) The present [king of England] is more popular than the last **one**.

So 'king of England' forms a constituent that excludes *the*. Thus we have evidence for the tree in (30).

This evidence doesn't actually rule out the tree in (29). It is not easy to rule out (29) on the basis of the discussion so far. However, an assumption that natural language structures only involve binary branching could be used to block structures like (29).

### 3.2 What kind of constituent is 'king of England'?

In other words, what is the name of the node labeled ?? in (30)?

Let us assume that it is an DP.

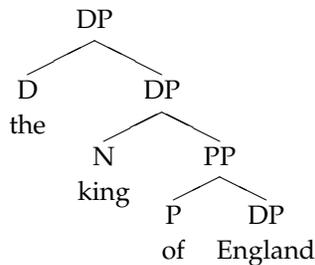
We find that this assumption is problematic in many ways.

- 'king of England' does not have the distribution of 'normal'/'full' determiner phrases. Normal DPs can occur in subject position, in object position, and as a prepositional object. 'king of England' cannot appear in any of these positions.

- (34) a. subject:
- [The king of England] invaded several countries.
  - \* [King of England] invaded several countries.
- b. object:
- I saw [the king of England] on the T yesterday.
  - \* I saw [king of England] on the T yesterday.
- c. prepositional object:
- I didn't give any money to [the king of England].
  - \* I didn't give any money to [king of England].

- Consider the tree for 'the king of England' under the assumption that 'king of England' is also an DP.

(35)



From this tree, we can read off the phrase structure rules involved in building it. They are shown in (36).

- (36) a. Categorical Rules:
- DP → D DP
  - DP → N PP
  - PP → P DP

- b. Lexical Rules:
- i.  $D \rightarrow \text{the}$
  - ii.  $N \rightarrow \text{king}$
  - iii.  $P \rightarrow \text{of}$
  - iv.  $DP \rightarrow \text{England}$

Note in particular the categorial rule (36a.i). It has the property that it expands a node label into itself i.e. it involves recursion. So we can go from DP to [D DP] to [D D DP] to [D D D DP] and so on. In principle, using the rules in (36), we can generate DPs like those in (37).

- (37) a. \* the the king of England  
 b. \* the the the king of England  
 c. \* the . . . the the the king of England

Now, it is very clear that none of the DPs in (37) are good noun phrases in English. From this we can conclude that the categorial rule (36a.i), which is the source of the recursion, cannot be correct.

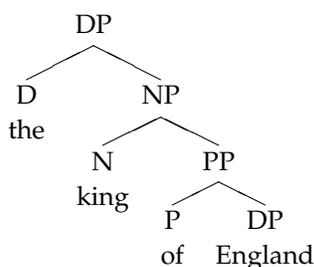
So:

- 'king of England' cannot be an DP
- and yet
- 'king of England' is a constituent of some sort.

Let us call it an NP.

Our tree now becomes:

(38)



*Endocentricity*: an XP can only be the projection of an  $X^0$ . Thus *king of England* can only be an NP or a PP and since we want *king of England* to be the same category as *king*, it had better be an NP.

## 4 Further Structure within the NP

Is there further internal structure within the NP? Does it make sense to talk about the complement/adjunct distinction when everything is optional?

Consider the phrase-structure rules responsible for generating (38) <sup>2</sup>:

- (39) a.  $DP \rightarrow D NP$

<sup>2</sup>From now on, we will only consider the categorial rules. The lexical rules are straightforward.

- b.  $NP \rightarrow N PP$
- c.  $PP \rightarrow P DP$

We see that D combines with an NP to its left and forms a DP. Similarly P combines with an DP to its left and forms a PP.

Likewise, (39) says that an N combines with any PP that follows it (i.e. any **postnominal** PP) and forms an DP.

But is this really the case? Do the PPs in (40a, b) have the same relation to the N?

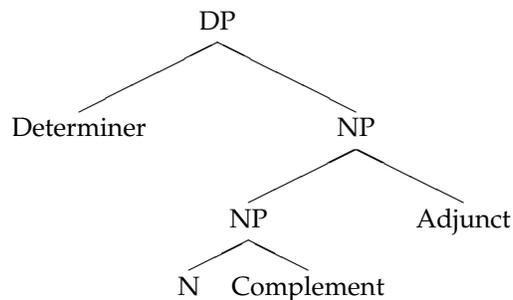
- (40) a. a student [of Physics]  
 b. a student [with long hair]

It seems not. Consider the following pattern:

- (41) a. i. He is [a student of Physics].  
 ii. = He is [studying Physics].  
 b. i. He is [a student with long hair].  
 ii. ≠ He is [studying long hair].

Drawing on the distinctions made within the VP, we can structurally distinguish between PPs like 'of Physics' (**complements**) and PPs like 'with long hair' (**adjuncts**) along the lines shown in (42).

(42)



In terms of phrase structure rules this is:

- (43) a.  $DP \rightarrow D NP$   
 b.  $NP \rightarrow NP PP$  (Adjunct Rule)  
 c.  $NP \rightarrow N PP$  (Complement Rule)

The rules in (43) make a prediction - if an NP contains both a complement PP and an adjunct PP, the complement PP should precede the adjunct PP. This prediction turns out to be true.

- (44) a. the student [of Physics] [with long hair]  
 b. \* the student [with long hair] [of Physics]

## 4.1 Optional Constituents of the DP/NP

Do all NPs have to contain a noun, a complement PP, and an adjunct PP? Do all DPs have to contain a determiner and an NP?

Well, they have to contain an N, otherwise they wouldn't be NPs. What about the others?

Consider the rules in (43). If you wanted to make an NP, would it be necessary to apply the Adjunct rule?

You could take an N and a complement PP and make an NP. Then you **could** combine the NP with an adjunct PP to make another NP.

You could, but you don't have to. You can now just combine your adjunct-less NP with a D on its left to make an DP.

So, NPs don't have to contain adjuncts. In other words, the adjunct rule is an **optional** rule.

Still, the rules in (43) insist that every DP must have a determiner and a complement PP (the Complement rule). This is, however, just false.

- (45) a. the student
- b. the student with long hair

(45a) is an NP without a complement PP, (45a) show that an NP without a complement PP can still take an adjunct PP. How can we modify our phrase structure rules to handle these case?

For this purpose, let us use the following terminology: **(A)** means that A is optional. So we can now change our complement rule from (46a) to (46b).

- (46) a.  $NP \rightarrow N PP$  (Old Complement Rule)
- b.  $NP \rightarrow N (PP)$  (New Complement Rule)

We also find optionality of determiners cf. (47a-e).

- (47) a. cheese from Greece
- b. students
- c. students with long hair
- d. students of physics
- e. students of physics with long hair

However, this optionality is **lexically determined** i.e. it only works for certain nouns - noncount nouns and plural count nouns but not singular count nouns.

- (48) a. \* Student likes pizza
- b. \* Student with long hair likes pizza

We could modify the rule introducing determiners in the way we modified the complement rule in (46).

- (49) a.  $DP \rightarrow D NP$  (Old Determiner Rule)
- b.  $DP \rightarrow (D) NP$  (New Determiner Rule)

But this is not a good idea for two reasons. The first is that the modification does not model the fact that only plural/mass NPs permit optionality of determiners. The second is that a rule

like  $DP \rightarrow NP$  violates a very general principle of structure building called **Endocentricity**. According to this principle, an XP has to have an  $X^0$  head.

Instead, we will assume that English has a null determiner, which imposes restrictions on its NP complement, just as other overt determiners do:

- (50) Feature Specification:
- a.  $D[agr:pl/mass] \rightarrow \phi$
  - b.  $D[agr:sg] \rightarrow a/\text{that}/\text{this}/\text{every}/\text{each}/\dots$
  - c.  $D[agr:pl] \rightarrow \text{most}/\text{all}/\text{many}/\text{several}/\dots$
  - d.  $D[agr:] \rightarrow \text{the}/\text{some}/\dots$

- (51) Feature Agreement:  
 $DP[agr:\alpha] \rightarrow D[agr:\alpha] NP[agr:\alpha]$

We could also consider DPs which seem to only consist of a D. This includes many determiners, and depending upon one's analysis all pronouns and proper names. A rule like ' $DP \rightarrow D$ ' does not violate endocentricity - in fact, we need a similar rule for NPs. This might be the right way to go with pronouns. Other cases might involve an overt determiner combining with a null NP.

- (52) John read all the books. I read some/most/all/several/many.

## 4.2 Non-branching Phrases

Consider the new complement rule:

- (53)  $NP \rightarrow N (PP)$  (New Complement Rule)

This rule is really equivalent to the following two rules:

- (54) a.  $NP \rightarrow N PP$   
b.  $NP \rightarrow N$

(54a) is nothing new. (54b) is definitely new. It tells us something unexpected. According to (54b), **student** in 'the student' is both an NP as well as an N, while **student in the student of Physics** is only an N, not an NP. Similarly, **student** in 'the student with long hair' should be both an NP as well as an N. We can check to see if these predictions are true.

The test we will use is substitution by the NP pro-form **one**.

- (55) a. The [student] with long hair is dating the **one** with short hair.  
b. This [student] works harder than that **one**.  
c. \* The [student] of chemistry was older than the **one** of Physics.

What can co-ordination tell us here?

## 4.3 A bit more on NP

Both (56a, b) make reference to NPs:

- (56) a. NP → NP PP (Adjunct Rule)  
 b. NP → N PP (Complement Rule)

How can we be sure that the node created by the complement rule isn't NP' and the node created by the adjunct rule NP''?

Again by a constituency test: we know that only like categories can be co-ordinated and we find that NPs created by the two different rules can be co-ordinated.

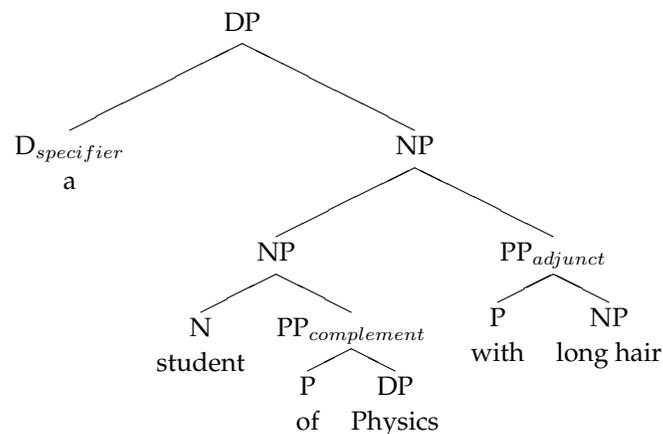
- (57) the [ [students of Chemistry with long hair] and [professors of Physics]]

In addition, the pro-NP **one** can refer to NPs created by either rule.

- (58) a. Which [student of Physics]? The **one** with long hair?  
 b. Which [student of Physics with long hair]? That one?

Hence we can conclude that the 'output' of both the rules is indeed one kind of node, which we call NP.

- (59) a student of Physics with long hair



## 5 Further distinctions between Complements and Adjuncts in NPs

### 5.1 Semantic Arguments

To attribute (59) to someone is to attribute two properties to them - one of studying Physics and another of having long hair. This is the case even with a reduced counterpart *student with long hair*. On the other hand, (60a, b) both involve only one property attribution: that of being a student in (60a) and that of studying Physics in (60b).

- (60) a. John is a student.  
 b. John is a student of Physics.

In some cases, PPs are quite unambiguously either adjuncts (*with long hair*) or complements (*of Physics*). In most cases, however, PPs don't wear their complement/adjunct status on their sleeves. Consider the ambiguous (61).

- (61) a student [*of high moral principles*]  
 a. a person who studies high moral principles  
 b. a student who has high moral principles

This ambiguity can be characterized in structural terms: on the reading in (61a), the PP *of high moral principles* is a complement of *student*, while on the reading in (61b), the PP *of high moral principles* is an adjunct. A similar point is made by (62).

- (62) a. Arguments [*with Tim*] are often pointless. (complement)  
 b. Arguments [*with few premises*] are often pointless. (adjunct)

Evidence for the proposal that *with Tim* in (62a) is a complement and that *with few premises* in (62b) is an adjunct comes from the contrast in (63).

- (63) a. Arguments [*with Tim*] [*with few premises*] are often pointless.  
 b. \*Arguments [*with few premises*] [*with Tim*] are often pointless.

## 5.2 Syntactic Arguments

- (64) Phrase Structure Rules for Noun Phrases  
 a.  $NP \rightarrow D NP$   
 b.  $NP \rightarrow NP PP$  (Adjunct Rule)  
 c.  $NP \rightarrow N (PP)$  (Complement Rule)

One consequence of these rules that we have seen earlier is that a complement must precede an adjunct.

- (65) a. a student [*of Physics*] [*with long hair*]  
 b. \* a student [*with long hair*] [*of Physics*]

These rules have other consequences too. Note that the adjunct rule is *recursive* i.e. in principle, it could apply an arbitrarily large number of times.

On the other hand, the complement rule is not recursive i.e. it can apply only once. These predictions are borne out:

- (66) a. a student [*with long hair*] [*with short arms*]  
 b. \* a student [*of Physics*] [*of Chemistry*]

Further, unlike complements which have to precede adjuncts, adjuncts can be freely reordered with respect to each other.

- (67) a. a student [*with long hair*] [*with short arms*]  
 b. a student [*with short arms*] [*with long hair*]

### 5.2.1 Co-ordination

Complements can be co-ordinated with other complements.

- (68) a student [of Physics] and [of Chemistry]

Likewise, adjuncts can be co-ordinated with other adjuncts.

- (69) a student [with short arms] and [with long hair]

But adjunct PPs and complements PPs cannot be co-ordinated.

- (70) a. \* a student [of Physics] and [with short arms]  
b. \* a student [with short arms] and [of Physics]

Since *a students of Physics* and *professors with long hair* are both NPs, our analysis predicts that it should be possible to co-ordinate them.

- (71) the [ [students of Physics] and [professors with long hair]]

### 5.2.2 Extraposition

Adjuncts are less tightly bound to the head noun than complements. This can be seen by the fact that it is possible to extrapose adjuncts PPs but not possible to extrapose complement PPs.

- (72) a. (?) A student came to see me yesterday [*with long hair*].  
b. \* A student came to see me yesterday [*of Physics*].

### 5.2.3 Preposing

Complements and Adjuncts behave differently with respect to preposing.

- (73) a. [What branch of Physics] is Jack a student of?  
b. \* [What kind of hair] is Paco a student with?

(Note that Complements and Adjuncts go in opposite directions with respect Extraposition and Preposing.)

## 5.3 Co-occurrence Restrictions

Heads place significant restrictions (i.e. *subcategorise*) on what can appear as their complement.

- (74) a. a student of Physics  
b. \* a boy of Physics  
c. \* a girl of Physics  
d. \* a teenager of Physics  
e. \* a goth of Physics

No similar restrictions are imposed on adjuncts.

- (75) a. a student with long hair  
 b. a boy with long hair  
 c. a girl with long hair  
 d. a teenager with long hair  
 e. a goth with long hair

Generalisation: heads are more closely related to their complements than to their adjuncts. Sub-categorisation restrictions hold only between a head and its complement, not between a head and its adjuncts.

- (76) Complements:  
 a. your reply [to my letter]  
 b. the attack [on Starr]  
 c. the loss [of the ship]  
 d. Joan's disgust [at Tamara's behavior]  
 e. his disillusionment [with life]

- (77) Adjuncts:  
 a. the book [on the table]  
 b. the advertisement [on the television]  
 c. the fight [after the match]  
 d. his resignation [because of the scandal]  
 e. a cup [with a broken handle]

## 5.4 Non-PP Complements and Adjuncts

So far we have only considered cases of PP complements and adjuncts. Can other kinds of phrases also be complements/adjuncts of nouns?

Complements: It seems that only PPs and full clauses (CPs) can be complements of nouns.

- (78) a. the suggestion [that we should abandon ship]  
 b. the demand [for him to resign]  
 c. the question [whether euthanasia is ethical]

On the other hand, a much wider range of phrases can occur as adjuncts e.g. temporal NPs, APs, and Relative Clauses.

- (79) a. the [ [<sub>NP</sub> abolition of taxes] [<sub>NP</sub> next year]]  
 b. the [ [<sub>NP</sub> students of Physics] [<sub>AP</sub> absent from class]]  
 c. the [ [<sub>NP</sub> king of England] [<sub>S</sub> who abdicated]]

The greater freedom found with adjuncts reflects the fact that fewer restrictions are imposed by a head on its adjuncts than on its complement.

## 5.5 Complex NPs

What happens when the PP complement or adjunct itself contains a non-trivial DP (i.e. a DP with internal structure)?

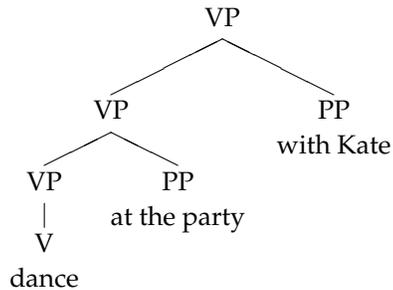
- (80) a. an advocate of the abolition of indirect taxation  
 b. a woman with an umbrella with a red handle  
 c. his dislike of men with big egos

How can we account for the ambiguity of (81)?

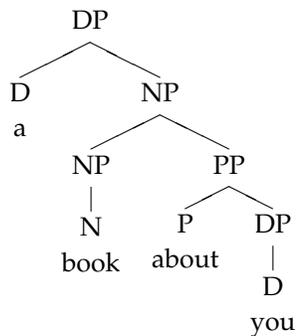
- (81) a woman with three children with ginger hair

## 6 Non-branching Projections

- (82) Sam will [dance at the party with Kate].



- (83) a book about you



What are non-branching projections doing for us?

Primarily they are helping us handle VP-ellipsis/*one*-anaphora: our analysis is that VP-ellipsis targets VPs and not V's:

- (84) a. Sam wants to [see me] and Kate wants to, too.  
 b. \*Sam wants to [see me] and Kate wants to [..... you].  
 c. Sam wants to [dance] and Kate wants to, too.  
 (VP-topicalization makes a similar cut.)

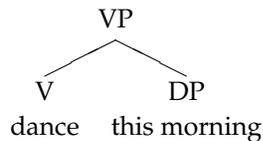
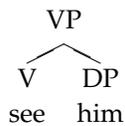
Likewise *one* is an NP anaphor and so it cannot replace N's, hence the ungrammaticality of *\*the one of England* versus the grammaticality of *the last one*. But it can replace *book* yielding *the one about you*.

A semantic characterization:

- (85) VPs are of type *et*
  - a. Transitive: V: eet, VP: et
  - b. Intransitive: V: et, VP: et
  
- (86) NPs are of type *et*
  - a. Nouns that take complements: N: eet, NP: et  
(unlike verbs, noun complements can freely go missing)
  - b. Nouns that do not take complements: N: et, NP: et

An alternate semantic proposal: nouns that take complements can be of type *et* or type *eet*. Nouns that do not take complements are always of type *et*. *one* can replace any Noun Phrase/Noun of type *et*. Similarly VP-ellipsis can target any VP/V of type *et*. Such a treatment would eliminate the need for non-branching projections.

But this means we cannot distinguish structurally between direct objects of transitive verbs and adjuncts on intransitive verbs.



An alternative structural treatment involves:

- (87) a. allowing projections to be simultaneously minimal and maximal - branching only takes place if another element comes in.
- b. indicating adjunction with a diacritic