4

Complex Feature Values

4.1 Introduction

By reanalyzing grammatical categories feature structures, we were able to codify the relatedness of syntactic categories and to express the property of headedness via a general principle: the Head Feature Principle. The grammar of the preceding chapter not only provides a more compact way to represent syntactic information, it also systematically encodes the fact that phrases of different types exhibit parallel structures. In particular, the rules we gave in the previous chapter suggest that lexical head daughters in English uniformly occur at the left edge of their phrases.[1] Of course, VPs and PPs are consistently head-initial. In addition, assuming our analysis of NPs includes the intermediate-level category NOM, nouns are initial in the phrases they head, as well. The Chapter **3** grammar thus expresses a correct generalization about English phrases.

One motivation for revising our current analysis, however, is that our rules are still not maximally general. We have three distinct rules introducing lexical heads, one for each of the three COMPS values. This would not necessarily be a problem, except that, as noted in Ghapter **2,** these three valences are far from the only possible environments lexical heads may require. Consider the examples in (1):

(1) a. Pat relies on Kim.
b.*Pat relies.
c. The child put the toy on the table.
d.*The child put the toy.
e. The teacher became angry with the students.
f.*The teacher became.
g. The jury believed the witness lied.

Examples (1a,b) show that some verbs require a following PP; (1c,d) show that some verbs must be followed by both an NP and a PP; (1e,f) show a verb that can be followed by a kind of phrase we have not yet discussed, called an adjective phrase (AP); and (1g) shows a verb that can be followed by an S. We say only that *became* CAN be followed by an AP and that *believed* CAN be followed by an S, because they can also appear in sentences like *Pat became an* astronaut and Pat *believed the* story, in which they are

[1] This is not true in some other languages, e.g. in Japanese, the lexical head daughters are phrase-final, resulting in SOV (Subject-Object-Verb) ordering, as well as noun-final NPs.

followed by NPs. In fact, it is extremely common for verbs to be able to appear in multiple environments. Similarly, (2) shows that ate, like many other English verbs, can be used either transitively or intransitively:

(2) The guests ate (the cheese).

Facts like these show that the number of values of COMPS must be far greater than three. Hence, the Chapter **3** grammar would have to be augmented by many more grammar rules in order to accommodate the full range of verbal subcategories. In addition, given the way COMPS values are keyed to rules, a worrisome redundancy would arise: the lexical distinctions would all be encoded twice – once in the phrase structure rules and once in the (many) new values of COMPS that would be required.

Exercise 1: More Subcategories of Verb

There are other subcategories of verb, taking different combinations of complements than those illustrated so far. Think of examples of as many as you can. In particular, look for verbs followed by each of the following sequences: NP-S, NP-AP, PP-S, and PP-PP.

Intuitively, we would like to have one rule that simply says that a phrase (a VP, in the cases above) may consist of a lexical head (a V, in these cases) followed by whatever other phrases the lexical head requires. We could then relegate to the lexicon (and only to the lexicon) the task of specifying for each word what elements must appear together with that word. In this chapter, we develop a way to do just this. It involves enriching our conception of valence features (SPR and COMPS) in a way somewhat analogous to what we did with grammatical categories in the previous chapter. The new conception of the valence features not only allows for more general rules, but also leads to a reduction of unnecessary structure in our trees and to improvements in our analysis of agreement phenomena.

4.2 Complements

4.2.1 Syntactic and Semantic Aspects of Valence

Before we begin the discussion of this analysis, let us consider briefly the status of the kinds of co-occurrence restrictions we have been talking about. It has sometimes been argued that the number and type of complements a verb takes is fully determined by its meaning. For example, the verb disappear is used to describe events involving a single entity (expressed by its subject); deny's semantics involves events with two participants, one typically human and the other a proposition; and an event described by hand must include three participants: the person who does the handing, the thing handed, and the recipient of the transaction. Correspondingly, disappear takes no complements, only a subject; deny takes a subject and a complement, which may be either an NP (as in The defendant denied the charges) or an S (as in The defendant denied he was *guilty*); and hand takes a subject and two NP complements (or one NP and one PP complement).

It is undeniable that the semantics of a verb is intimately related to its valence. There is, however, a certain amount of syntactic arbitrariness to it, as well. For example, the

words eat, dine, and devour all denote activities necessarily involving both a consumer of food and the food itself. Hence, if a word's valence were fully determined by its meanings, one might expect that all three would be simple transitives, requiring a subject and an NP complement (that is, a direct object). But this expectation would be wrong – *dine* is intransitive, devour is obligatorily transitive, and (as noted above), eat can be used intransitively or transitively:

(3) a. The guests devoured the meal.
b. *The guests devoured.
c. *The guests dined the meal.
d. The guests dined.
e. The guests ate the meal.
f. The guests ate.

Thus, though we recognize that there is an important link between meaning and valence, we will continue to specify valence syntactically. We will say more about the connection between meaning and valence – and more generally about the syntax-semantics interface – in later chapters.

4.2.2 The COMPS Feature

In the Chapter **3** grammar, the lexical entry for a verb like deny would specify that it is [COMPS str]. This ensures that it can only appear in word structures whose mother node is specified as [COMPS str], and such word structures can be used to build larger structures only by using the rule of our grammar that introduces an immediately following NP. Hence, deny has to be followed by an NP.[2] As noted above, the co-occurrence effects of complement selection are dealt with by positing both a new COMPS value and a new grammar rule for each co-occurrence pattern.

How can we eliminate the redundancy of such a system? An alternative approach to complement selection is to use features directly in licensing complements – that is, to have a feature whose value specifies what the complements must be. We will now make this intuitive idea explicit. First, recall that in the last chapter we allowed some features (e.g. HEAD, AGR) to take values that are feature structures themselves. If we treat COMPS as such a feature, we can allow its value to state directly what the word's complement must be. The value of COMPS for *deny* can simply be an NP, as shown in (4):

(4) $$\begin{bmatrix} \text{COMPS} & \begin{bmatrix} \textit{phrase} & \\ \text{HEAD} & \textit{noun} \\ \text{SPR} & + \end{bmatrix} \end{bmatrix}$$

and in abbreviated form in (5):

(5) $$\begin{bmatrix} \text{COMPS} & \text{NP} \end{bmatrix}$$

Similarly, we can indicate that a verb takes another type of complement: rely, become, and believe, for example, can take COMPS values of PP, AP, and S, respectively. Optional

[2]Soon, we will consider the other possible environment for deny, namely the one where it is followed by a clause.

complements, such as the object of eat can be indicated using parentheses; that is, the lexical entry for eat can specify [COMPS (NP)]. Likewise, we can indicate alternative choices for complements using the vertical bar notation introduced in the discussion of regular expressions in Chapter 2. So the entry for deny or believe includes the specification: [COMPS NP | S].

Of course there is a problem with this proposal: it does not cover verbs like hand and put that require more than one complement. But it's not hard to invent a straightforward way of modifying this analysis to let it encompass multiple complements. Instead of treating the value of COMPS as a single feature structure, we will let it be a LIST of feature structures.[3] Intuitively, the list specifies a sequence of categories corresponding to the complements that the word combines with. So, for example, the COMPS values for deny, become, and eat will be lists of length one. For hand, the COMPS value will be a list of length two, namely ⟨ NP , NP ⟩. For verbs taking no complements, like disappear, the value of COMPS will be ⟨ ⟩ (a list of length zero). This will enable the rules we write to ensure that a tree containing a verb will be well-formed only if the sisters of the V-node can be identified with the categories specified on the list of the verb. For example, *rely* will only be allowed in trees where the VP dominates a V and a PP.

Now we can collapse all the different rules for expanding a phrase into a lexical head (H) and other material. We can just say:

(6) Head-Complement Rule

$$\begin{bmatrix}\textit{phrase} & \\ \text{COMPS} & \langle\ \rangle\end{bmatrix} \rightarrow \text{H}\begin{bmatrix}\textit{word} & \\ \text{VAL} & \begin{bmatrix}\text{COMPS} & \langle \boxed{1}, \ldots, \boxed{n} \rangle\end{bmatrix}\end{bmatrix}\ \boxed{1} \ldots \boxed{n}$$

The tags in this rule enforce identity between the non-head daughters and the elements of the COMPS list of the head. The $\boxed{1} \ldots \boxed{n}$ notation allows this rule to account for phrases with a variable number of non-head daughters. n stands for any integer greater than or equal to 1. Thus, if a word is specified lexically as [COMPS ⟨ AP ⟩], it must co-occur with exactly one AP complement; if it is [COMPS ⟨ NP , NP ⟩], it must co-occur with exactly two NP complements, and so forth. Finally, the mother of any structure licensed by (6), which we will call a HEAD-COMPLEMENT PHRASE, must be specified as [COMPS ⟨ ⟩], because that mother must satisfy the description on the left-hand side of the rule.[4]

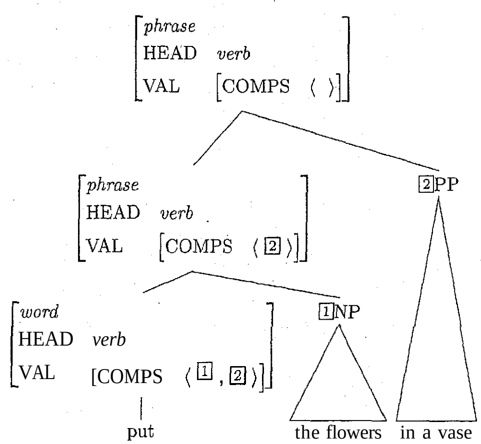
In short, the COMPS list of a lexical entry specifies a word's co-occurrence requirements; and the COMPS list of a phrasal node is empty. So, in particular, a V must have sisters that match all the feature structures in its COMPS value, and the VP that it heads has the empty list as its COMPS value and hence cannot combine with complements. The Head-Complement Rule, as stated, requires all complements to be realized as sisters of the lexical head.[5]

[3] Recall that we used this same technique to deal with multiple founders of organizations in our feature-structure model of universities presented at the beginning of Chapter 3.

[4] Note that by underspecifying the complements introduced by this rule – not even requiring them to be phrases, for example – we are implicitly leaving open the possibility that some complements will be nonphrasal. This will become important below and in the analysis of negation presented in Chapter 13.

[5] This flat structure appears well motivated for English, but our general theory would allow us to write a Head-Complement Rule for some other language that allows some of the complements to be introduced higher in the tree structure. For example, structures like the one in (i) would be allowed by a version of the Head-Complement Rule that required neither that the head daughter be of type word nor that the mother have an empty COMPS list:

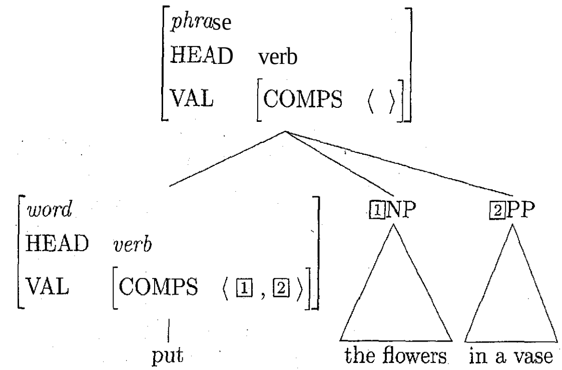
(i) Tree Licensed by a Hypothetical Alternative Head-Complement Rule:



Such grammatical variations might be regarded as 'parameters' that are set differently in particular languages. That is, it may be that all languages manifest the Head-Complement Rule, but there are minor differences in the way languages incorporate the rule into their grammar. The order of the head and the complements is another possible parameter of variation.

If you think in terms of building the tree bottom-up, starting with the verb as head, then the verb has certain demands that have to be satisfied before a complete, or 'saturated', constituent is formed. On this conception, the complements can be thought of as being 'cancelled off' of the head daughter's COMPS list in the process of building a headed phrase. We illustrate this with the VP *put* the *flowers* in a vase: the verb put requires both a direct object NP and a PP complement, so its COMPS value is ⟨ NP , PP ⟩. The requisite NP and PP will both be sisters of the V, as in (7), as all three combine to form a VP, i.e. a verbal phrase whose complement requirements have been fulfilled:

(7)



As is evident from this example, we assume that the elements in the value of COMPS occur in the same order as they appear in the sentence. We will continue to make this assumption, though ultimately a more sophisticated treatment of linear ordering of phrases in sentences may be necessary.

4.2.3 Complements vs. Modifiers

A common source of confusion is the fact that some kinds of constituents, notably PPs, can function either as complements or as modifiers. This often raises the question of how to analyze a particular PP: should it be treated as a complement, licensed by a PP on the COMPS list of a nearby word, or should it be analyzed as a modifier, introduced by a different grammar rule? Some cases are clear. For example, we know that a PP is a complement when the choice of preposition is idiosyncratically restricted by another word, such as the verb *rely*, which requires a PP headed by *on* or *upon*:

(8) a. We relied on/upon Leslie.
  b.*We relied over/with/on top of/above Leslie.

In fact, PPs that are obligatorily selected by a head (e.g. the directional PP required by *put*) can safely be treated as complements, as we will assume that modifiers are always optional.

Conversely, there are certain kinds of PP that seem to be able to co-occur with almost any kind of verb, such as temporal or locative PPs, and these are almost always analyzed as modifiers. Another property of this kind of PP is that they can iterate: that is, where you can get one, you can get many:

(9) a. We celebrated in the streets.
  b. We celebrated in the streets in the rain on Tuesday in the morning.

The underlying intuition here is that complements refer to the essential participants in the situation that the sentence describes, whereas modifiers serve to further refine the description of that situation. This is not a precisely defined distinction, and there are problems with trying to make it into a formal criterion. Consequently, there are difficult borderline cases that syntacticians disagree about. Nevertheless, there is considerable agreement that the distinction between complements and modifiers is a real one that should be reflected in a formal theory of grammar.

4.2.4 Complements of Non-verbal Heads

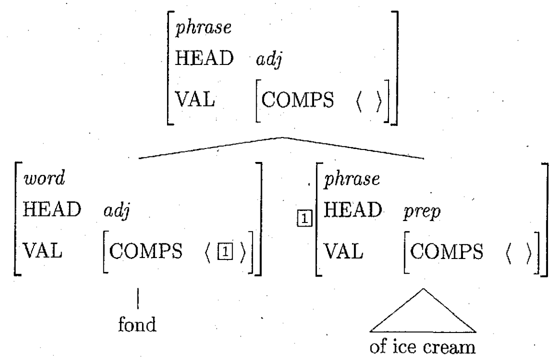
Returning to our analysis of complements, notice that although we have motivated our treatment of complements entirely in terms of verbs and verb phrases, we have formulated our analysis to be more general. In particular, our grammar of head-complement structures allows adjectives, nouns, and prepositions to take complements of various types. The following examples suggest that, like verbs, these kinds of words exhibit a range of valence possibilities:

(10) Adjectives
  a. The children are happy.
  b. The children are happy with the ice cream.
  c. The children are happy that they have ice cream.
  d.*The children are happy of ice cream.
  e.*The children are fond.
  f.*The children are fond with the ice cream.
  g.*The children are fond that they have ice cream.
  h. The children are fond of ice cream.

(11) Nouns
  a. A magazine appeared on the newsstands.
  b. A magazine about crime appeared on the newsstands.
  c. *Newsweek* appeared on the newsstands.
  d.**Newsweek* about crime appeared on the newsstands.
  e. The report surprised many people.
  f. The report that crime was declining surprised many people.
  g. The book surprised many people.
  h.*The book that crime was declining surprised many people.

(12) Prepositions
  a. The storm arrived after the picnic.
  b. The storm arrived after we ate lunch.
  c. The storm arrived during the picnic.
  d.*The storm arrived during we ate lunch.
  e.*The storm arrived while the picnic.
  f. The storm arrived while we ate lunch.

The Head-Complement Rule can license APs, PPs, and NPs in addition to VPs. As with the VPs, it will license only those complements that the head A, P or N is seeking. This is illustrated for adjectives in (13): the complement PP, tagged $\boxed{1}$, is precisely what the head adjective's COMPS list requires:

(13)


Exercise 2: COMPS Values of Non-Verbal Heads

Based on the examples above, write out the COMPS values for the lexical entries of *happy*, *magazine*, *Newsweek*, *report*, *book*, *after*, *during*, and *while*.

4.3 Specifiers

Co-occurrence restrictions are not limited to complements. As we have noted in earlier chapters, certain verb forms appear with only certain types of subjects. In particular, in the present tense, English subjects and verbs must agree in number. Likewise, as we saw in Problem **3** of Chapter **3,** certain determiners co-occur only with nouns of a particular number:

(14) a. This dog barked.
b.*This dogs.barked.
c.*These dog barked.
d. These dogs barked.

Moreover, some determiners co-occur only with 'mass' nouns (e.g. furniture, footwear, *information*), and others only with 'count' nouns (e.g. chair, shoe, fact), as illustrated in (15):

(15) a. Much furniture was broken.
b.*A furniture was broken.
c.*Much chair was broken.
d. A chair was broken.

We can handle such co-occurrence restrictions in much the same way that we dealt with the requirements that heads impose on their complements. To do so, we will reinterpret the feature SPR in the same way we reinterpreted the feature COMPS. Later in this chapter (see Sections 4.6.1 and 4.6.2), we'll see how we can use these features to handle facts like those in (14)–(15).

Recall that in Chapter 3, we used the term specifier to refer to both subjects and determiners. We will now propose to collapse our two earlier head-specifier rules into one grammar rule that will be used to build both Ss and NPs. In the Chapter **3** grammar, the feature SPR takes atomic values (+ or –) and records whether or not the phrase contains a specifier.[6] On analogy with the feature COMPS, the feature SPR will now take a list as its value. The lexical entry for a verb (such as sleep, deny, or hand) will include the following specification:

(16) $\begin{bmatrix}\text{SPR} & \langle \text{NP} \rangle\end{bmatrix}$

Likewise, the lexical entry for a noun like book, meal, or *gift* will include the following specification:

(17) $[\text{SPR} \ \ \langle [\text{HEAD} \ \ \text{det}] \rangle]$

The decision to treat the value of SPR as a list may strike some readers as odd, since sentences only have a single subject and NPs never have more than one determiner. But notice that it allows the feature SPR to continue to serve roughly the function it served in the Chapter 3 grammar, namely recording whether the specifier requirement of a phrase is satisfied. Indeed, making SPR list-valued provides a uniform way of formulating the

[6]More precisely, whether or not a given phrase has satisfied any needs it might have to combine with a specifier. Recall that proper nouns are also [SPR +] in the Chapter **3** grammar.

idea that a particular valence requirement is unfulfilled (the valence feature – COMPS or SPR – has a nonempty value) or else is fulfilled (the value of the valence feature is the empty list).

We can now redefine the category NOM in terms of the following feature structure descriptions:[7]

(18)
$$\text{NOM} = \begin{bmatrix} \text{HEAD} & \textit{noun} \\ \text{VAL} & \begin{bmatrix} \text{COMPS} & \langle\ \rangle \\ \text{SPR} & \langle \text{X} \rangle \end{bmatrix} \end{bmatrix}$$

And once again there is a family resemblance between our interpretation of NOM and the description abbreviated by VP, which is now as shown in (19):

(19)
$$\text{VP} = \begin{bmatrix} \text{HEAD} & \textit{verb} \\ \text{VAL} & \begin{bmatrix} \text{COMPS} & \langle\ \rangle \\ \text{SPR} & \langle \text{X} \rangle \end{bmatrix} \end{bmatrix}$$

Both (18) and (19) have empty COMPS lists and a single element in their SPR lists. Both are intermediate between categories with nonempty COMPS lists and saturated expressions – that is, expressions whose COMPS and SPR lists are both empty.

Similarly, we can introduce a verbal category that is analogous in all relevant respects to the saturated category NP. This verbal category is the feature structure analog of the familiar category S:

(20)
$$\text{NP} = \begin{bmatrix} \text{HEAD} & \textit{noun} \\ \text{VAL} & \begin{bmatrix} \text{COMPS} & \langle\ \rangle \\ \text{SPR} & \langle\ \rangle \end{bmatrix} \end{bmatrix} \qquad \text{S} = \begin{bmatrix} \text{HEAD} & \textit{verb} \\ \text{VAL} & \begin{bmatrix} \text{COMPS} & \langle\ \rangle \\ \text{SPR} & \langle\ \rangle \end{bmatrix} \end{bmatrix}$$

Note crucially that our abbreviations for NOM, VP, NP and S no longer mention the type *phrase*. Since these are the constructs we will use to formulate rules and lexical entries in this chapter (and the rest of the book), we are in effect shifting to a perspective where phrasality has a much smaller role to play in syntax. The binary distinction between words and phrases is largely replaced by a more nuanced notion of 'degree of saturation' of an expression – that is the degree to which the elements specified in the head's valence features are present in the expression. As we will see in a moment, there is a payoff from this perspective in terms of simpler phrase structure trees.

Because NP and S now have a parallel formulation in terms of feature structures and parallel constituent structures, we may collapse our old rules for expanding these categories (given in (21)) into a single rule, shown in **(22):**

[7]The specification [SPR ⟨ X ⟩] represents a SPR list with exactly one element on it. The 'X' is used to represent a completely underspecified feature structure. In the case of a NOM, this element will always be [HEAD *det*], but it would be redundant to state this in the definition of the abbreviation.

(21) Head-Specifier Rules from the Chapter Three Grammar:

a.
$$\left[\begin{array}{ll} \textit{phrase} & \\ \text{VAL} & \left[\begin{array}{ll}\text{COMPS} & \textit{itr} \\ \text{SPR} & + \end{array}\right]\end{array}\right] \rightarrow \left[\begin{array}{ll}\text{NP} & \\ \text{HEAD} & \left[\text{AGR} \ \boxed{1}\right]\end{array}\right] \ \mathbf{H}\left[\begin{array}{ll} \textit{phrase} & \\ \text{HEAD} & \left[\begin{array}{ll} \textit{verb} & \\ \text{AGR} & \boxed{1}\end{array}\right] \\ \text{VAL} & \left[\text{SPR} \ -\right]\end{array}\right]$$

b.
$$\left[\begin{array}{ll} \textit{phrase} & \\ \text{VAL} & \left[\begin{array}{ll}\text{COMPS} & \textit{itr} \\ \text{SPR} & + \end{array}\right]\end{array}\right] \rightarrow \text{D} \ \mathbf{H}\left[\begin{array}{ll} \textit{phrase} & \\ \text{HEAD} & \textit{noun} \\ \text{VAL} & \left[\text{SPR} \ -\right]\end{array}\right]$$

(22) Head-Specifier Rule (Version I)

$$\left[\begin{array}{ll} \textit{phrase} & \\ \text{VAL} & \left[\begin{array}{ll}\text{COMPS} & \langle\ \rangle \\ \text{SPR} & \langle\ \rangle \end{array}\right]\end{array}\right] \rightarrow \boxed{2} \ \mathbf{H}\left[\text{VAL} \ \left[\begin{array}{ll}\text{COMPS} & \langle\ \rangle \\ \text{SPR} & \langle \boxed{2} \rangle \end{array}\right]\right]$$

The tag □ in this rule identifies the SPR requirement of the head daughter with the non-head daughter. If the head daughter is 'seeking' an NP specifier (i.e. is specified as [SPR ⟨ NP ⟩]), then the non-head daughter will be an NP. If the head daughter is 'seeking' a determiner specifier, then the non-head daughter will be [HEAD det]. Phrases licensed by (22) will be known as HEAD-SPECIFIER PHRASES.

We said earlier that the lexical entries for nouns and verbs indicate what kind of specifier they require. However, the head-daughter of a head-specifier phrase need not be a word. For example, in the sentence *Kim likes books*, the head daughter of the head-specifier phrase will be the phrase *likes books*. Recall that the head-complement rules in the Chapter 3 grammar all required that mother and the head daughter be specified as [SPR −]. In our current grammar, however, we need to ensure that the particular kind of specifier selected by the head daughter in a head-complement phrase is also selected by the head-complement phrase itself (so that a VP combines only with an NP and a NOM combines only with a determiner). We must somehow guarantee that the SPR value of a head-complement phrase is the same as the SPR value of its head daughter.[8] We might thus add a stipulation to this effect, as shown in (23):[9]

(23) Head-Complement Rule (Temporary Revision)

$$\left[\begin{array}{ll} \textit{phrase} & \\ \text{VAL} & \left[\begin{array}{ll}\text{SPR} & \boxed{A} \\ \text{COMPS} & \langle\ \rangle \end{array}\right]\end{array}\right] \rightarrow \mathbf{H}\left[\begin{array}{ll} \textit{word} & \\ \text{VAL} & \left[\begin{array}{ll}\text{SPR} & \boxed{A} \\ \text{COMPS} & \langle \boxed{1}, \ldots, \boxed{n} \rangle \end{array}\right]\end{array}\right] \ \boxed{1} \ldots \boxed{n}$$

[8]At first glance, one might be tempted to accomplish this by making SPR a head feature, but in that case the statement of the HFP would have to be complicated, to allow rule (22) to introduce a discrepancy between the HEAD value of a mother and its head daughter.

[9]This version of the Head-Complement Rule should be considered a temporary revision, as we will soon find a more general way to incorporate this constraint into the grammar.

(Note that here we are using the tag $\boxed{A}$ to designate neither an atomic value nor a feature structure, but rather a list of feature structures.[10])

Applying the Rules

Now that we have working versions of both the Head-Specifier and Head-Complement Rules, let's use them to construct a tree for a simple example. These rules build the tree in (26) for the sentence in (24) from the lexical entries in (25):[11]

(24) Alex likes the opera.

(25) a.
$$\left\langle \text{likes}, \left[\begin{array}{ll} \textit{word} & \\ \text{HEAD} & \textit{verb} \\ \text{VAL} & \left[\begin{array}{ll}\text{SPR} & \langle \text{NP} \rangle \\ \text{COMPS} & \langle \text{NP} \rangle \end{array}\right]\end{array}\right] \right\rangle$$

b.
$$\left\langle \text{Alex}, \left[\begin{array}{ll} \textit{word} & \\ & \textit{noun} \\ & \left[\begin{array}{ll}\text{SPR} & \langle\ \rangle \\ \text{COMPS} & \langle\ \rangle \end{array}\right]\end{array}\right] \right\rangle$$

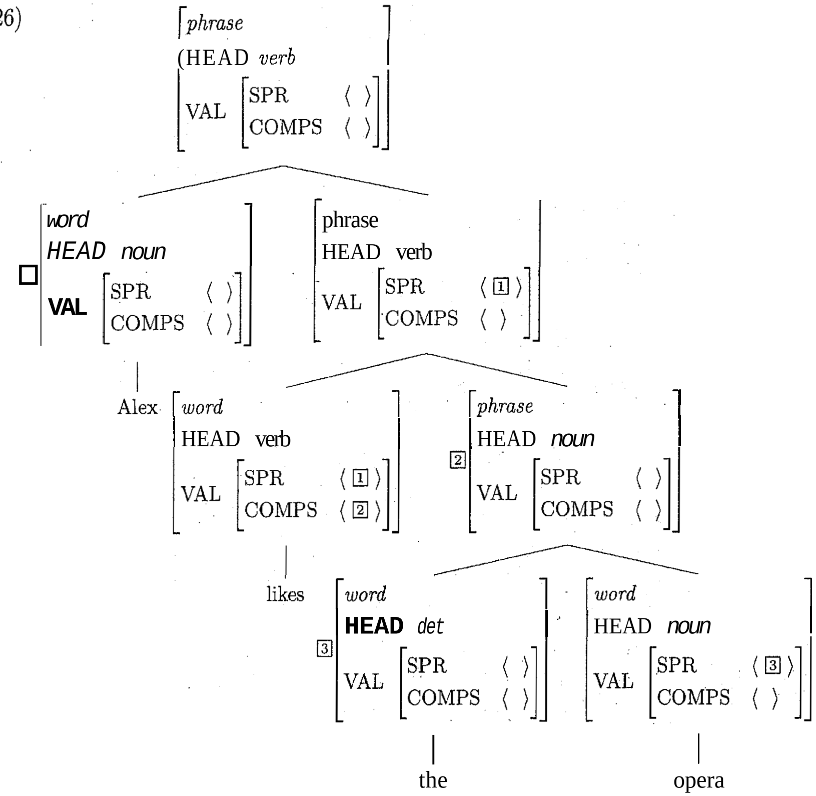
c.
$$\left\langle \text{the}, \left[\begin{array}{ll} \textit{word} & \\ \text{HEAD} & \textit{det} \\ \text{VAL} & \left[\begin{array}{ll}\text{SPR} & \langle\ \rangle \\ \text{COMPS} & \langle\ \rangle \end{array}\right]\end{array}\right] \right\rangle$$

d.
$$\left\langle \text{opera}, \left[\begin{array}{ll} \textit{word} & \\ \text{HEAD} & \textit{noun} \\ \text{VAL} & \left[\begin{array}{ll}\text{SPR} & \langle \text{D} \rangle \\ \text{COMPS} & \langle\ \rangle \end{array}\right]\end{array}\right] \right\rangle$$

[10]We will henceforth adopt the convention of using numbers to tag feature structures or atomic values and letters to tag lists of feature structures.

[11]For the purposes of this example, we are ignoring the problem of subject-verb agreement. It will be taken up below in Section 4.6.1.

(26)



There are several things to notice about this tree:

First, compared to the trees generated by the Chapter **3** grammar, it has a simpler constituent structure. In particular, it has no non-branching nodes (except those immediately dominating the actual words). The Head-Specifier Rule requires that its head daughter be [COMPS ⟨ ⟩], but there are two ways that this could come about. The head daughter could be a word that is [COMPS ⟨ ⟩] to start with, like opera; or it could be a phrase licensed by the Head-Complement Rule, like likes the opera. This phrase is [COMPS ⟨ ⟩] according to the definition of the Head-Complement Rule. In brief, the head daughter of the Head-Specifier Rule can be either a word or a phrase, as long as it is [COMPS ⟨ ⟩].

Similarly, the verb likes requires an NP complement and an NP specifier. Of course, the symbol NP (and similarly D)) is just an abbreviation for a feature structure description, namely that shown in (20). Once again, we see that the type (word or phrase) of the expression isn't specified, only the HEAD, SPR and COMPS values. Thus any nominal expression that is saturated (i.e. has no unfulfilled valence features) can serve as the specifier or complement of likes, regardless of whether it's saturated because it started out that way (like Alex) or because it 'has already found' the specifier it selected lexically (as in the opera).

This is an advantage of the Chapter 4 grammar over the Chapter **3** grammar: the non-branching nodes in the trees licensed by the Chapter **3** grammar constitute unmotivated extra structure. As noted above, this structural simplification is a direct consequence of our decision to continue specifying things in terms of NP, NOM, S and VP, while changing the interpretation of these symbols. However, we will continue to use the symbols N and V as abbreviations for the following feature structure descriptions:

(27)
$$\mathrm{N} = \begin{bmatrix} \textit{word} & \\ \text{HEAD} & \textit{noun} \end{bmatrix} \qquad \mathrm{V} = \begin{bmatrix} \textit{word} & \\ \text{HEAD} & \textit{verb} \end{bmatrix}$$

This means that in some cases, two abbreviations may apply to the same node. For instance, the node above Alex in (26) may be abbreviated as either NP or N. Similarly, the node above opera may be abbreviated as either NOM or N. This ambiguity is not problematic, as the abbreviations have no theoretical status in our grammar: they are merely there for expository convenience.

Another important thing to notice is that the rules are written so that head-complement phrases are embedded within head-specifier phrases, and not vice versa. The key constraint here is the specification on the Head-Complement Rule that the head daughter must be of type *word*. Since the mother of the Head-specifier Rule is of type phrase, a head-specifier phrase can never serve as the head daughter of a head-complement phrase.

A final thing to notice about the tree is that in any given phrase, one item is the head and it selects for its sisters. That is, *Alex* is the specifier of likes the opera (and also of *likes*), and likes is not the specifier or complement of anything.

Exercise 3: Which Rules Where?

Which subtrees of (26) are licensed by the Head-Complement Rule and which are licensed by the Head-Specifier Rule?

4.5 The Valence Principle

Recall that in order to get the SPR selection information from a lexical head like likes or story to the (phrasal) VP or NOM that it heads, we had to add a stipulation to the Head-Complement Rule. More stipulations are needed if we consider additional rules. In particular, recall the rule for introducing PP modifiers, discussed in the previous chapter. Because no complements or specifiers are introduced by this rule, we do not want any cancellation from either of the head daughter's valence features to take place. Hence, we would need to complicate the rule so as to transmit values for both valence features up from the head daughter to the mother, as shown in (28):

(28) Head-Modifier Rule (Version I)

$$\begin{bmatrix} \textit{phrase} & \\ \text{VAL} & \begin{bmatrix} \text{SPR} & \boxed{A} \\ \text{COMPS} & \boxed{B} \end{bmatrix} \end{bmatrix} \rightarrow \mathbf{H}\begin{bmatrix} \text{VAL} & \begin{bmatrix} \text{SPR} & \boxed{A} \\ \text{COMPS} & \boxed{B}\langle\ \rangle \end{bmatrix} \end{bmatrix} \quad \text{PP}$$

Without some such requirement, the combination of a modifier and a VP wouldn't be constrained to be a VP rather than, say, an S. Similarly, a modifier could combine with an S to build a VP. It is time to contemplate a more general theory of how the valence features behave in headed phrases.

The intuitive idea behind the features SPR and COMPS is quite straightforward: certain lexical entries specify what they can co-occur with by listing the particular kinds of dependents they select. We formulated general rules stating that all the head's COMPS members are 'discharged' in a head-complement phrase and that the item in the SPR value is discharged in a head-specifier phrase. But to make these rules work, we had to add constraints preserving valence specifications in all other instances: the mother in the Head-Specifier Rule preserves the head's COMPS value (the empty list); the mother in the Head-Complement Rule preserves the head's SPR value, and the mother in the Head-Modifier Rule must preserve both the COMPS value and the SPR value of the head. The generalization that can be factored out of our rules is expressed as the following principle which, like the HFP, constrains the set of trees that are licensed by our grammar rules:

(29) The Valence Principle
Unless the rule says otherwise, the mother's values for the VAL features (SPR and COMPS) are identical to those of the head daughter.

By 'unless the rule says otherwise', we mean simply that the Valence Principle is enforced unless a particular grammar rule specifies both the mother's and the head daughter's value for some valence feature.

The effect of the Valence Principle is that: (1) the appropriate elements mentioned in particular rules are canceled from the relevant valence specifications of the head daughter in head-complement or head-specifier phrases, and (2) all other valence specifications are, simply passed up from head daughter to mother. Once we factor these constraints out of our headed rules and put them into a single principle, it again becomes possible to simplify our grammar rules. This is illustrated in (30):

(30) a. Head-Specifier Rule (Near-Final Version)

$$\begin{bmatrix} \textit{phrase} \\ \text{VAL} & \begin{bmatrix}\text{SPR} & \langle\ \rangle\end{bmatrix} \end{bmatrix} \rightarrow \boxed{1} \quad \mathbf{H}\begin{bmatrix} \text{VAL} & \begin{bmatrix} \text{SPR} & \langle \boxed{1} \rangle \\ \text{COMPS} & \langle\ \rangle \end{bmatrix} \end{bmatrix}$$

b. Head-Complement Rule (Final Version)

$$\begin{bmatrix} \textit{phrase} \\ \text{VAL} & \begin{bmatrix}\text{COMPS} & \langle\ \rangle\end{bmatrix} \end{bmatrix} \rightarrow \mathbf{H}\begin{bmatrix} \textit{word} \\ \text{VAL} & \begin{bmatrix} \text{COMPS} & \langle \boxed{1}, \ldots, \boxed{n} \rangle \end{bmatrix} \end{bmatrix} \ \boxed{1} \ldots \boxed{n}$$

c. Head-Modifier Rule (Version II)

$$\begin{bmatrix}\textit{phrase}\end{bmatrix} \rightarrow \mathbf{H}\begin{bmatrix} \text{VAL} & \begin{bmatrix} \text{COMPS} & \langle\ \rangle \end{bmatrix} \end{bmatrix} \ \text{PP}$$

While the simplicity of the rules as formulated in (30) is striking, our work is not yet done. We will make further modifications to the Head-Modifier Rule in the next chapter and again in Chapter 14. The Head-Specifier Rule will receive some minor revision in Chapter 14 as well. While the Head-Complement Rule is now its final form, we will be introducing further principles that the rules interact with in later chapters.

4.6 Agreement Revisited

Let us now return to the problem of agreement. Our earlier analysis assigned the feature AGR to both nouns and verbs, and one of our grammar rules stipulated that the AGR values of VPs and their subjects had to match. In addition, as we saw in Problem 3 of Chapter 3, determiner-noun agreement is quite similar and could be treated by a similar stipulation on a different grammar rule. These two rules are now collapsed into our Head-Specifier Rule and so we could consider maintaining essentially the same rule-based analysis of agreement in this chapter's grammar.

However, there is a problem with this approach. There are other constructions, illustrated in (31), that we will also want to analyze as head-specifier phrases:

(31) a. They want/preferred [them *arrested*].
b. We want/preferred [them *on* our team].
c. With [them *on* our team], we'll be sure to win.
d. With [my parents as *supportive* as they are], I'll be in fine shape.

Clauses like the bracketed expressions in (31a,b) are referred to as SMALL CLAUSES; the constructions illustrated in (31c,d) are often called ABSOLUTE constructions. The problem here is that the italicized prepositions and adjectives that head these head-specifier phrases are not compatible with the feature AGR, which is defined only for the parts of speech *det*, *noun*, and *verb*. Nor would there be any independent reason to let English prepositions and adjectives bear AGR specifications, as they have no inflectional forms and participate in no agreement relations. Hence, if we are to unify the account of these head-specifier phrases, we cannot place any general constraint on them which makes reference to AGR.

There is another approach to agreement that avoids this difficulty. Suppose we posit a lexical constraint on verbs and common nouns that requires their AGR value and the AGR value of the specifier they select to be identical. This constraint could be formulated as in (32):

(32) Specifier-Head Agreement Constraint (SHAC)
Verbs and common nouns must be specified as:

$$\begin{bmatrix} \text{HEAD} & \begin{bmatrix}\text{AGR} & \boxed{1}\end{bmatrix} \\ \text{VAL} & \begin{bmatrix}\text{SPR} & \langle \begin{bmatrix}\text{AGR} & \boxed{1}\end{bmatrix} \rangle\end{bmatrix} \end{bmatrix}$$

This formulation does not specify precisely what the SHAC's formal status in the grammar is. This will be rectified in Chapter 8. We introduce it here so that we can move subject-verb agreement and determiner-noun agreement out of the grammar rules and into the lexicon, without having to stipulate the agreement separately in the lexical entry of every verb and common noun. The formalization in Chapter 8 has the desired effect of avoiding the unwanted redundancy by locating specifier-head agreement in one place in the grammar.

4.6.1 Subject-Verb Agreement

This proposal can accommodate the facts of subject-verb agreement without difficulty. A verb like *walks* has a lexical entry like the one shown in (33):

(33) walks:

$$\begin{bmatrix} \text{HEAD} & \begin{bmatrix} \textit{verb} & \\ \text{AGR} & \boxed{1}\begin{bmatrix} \text{PER} & \text{3rd} \\ \text{NUM} & \text{sg} \end{bmatrix} \end{bmatrix} \\ \text{VAL} & \begin{bmatrix} \text{SPR} & \left\langle \begin{matrix} \text{NP} \\ \begin{bmatrix} \text{AGR} & \boxed{1} \end{bmatrix} \end{matrix} \right\rangle \end{bmatrix} \end{bmatrix}$$

Given entries like (33), the Head-Specifier Rule in (30a) above will induce agreement, simply by identifying the head daughter's SPR value with the specifier daughter. An NP like (34) is a compatible specifier for (33), but an NP like (35) is not:

(34) Kim:

$$\begin{bmatrix} \text{HEAD} & \begin{bmatrix} \textit{noun} & \\ \text{AGR} & \begin{bmatrix} \text{PER} & \text{3rd} \\ \text{NUM} & \text{sg} \end{bmatrix} \end{bmatrix} \\ \text{VAL} & \begin{bmatrix} \text{SPR} & \langle\ \rangle \end{bmatrix} \end{bmatrix}$$

(35) we:

$$\begin{bmatrix} \text{HEAD} & \begin{bmatrix} \textit{noun} & \\ \text{AGR} & \begin{bmatrix} \text{PER} & \text{1st} \\ \text{NUM} & \text{pl} \end{bmatrix} \end{bmatrix} \\ \text{VAL} & \begin{bmatrix} \text{SPR} & \langle\ \rangle \end{bmatrix} \end{bmatrix}$$

This lexicalized approach to subject-verb agreement will account for the familiar contrasts like (36):

(36) a. Kim walks.
b.*We walks.

As before, the HFP will transmit agreement constraints down to the head noun of a subject NP, accounting for the pattern illustrated in (37):

(37) a. The child walks.
b.*The children walks.

At the same time, since the Head-Specifier Rule now makes no mention of AGR, it may also be used to construct small clauses (as in (31a, b)) and absolute constructions (as in (31c, d)), whose head daughters can be APs or PPs that are incompatible with AGR.[12]

[12] The details of the grammar of small clauses and absolute constructions, however, are beyond the scope of this textbook.

Let us now examine subject-verb agreement more closely. First, recall that English agreement depends on person, as well as number. We have analyzed person in terms of varying specifications for the feature PER. [PER 1st] is our notation for first person, that is, the pronouns *I* and *we*. [PER 2nd] denotes second person, which in English is always *you*. [PER 3rd] covers all nonpronominal NPs, as well as *he*, *she*, *it*, and *they*. Most present tense English verbs have one form when their subjects are third-person singular (namely a form ending in *-s*) and another form covering all other persons and numbers. The only verb whose present tense system makes finer distinctions than this is *be*, which has a special first-person singular form, *am*, a third-person singular form, *is*, and an additional form *are* (appropriate wherever *am* and *is* are not).

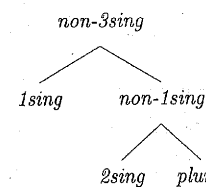
The generalization we would like to capture is this: although there are six different combinations of person and number in English, the vast majority of English verbs group these six possibilities into two sets – third person singular and other. This distinction can be incorporated into our grammar via the type hierarchy. Suppose we introduce two types called *3sing* and *non-3sing*, both immediate subtypes of the type *agr-cat*.

Instances of the type *3sing* obey the constraint shown in (38):

(38) $\textit{3sing} : \begin{bmatrix} \text{PER} & \text{3rd} \\ \text{NUM} & \text{sg} \end{bmatrix}$

The subtypes of *non-3sing* will be constrained to have other combinations of PER and NUM values. One possible organization of these subtypes (and the one we will adopt) is shown in (39):

(39)



The types *1sing*, *2sing*, and *plural* bear the constraints shown in (40):

(40) $\textit{1sing} : \begin{bmatrix} \text{PER} & \text{1st} \\ \text{NUM} & \text{sg} \end{bmatrix}$

$\textit{2sing} : \begin{bmatrix} \text{PER} & \text{2nd} \\ \text{NUM} & \text{sg} \end{bmatrix}$

$\textit{plural} : \begin{bmatrix} \text{NUM} & \text{pl} \end{bmatrix}$

The types *3sing* and *non-3sing* are motivated by the co-occurrence of verbs and nouns, however, there is actually independent evidence for the type distinction. Recall that one function of the type hierarchy is to allow us to state which features are approriate for each type of linguistic object. While PER and NUM are appropriate for both *3sing* and *non-3sing* (and will therefore be declared on the supertype *agr-cat*), the feature GEND(ER) is only appropriate to *3sing*: GEND (with values *masc*, *fem*, and *neut*) will serve to differentiate among *he*, *she*, and *it*, *him*, *her*, and *it*, and *himself*, *herself*, and *itself.* There is no motivation in English for assigning GEND to anything other than words that are third-person and singular.

With the addition of GEND, the full set of possible AGR values is as shown in (41):

(41) Possible AGR Values

$$\begin{bmatrix} \textit{1sing} & \\ \text{PER} & \text{1st} \\ \text{NUM} & \text{sg} \end{bmatrix} \begin{bmatrix} \textit{2sing} & \\ \text{PER} & \text{2nd} \\ \text{NUM} & \text{sg} \end{bmatrix}$$

$$\begin{bmatrix} \textit{plural} & \\ \text{PER} & \text{1st} \\ \text{NUM} & \text{pl} \end{bmatrix} \begin{bmatrix} \textit{plural} & \\ \text{PER} & \text{2nd} \\ \text{NUM} & \text{pl} \end{bmatrix} \begin{bmatrix} \textit{plural} & \\ \text{PER} & \text{3rd} \\ \text{NUM} & \text{pl} \end{bmatrix}$$

$$\begin{bmatrix} \textit{3sing} & \\ \text{PER} & \text{3rd} \\ \text{NUM} & \text{sg} \\ \text{GEND} & \text{fem} \end{bmatrix} \begin{bmatrix} \textit{3sing} & \\ \text{PER} & \text{3rd} \\ \text{NUM} & \text{sg} \\ \text{GEND} & \text{masc} \end{bmatrix} \begin{bmatrix} \textit{3sing} & \\ \text{PER} & \text{3rd} \\ \text{NUM} & \text{sg} \\ \text{GEND} & \text{neut} \end{bmatrix}$$

Observe the absence of GEND on the *non-3sing* types.

This treatment of the AGR values of nouns and NPs leads to a (minor) simplification in the lexical entries for nouns and verbs. The third-person singular proper noun *Kim* and the present-tense verb form *walks* will now have lexical entries like the following:

(42) a.

$$\left\langle \text{Kim}\ , \begin{bmatrix} \text{HEAD} & \begin{bmatrix} \textit{noun} & \\ \text{AGR} & \textit{3sing} \end{bmatrix} \\ \text{VAL} & \begin{bmatrix} \text{COMPS} & \langle\ \rangle \\ \text{SPR} & \langle\ \rangle \end{bmatrix} \end{bmatrix} \right\rangle$$

b.

$$\left\langle \text{walks}\ , \begin{bmatrix} \text{HEAD} & \begin{bmatrix} \textit{verb} & \\ \text{AGR} & \textit{3sing} \end{bmatrix} \\ \text{VAL} & \begin{bmatrix} \text{SPR} & \langle \text{NP} \rangle \end{bmatrix} \end{bmatrix} \right\rangle$$

Lexical entries like (42b) are further subject to the SHAC, as described above.

On the other hand, we can use a single lexical entry for all the other present tense uses of a given verb. It is often assumed that it is necessary to posit separate lexical entries for present tense verb forms that take plural subjects and those that take singular, non-third-person subjects, as sketched in (43a,b):

(43) a.

$$\left\langle \text{walk}\ , \begin{bmatrix} \text{HEAD} & \begin{bmatrix} \textit{verb} & \\ \text{AGR} & \begin{bmatrix} \text{NUM} & \text{pl} \end{bmatrix} \end{bmatrix} \\ \text{VAL} & \begin{bmatrix} \text{SPR} & \langle \text{NP} \rangle \end{bmatrix} \end{bmatrix} \right\rangle$$

b.

$$\left\langle \text{walk}\ , \begin{bmatrix} \text{HEAD} & \begin{bmatrix} \textit{verb} & \\ \text{AGR} & \begin{bmatrix} \text{PER} & \text{1st} \mid \text{2nd} \\ \text{NUM} & \text{sg} \end{bmatrix} \end{bmatrix} \\ \text{VAL} & \begin{bmatrix} \text{SPR} & \langle \text{NP} \rangle \end{bmatrix} \end{bmatrix} \right\rangle$$

But such an analysis would fail to explain the fact that the former type of verb would always be identical in form to the latter: again, a suspicious loss of generalization in the lexicon.

Once we bifurcate the types of AGR values, as described above, this problem disappears. We need only a single kind of verb subsuming both (43a) and (43b), one that includes the following lexical information:

(44)

$$\begin{bmatrix} \text{HEAD} & \begin{bmatrix} \text{AGR} & \textit{non-3sing} \end{bmatrix} \end{bmatrix}$$

Because of the SHAC, verbs so specified project VPs that take subjects whose head nouns must bear *non-3sing* AGR values, and these, as described above, must either be first-person singular, second-person singular, or plural.

The disjunctions needed for describing classes of verbs are thus given by the type hierarchy, not by writing arbitrarily disjunctive lexical entries. In fact, one of the goals of a grammar that uses types is to predict in this manner which disjunctions play a significant role in the grammatical analysis of a given language (or of language in general).

Exercise 4: The AGR Values of *am* and *are*

What would be the AGR values in the lexical entries for *am* and *are*?

4.6.2 Determiner-Noun Agreement

We have just seen how our new analysis of specifiers, taken together with the Specifier-Head Agreement Constraint and the Head Feature Principle, provides an account of the fact that a third-person singular verb form (e.g. *walks*) takes a subject NP headed by a third-person singular noun. But, as we have already seen, the specifiers of the phrases projected from these nouns also agree in number. Recall from Problem 3 of Chapter 3 that English has determiners like *this* and *a*, which only appear with singular nouns, plural determiners like *these* and *few*, which only appear with plural nouns, and other determiners like *the*, which go either way:

(45) a. This dog barked.
b.*This dogs barked.
c. A dog barked.
d.*A dogs barked.

(46) a.*These dog barked.
b. These dogs barked.

c.*Few dog barked.

d. Few dogs barked.

(47) a. The dog barked.

b. The dogs barked.

There is systematic number agreement between heads and specifiers within the NP.

We will assume that common nouns are lexically specified as shown in (48):

(48) $\left[\text{SPR} \quad \langle \, [\text{HEAD} \;\; \textit{det}] \, \rangle \right]$

Hence, by the SHAC, whatever constraints we place on the AGR value of common nouns will also apply to the determiners they co-occur with. Determiner-noun agreement, like subject-verb agreement, is a lexical fact about nouns. This account makes crucial use of our hypothesis (discussed in detail in Chapter 3) that determiners and nouns both bear AGR specifications, as illustrated in (49):[13]

(49) person, boat, a, this: $\left[\text{AGR} \quad \textit{3sing}\right]$

people, boats, few, these: $\left[\text{AGR} \quad \begin{bmatrix}\text{PER} & \text{3rd}\\ \text{NUM} & \text{pl}\end{bmatrix}\right]$

the: $\left[\text{AGR} \quad \left[\text{PER} \quad \text{3rd}\right]\right]$

These lexical specifications, taken together with the SHAC and the HFP, provide a complete account of the agreement data in (45)–(47) above.

4.6.3 Count and Mass Revisited (COUNT)

In Section 4.4 above, we also observed that some determiners are restricted to occur only with 'mass' nouns (e.g. *furniture*), and others only with 'count' nouns (e.g. *chair*):

(50) a. Much furniture was broken.

b.*A furniture was broken.

c.*Much chair was broken.

d. A chair was broken.

The co-occurrence restriction illustrated in (50) – that is, the count noun/mass noun distinction – might, of course, be solely a semantic matter. In order to give it a semantic analysis, we would need to find a solid semantic criterion that would relate the meaning of any given noun to its classification according to the distributional facts. Indeed, many mass nouns (such as *air*, *water*, *sand*, and *information*) do seem to have a lot in common semantically. However, the distributional class of mass nouns also contains words like *furniture* and *succotash*.[14] These words tend to resist semantic characterizations that

[13]Since we identify the whole AGR values, we are actually analyzing determiners and nouns as agreeing in both person and number. This analysis makes different predictions from an analysis that just identified the NUM values. It might for example allow a proper treatment of NPs like *you philosophers* or *us linguists*, assuming that pronouns lead a second life as determiners.

[14]a dish of cooked lima beans and corn

work for the other members of the class. For example, no matter how you divide up a quantity of water, the smaller portions are still water. The same is more or less true for *air*, *sand*, and *information*, but not true for *furniture* and *succotash*. Any semantic analysis that doesn't extend to all members of the distributional class 'mass nouns' will need to be supplemented with a purely syntactic analysis of the (semantically) oddball cases.

In the absence of a complete semantic analysis, we will analyze the data in (50) syntactically by introducing a feature COUNT. Certain determiners (e.g. *a* and *few*) will be lexically specified as [COUNT +] and others (e.g. *much*) will be lexically treated as [COUNT −], on the basis of which nouns they co-occur with. Still other determiners, such as *the*, will be lexically unmarked for this feature, because they co-occur with both kinds of nouns. The SPR value of a count noun like *chair* would then be ⟨ D[COUNT +] ⟩, forcing such nouns to co-occur with a count determiner. And the SPR value of a mass noun like *furniture* would be ⟨ D[COUNT −] ⟩.[15]

Notice that, in contrast to AGR, COUNT is a feature only of determiners. What we might informally refer to as a 'count noun' (like *dog*) is actually one whose SPR value contains a [COUNT +] determiner. This information is not passed up to the NP node that dominates the noun. Since a verb's SPR value specifies what kind of NP it takes as its subject, only information that appears on the NP node can be selected. Consequently, our analysis predicts that no English verb requires a count (or mass) subject (or object). To the best of our knowledge, this prediction is correct.

4.6.4 Summary

In this section, we have considered two kinds of agreement: subject-verb agreement and determiner-noun agreement. In both cases, we have analyzed the agreement in terms of the SPR requirement of the head (verb or noun). Once we take into account the effects of the SHAC, our analysis includes the following lexical entries:

(51) a.

$$\left\langle \text{dog} \, , \begin{bmatrix} \textit{word} & \\ \text{HEAD} & \begin{bmatrix}\textit{noun} & \\ \text{AGR} & \boxed{1}\end{bmatrix} \\ \text{VAL} & \begin{bmatrix} \text{SPR} & \left\langle \begin{bmatrix} \text{HEAD} & \begin{bmatrix}\textit{det} & \\ \text{AGR} & \boxed{1}\textit{3sing} \\ \text{COUNT} & + \end{bmatrix} \\ \text{VAL} & \begin{bmatrix}\text{SPR} & \langle\ \rangle \\ \text{COMPS} & \langle\ \rangle\end{bmatrix} \end{bmatrix} \right\rangle \\ \text{COMPS} & \langle\ \rangle \end{bmatrix} \end{bmatrix} \right\rangle$$

[15]We postpone discussion of the optionality of determiners until Chapter 8.

b.

$$\left\langle \text{walks}, \begin{bmatrix} \textit{word} \\ \text{HEAD} & \begin{bmatrix} \textit{verb} \\ \text{AGR} & \boxed{1} \end{bmatrix} \\ \text{VAL} & \begin{bmatrix} \text{SPR} & \left\langle \begin{bmatrix} \text{HEAD} & \begin{bmatrix} \textit{noun} \\ \text{AGR} & \boxed{1}\textit{3sing} \end{bmatrix} \\ \text{VAL} & \begin{bmatrix} \text{SPR} & \langle\ \rangle \\ \text{COMPS} & \langle\ \rangle \end{bmatrix} \end{bmatrix} \right\rangle \\ \text{COMPS} & \langle\ \rangle \end{bmatrix} \end{bmatrix} \right\rangle$$

c.

$$\left\langle \text{the}, \begin{bmatrix} \textit{word} \\ \text{HEAD} & \textit{det} \\ \text{VAL} & \begin{bmatrix} \text{SPR} & \langle\ \rangle \\ \text{COMPS} & \langle\ \rangle \end{bmatrix} \end{bmatrix} \right\rangle$$

We have designed the architecture of our feature structures and the way they interact with our general principles to have specific empirical consequences. The parallel distribution of the feature AGR in the noun and verb feature structures above reflects the fact that both verbs and nouns agree with their specifiers. In the sentence *The dog walks*, the AGR value on the noun *dog* will pass up to the NP that it heads, and that NP then has to satisfy the specifier requirement of the verb *walks*. Nouns play a dual role in agreement: as the head of the specifier in subject-verb agreement, and as the head with which the specifier must agree in determiner-noun agreement.[16]

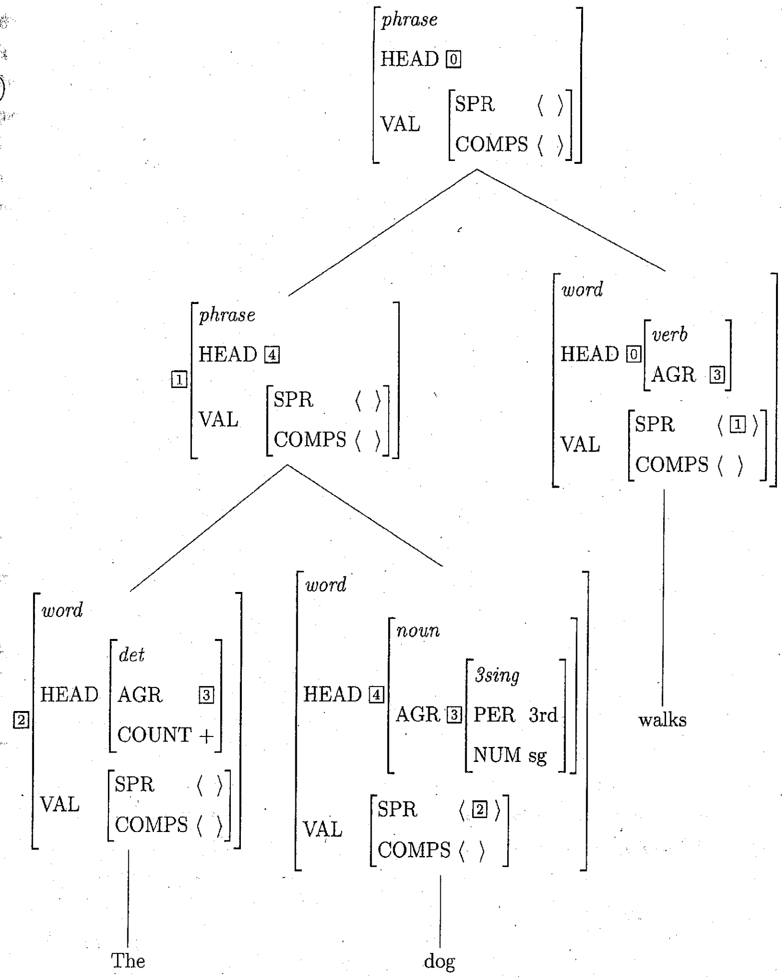
The picture we now have of head-specifier structures is summarized in (52).

[16]Notice that verbs also pass up their AGR specification to the VP and S phrases they project. Hence, our analysis predicts that this information about the subject NP of a sentence is locally accessible at those higher levels of structure and could be selected for or agreed with higher in the tree. This view might well be supported by the existence of verb agreement in 'tag questions':

(i) He is leaving, isn't he?
(ii) *He is leaving, isn't she?
(iii) *He is leaving, aren't they?
(iv) They are leaving, aren't they?
(v) *They are leaving, isn't she?

Once again, such issues are beyond the scope of this textbook. For more on tag questions, see Bender and Flickinger 1999.

(52)



There are several things to notice about this tree:

- The HEAD value of the noun *dog* ($\boxed{4}$) and that of the phrase above it are identical in virtue of the HFP.
- Similarly, the HFP guarantees that the HEAD value of the verb *walks* ($\boxed{0}$) and that of the phrase above it are identical.
- The SHAC guarantees that the AGR value of the verb ($\boxed{3}$) is identical to that of the NP it selects as a specifier ($\boxed{1}$).
- The SHAC also guarantees that the AGR value of the noun ($\boxed{3}$) is identical to that of the determiner it selects as a specifier ($\boxed{2}$).
- Since the AGR of the noun specification is within the noun's HEAD value $\boxed{4}$, it follows from the interaction of the SHAC and the HFP that the AGR values of the NP, N, and D in (52) are all identical.

- This means in turn that whenever a verb selects a certain kind of subject NP (an [AGR *3sing*] NP in the case of the verb *walks* in (52)), that selection will restrict what kind of noun and (indirectly, through the noun's own selectional restrictions) what kind of determiner can occur within the subject NP, as desired.

4.7 Coordination and Agreement

The coordination rule from the Chapter 3 grammar, repeated here as (53), identifies the entire *expression* of the mother with the *expressions* of the conjunct daughters:

(53) Coordination Rule (Chapter 3 version):

$$\boxed{1} \rightarrow \boxed{1}^{+} \begin{bmatrix} \textit{word} & \\ \text{HEAD} & \textit{conj} \end{bmatrix} \boxed{1}$$

Together with our analysis of agreement, this rule makes some incorrect predictions. For example, it wrongly predicts that the examples in (54) should be ungrammatical, since the conjunct daughters have differing AGR values:

(54) a. I walk and Dana runs.
b. Two cats and one dog live there.

Exercise 5: AGR in Coordination
Using abbreviations like NP, S and VP, draw the tree the grammar should assign to (54a). What are the AGR values of the S nodes dominating *I walk* and *Dana runs*? Where do they come from?

These data show that requiring complete identity of feature values between the conjuncts is too strong. In fact, the problem of determining exactly which information must be shared by the conjuncts and the mother in coordinate structures is a very tricky one. For now, we will revise the Coordination Rule as in (55), but we will return to this rule again in Chapters 5, 8 and 14:

(55) Coordination Rule (Chapter 4 version):

$$\begin{bmatrix} \text{VAL} & \boxed{1} \end{bmatrix} \rightarrow \begin{bmatrix} \text{VAL} & \boxed{1} \end{bmatrix}^{+} \begin{bmatrix} \textit{word} & \\ \text{HEAD} & \textit{conj} \end{bmatrix} \begin{bmatrix} \text{VAL} & \boxed{1} \end{bmatrix}$$

The Coordination Rule in (55) states that any number of constituents with the same VAL value can be coordinated to form a constituent whose mother has the same VAL value. Since AGR is in HEAD (not VAL), the rule in (55) will license the sentences in (54).

However, this rule goes a bit too far in the other direction, and now overgenerates. For example, it allows NPs and Ss to coordinate with each other:

(56)*The dog slept and the cat.

On the other hand, the overgeneration is not as bad as it might seem at first glance. In particular, for non-saturated constituents (i.e. those with non-empty SPR or COMPS values), the requirement that the SPR and COMPS values be identified goes a long way

towards ensuring that the conjuncts have the same part of speech as well. For example, a NOM like *cat* can't be coordinated with a VP like *slept* because they have different SPR values. In Chapter 8 we will see how to constrain conjuncts to have the same part of speech without requiring identity of the whole HEAD value.

Identifying VAL values (and therefore SPR values) also makes a very nice prediction about VP versus S coordination. While Ss with different AGR values can be coordinated as in (54a), VPs with different AGR values cannot, as shown in (57):

(57)*Kim walks and run.

Another way to phrase this is that VPs with differing SPR requirements can't be coordinated, and that is exactly how we capture this fact. Problem 9 addresses the issue of AGR values in coordinated NPs.

4.8 Case Marking

Yet another kind of selectional dependency found in many languages is the phenomenon of CASE MARKING. Case marking is a kind of variation in the form of Ns or NPs, depending on their syntactic environment. (This was addressed briefly in Problem 6 of Chapter 2.)

While many languages have case systems that involve all kinds of nouns, English has a very impoverished case system, where only pronouns show case distinctions:

(58) a. We like them.
b. They like us.
c.*We like they.
d.*Us like them.
e. Kim likes dogs.
f. Dogs like Kim.

In these examples, the forms *we* and *they* are in the NOMINATIVE case (sometimes called the SUBJECTIVE case), and the forms *us* and *them* are in the ACCUSATIVE case (sometimes called the OBJECTIVE case). Other languages have a larger selection of cases.

In Chapter 2, Problem 6 asked you to write phrase structure rules that would account for the different case markings associated with different positions in English. This kind of analysis of case marking no longer makes much sense, because we have replaced the very specific phrase structure rules of earlier chapters with more general rule schemas. With the theoretical machinery developed in this chapter, we handle case entirely in the lexicon, without changing our grammar rules. That is, the style of analysis we developed for agreement will work equally well for case marking. All we'll need is a new feature CASE that takes the atomic values 'nom' and 'acc' (and others for languages with more case distinctions). Problems 5–8 concern applying the machinery to case systems in English, Icelandic, and the Australian language Wambaya, and address issues such as what kind of feature structure CASE is a feature of.

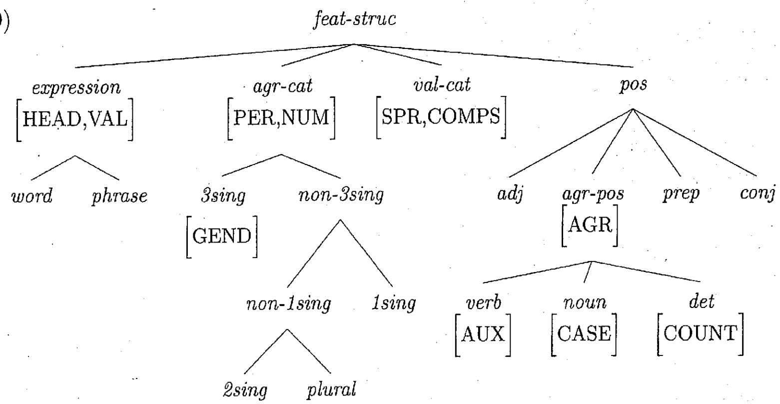
4.9 Summary

In the previous chapter, we had already seen that cross-categorial generalizations about phrase structure can be expressed in terms of schematic phrase structure rules and categories specified in terms of feature structures. In this chapter, the real power of feature structure grammars has begun to emerge. We have begun the process of providing a unified account of the generalizations about complementation and specifier selection, in terms of the list-valued features COMPS and SPR. These features, together with the Valence Principle, have enabled us to eliminate further redundancy from our grammar rules. In fact, our grammar has now been reduced to four very general rules. In this chapter, we've also seen that key generalizations about agreement can be expressed in terms of this highly compact rule system, once we rely on categories modeled as feature structures and a single Specifier-Head Agreement Constraint. Problems 5 through 8 concern extending this style of analysis to case marking phenomena.

4.10 The Chapter 4 Grammar

4.10.1 The Type Hierarchy

(59)



4.10.2 Feature Declarations and Type Constraints

TYPE	FEATURES/CONSTRAINTS	IST
feat-struc		
expression	$\begin{bmatrix}\text{HEAD} & \textit{pos}\\ \text{VAL} & \textit{val-cat}\end{bmatrix}$	*feat-struc*
word		*expression*
phrase		*expression*
val-cat	$\begin{bmatrix}\text{SPR} & \textit{list(expression)}^{17}\\ \text{COMPS} & \textit{list(expression)}\end{bmatrix}$	*feat-struc*
pos		*feat-struc*
agr-pos	$\begin{bmatrix}\text{AGR} & \textit{agr-cat}\end{bmatrix}$	*pos*
verb	$\begin{bmatrix}\text{AUX} & \{+, -\}\end{bmatrix}$	*agr-pos*
noun	$\begin{bmatrix}\text{CASE} & \{\text{nom, acc}\}\end{bmatrix}$	*agr-pos*
det	$\begin{bmatrix}\text{COUNT} & \{+, -\}\end{bmatrix}$	*agr-pos*
adj,prep,conj		*pos*
agr-cat	$\begin{bmatrix}\text{PER} & \{\text{1st, 2nd, 3rd}\}\\ \text{NUM} & \{\text{sg, pl}\}\end{bmatrix}$	*feat-struc*
3sing	$\begin{bmatrix}\text{PER} & \text{3rd}\\ \text{NUM} & \text{sg}\\ \text{GEND} & \{\text{fem, masc, neut}\}\end{bmatrix}$	*agr-cat*
non-3sing		*agr-cat*
1sing	$\begin{bmatrix}\text{PER} & \text{1st}\\ \text{NUM} & \text{sg}\end{bmatrix}$	*non-3sing*
non-1sing		*non-3sing*
2sing	$\begin{bmatrix}\text{PER} & \text{2nd}\\ \text{NUM} & \text{sg}\end{bmatrix}$	*non-1sing*
plural	$\begin{bmatrix}\text{NUM} & \text{pl}\end{bmatrix}$	*non-1sing*

[17]The formal status of list types like this one is explicated in the Appendix to Chapter 6.

4.10.3 Abbreviations

(60)

$$\text{S} = \begin{bmatrix} \text{HEAD} & \textit{verb} \\ \text{VAL} & \begin{bmatrix} \text{COMPS} & \langle\ \rangle \\ \text{SPR} & \langle\ \rangle \end{bmatrix} \end{bmatrix} \qquad \text{NP} = \begin{bmatrix} \text{HEAD} & \textit{noun} \\ \text{VAL} & \begin{bmatrix} \text{COMPS} & \langle\ \rangle \\ \text{SPR} & \langle\ \rangle \end{bmatrix} \end{bmatrix}$$

$$\text{VP} = \begin{bmatrix} \text{HEAD} & \textit{verb} \\ \text{VAL} & \begin{bmatrix} \text{COMPS} & \langle\ \rangle \\ \text{SPR} & \langle \text{X} \rangle \end{bmatrix} \end{bmatrix} \qquad \text{NOM} = \begin{bmatrix} \text{HEAD} & \textit{noun} \\ \text{VAL} & \begin{bmatrix} \text{COMPS} & \langle\ \rangle \\ \text{SPR} & \langle \text{X} \rangle \end{bmatrix} \end{bmatrix}$$

$$\text{V} = \begin{bmatrix} \textit{word} & \\ \text{HEAD} & \textit{verb} \end{bmatrix} \qquad \text{N} = \begin{bmatrix} \textit{word} & \\ \text{HEAD} & \textit{noun} \end{bmatrix}$$

$$\text{D} = \begin{bmatrix} \textit{word} & \\ \text{HEAD} & \textit{det} \\ \text{VAL} & \begin{bmatrix} \text{COMPS} & \langle\ \rangle \\ \text{SPR} & \langle\ \rangle \end{bmatrix} \end{bmatrix}$$

4.10.4 The Grammar Rules

(61) Head-Specifier Rule

$$\begin{bmatrix} \textit{phrase} & \\ \text{VAL} & \begin{bmatrix} \text{SPR} & \langle\ \rangle \end{bmatrix} \end{bmatrix} \rightarrow \boxed{1}\ \ \textbf{H}\begin{bmatrix} \text{VAL} & \begin{bmatrix} \text{SPR} & \langle \boxed{1} \rangle \\ \text{COMPS} & \langle\ \rangle \end{bmatrix} \end{bmatrix}$$

(62) Head-Complement Rule

$$\begin{bmatrix} \textit{phrase} & \\ \text{VAL} & \begin{bmatrix} \text{COMPS} & \langle\ \rangle \end{bmatrix} \end{bmatrix} \rightarrow \textbf{H}\begin{bmatrix} \textit{word} & \\ \text{VAL} & \begin{bmatrix} \text{COMPS} & \langle \boxed{1}, \ldots, \boxed{n} \rangle \end{bmatrix} \end{bmatrix} \boxed{1} \ldots \boxed{n}$$

(63) Head-Modifier Rule

$$\begin{bmatrix} \textit{phrase} \end{bmatrix} \rightarrow \textbf{H}\begin{bmatrix} \text{VAL} & \begin{bmatrix} \text{COMPS} & \langle\ \rangle \end{bmatrix} \end{bmatrix} \text{PP}$$

(64)

Coordination Rule

$$\begin{bmatrix} \text{VAL} & \boxed{1} \end{bmatrix} \rightarrow \begin{bmatrix} \text{VAL} & \boxed{1} \end{bmatrix}^{+} \begin{bmatrix} \textit{word} & \\ \text{HEAD} & \textit{conj} \end{bmatrix} \begin{bmatrix} \text{VAL} & \boxed{1} \end{bmatrix}$$

4.10.5 The Principles

(65) Head Feature Principle (HFP)

In any headed phrase, the HEAD value of the mother and the HEAD value of the head daughter must be identical.

(66) Valence Principle

Unless the rule says otherwise, the mother's values for the VAL features (SPR and COMPS) are identical to those of the head daughter.

(67) Specifier-Head Agreement Constraint (SHAC)[18]

Verbs and common nouns must be specified as:

$$\begin{bmatrix} \text{HEAD} & \begin{bmatrix} \text{AGR} & \boxed{1} \end{bmatrix} \\ \text{VAL} & \begin{bmatrix} \text{SPR} & \langle \begin{bmatrix} \text{AGR} & \boxed{1} \end{bmatrix} \rangle \end{bmatrix} \end{bmatrix}$$

4.10.6 Sample Lexical Entries

(68)

$$\left\langle \text{I}\ , \begin{bmatrix} \textit{word} & \\ \text{HEAD} & \begin{bmatrix} \textit{noun} & \\ \text{AGR} & \textit{1sing} \end{bmatrix} \\ \text{VAL} & \begin{bmatrix} \text{SPR} & \langle\ \rangle \\ \text{COMPS} & \langle\ \rangle \end{bmatrix} \end{bmatrix} \right\rangle$$

(69)

$$\left\langle \text{dog}\ , \begin{bmatrix} \textit{word} & \\ \text{HEAD} & \begin{bmatrix} \textit{noun} & \\ \text{AGR} & \textit{3sing} \end{bmatrix} \\ \text{VAL} & \begin{bmatrix} \text{SPR} & \left\langle \begin{matrix} \text{D} \\ \begin{bmatrix} \text{COUNT} & + \end{bmatrix} \end{matrix} \right\rangle \\ \text{COMPS} & \langle\ \rangle \end{bmatrix} \end{bmatrix} \right\rangle$$

(70)

$$\left\langle \text{furniture}\ , \begin{bmatrix} \textit{word} & \\ \text{HEAD} & \begin{bmatrix} \textit{noun} & \\ \text{AGR} & \textit{3sing} \end{bmatrix} \\ \text{VAL} & \begin{bmatrix} \text{SPR} & \left\langle \begin{matrix} \text{D} \\ \begin{bmatrix} \text{COUNT} & - \end{bmatrix} \end{matrix} \right\rangle \\ \text{COMPS} & \langle\ \rangle \end{bmatrix} \end{bmatrix} \right\rangle$$

(71)

$$\left\langle \text{a}\ , \begin{bmatrix} \textit{word} & \\ \text{HEAD} & \begin{bmatrix} \textit{det} & \\ \text{AGR} & \textit{3sing} \\ \text{COUNT} & + \end{bmatrix} \\ \text{VAL} & \begin{bmatrix} \text{SPR} & \langle\ \rangle \\ \text{COMPS} & \langle\ \rangle \end{bmatrix} \end{bmatrix} \right\rangle$$

[18] The SHAC is a principle for now, but once we have a more developed theory of lexical types in Chapter 8, it will be expressed as a constraint on the type *inflecting-lexeme*.

(72)
$$\left\langle \text{much}\ , \begin{bmatrix} \textit{word} & \\ \text{HEAD} & \begin{bmatrix}\textit{det} & \\ \text{AGR} & \textit{3sing}\\ \text{COUNT} & -\end{bmatrix}\\ \text{VAL} & \begin{bmatrix}\text{SPR} & \langle\ \rangle \\ \text{COMPS} & \langle\ \rangle\end{bmatrix}\end{bmatrix}\right\rangle$$

(73)
$$\left\langle \text{barks}\ , \begin{bmatrix} \textit{word} & \\ \text{HEAD} & \begin{bmatrix}\textit{verb} & \\ \text{AGR} & \textit{3sing}\end{bmatrix}\\ \text{VAL} & \begin{bmatrix}\text{SPR} & \langle \text{NP} \rangle \\ \text{COMPS} & \langle\ \rangle\end{bmatrix}\end{bmatrix}\right\rangle$$

(74)
$$\left\langle \text{like}\ , \begin{bmatrix} \textit{word} & \\ \text{HEAD} & \begin{bmatrix}\textit{verb} & \\ \text{AGR} & \textit{non-3sing}\end{bmatrix}\\ \text{VAL} & \begin{bmatrix}\text{SPR} & \langle \text{NP} \rangle \\ \text{COMPS} & \langle \text{NP} \rangle\end{bmatrix}\end{bmatrix}\right\rangle$$

4.11 Further Reading

The idea of schematizing phrase structure rules across parts of speech was introduced into generative grammar by Chomsky (1970). For a variety of perspectives on grammatical agreement, see Barlow and Ferguson 1988. A helpful discussion of Icelandic case (see Problem 7) is provided by Andrews (1982). For discussion and an analysis of NP coordination, see Dalrymple and Kaplan 2000 and Sag 2003.

4.12 Problems

Problem 1: Valence Variations

In this problem, you will be asked to write lexical entries (including HEAD, SPR, and COMPS values). You may use NP, VP, etc. as abbreviations for the feature structures on COMPS lists.

As you do this problem, keep the following points in mind: (1) In this chapter we've changed COMPS to be a list-valued feature, and (2) heads select for their specifier and complements (if they have any); the elements on the SPR and COMPS lists do not simultaneously select for the head.

[*Hint: For the purposes of this problem, assume that adjectives and prepositions all have empty SPR lists.*]

A. Write lexical entries for the words *here* and *there* as they are used in (i).

(i) Kim put the book here/there.

[*Hint: Compare (i) to (7) on page 97.*]

B. Write a lexical entry for the adjective *fond.* Your lexical entry should account for the data in (10d–h).

C. Assume that motion verbs like *jump*, *move*, etc. take an optional PP complement, that is, that these verbs have the following specification in their lexical entries:

$$\begin{bmatrix}\text{COMPS} & \langle\ (\text{PP})\ \rangle\end{bmatrix}$$

Given that, use the following examples to write the lexical entries for the prepositions *out*, *from* and *of*:

(i) Kim jumped out of the bushes.
(ii) Bo jumped out from the bushes.
(iii) Lee moved from under the bushes.
(iv) Leslie jumped out from under the bushes.
(v) Dana jumped from the bushes.
(vi) Chris ran out the door.
(vii)*Kim jumped out of from the bushes.
(viii) Kim jumped out.
(ix)*Kim jumped from.

D. Based on the following data, write the lexical entries for the words *grew* (in the 'become' sense, not the 'cultivate' sense), *seemed*, *happy*, and *close*.

(i) They seemed happy (to me).
(ii) Lee seemed an excellent choice (to me).
(iii)*They seemed (to me).
(iv) They grew happy.
(v)*They grew a monster (to me).
(vi)*They grew happy to me.
(vii) They grew close to me.
(viii) They seemed close to me to Sandy.

[*Note: APs have an internal structure analogous to that of VPs. Though no adjectives select NP complements (in English), there are some adjectives that select PP complements (e.g. to me), and some that do not.*]

E. Using the lexical entries you wrote for part (D), draw a tree (showing the values of HEAD, SPR, and COMPS at each node, using tags as appropriate) for *They seemed close to me to Sandy.*

Problem 2: Spanish NPs I

In English, gender distinctions are only shown on pronouns, and the vast majority of common nouns are [GENDER neuter] (that is, if they serve as the antecedent of a pronoun, that pronoun will be *it*). The gender system in Spanish differs from English in two respects. First, gender distinctions are shown on determiners and adjectives as well as on pronouns. Second, all common nouns are assigned either masculine or feminine gender (there is no neuter). This problem concerns agreement in Spanish, including gender agreement.

Consider the following data from Spanish:

(i) a. La jirafa corrió.
The.FEM.SG giraffe ran.3SG
'The giraffe ran.'
b.*Las/El/Los jirafa corrió.

(ii) a. Las jirafas corrieron.
The.FEM.PL giraffes ran.3PL
'The giraffes ran.'
b.*La/El/Los jirafas corrieron.

(iii) a. El pingüino corrió.
The.MASC.SG penguin RAN.3SG
'The penguin ran.'
b.*La/Las/Los pingüino corrió.

(iv) a. Los pingüinos corrieron.
The.MASC.PL penguins RAN.3PL
'The penguins ran.'
b.*La/Las/El pingüinos corrieron.

A. Do the Spanish nouns shown obey the SHAC? Why or why not?
B. For English, we argued that the feature GEND(ER) is only appropriate for agreement categories (*agr-cats*) that are *3sing* (i.e. PER 3rd, NUM sg). Is this true for Spanish as well? Why or why not?
C. Write lexical entries for *la*, *los*, and *pingüino*.

Problem 3: COUNT and NUM

Section 4.6.2 provides analyses of the co-occurrence restrictions between nouns and determiners that have to do with the count/mass distinction and with number agreement. An alternative analysis would eliminate the feature COUNT and assign three values to the feature NUM: sg, pl, and mass. That is, mass nouns like *furniture* would be given the value [NUM mass]. Use the following data to provide an argument favoring the analysis given in the text over this alternative:

(i) We don't have much $\left\{\begin{array}{l}\text{rice}\\\text{oats}\end{array}\right\}$.

(ii) *We don't have many $\left\{\begin{array}{l}\text{rice}\\\text{oats}\end{array}\right\}$.

(iii) The rice is in the bowl.
(iv)*The rice are in the bowl.
(v) The oats are in the bowl.
(vi)*The oats is in the bowl.

[*Note: You may speak a variety of English that accepts many oats as a well-formed NP. There are some other nouns that are like oats in the relevant respects in at least some dialects, including grits (as a kind of cereal), mashed potatoes, and (somewhat distastefully, but grammatically more clearly) feces. If you can find a noun that patterns as we claim oats does in examples (i)–(vi), work the problem using that noun. If your dialect has no such nouns, then work the problem for the dialect described here, putting aside your own judgments.*]

Problem 4: Complements and Specifiers in Pipil

Consider the following data from Pipil (Uto-Aztecan, El Salvador).[19]

(i) Miki-k ne masaat.
die.PAST the deer
'The deer died.'

(ii) Mukwep-ki ne tengerechul.
return.PAST the lizard
'The lizard returned.'

(iii) Yaah-ki kadentroh ne taakatsin.
go.PAST inside the little-man
'The little man went inside.'

(iv) Muchih-ki alegrár ne piltsintsín.
do.PAST rejoicing the little-boy
'The little boy rejoiced.' (Literally, 'The little boy did rejoicing.')

(v) Kichih-ke-t ne tiit ne pipiltsitsín.
make.PAST.PLURAL the fire the little-boys
'The little boys made the fire.'

A. Assume Pipil has a VP constituent—that is, a constituent that groups together the verb and its complements but excludes the specifier. Based on the VPs in (iii)–(v) write a Head-Complement Rule for this language.
B. Does this language have one Head-Specifier Rule or two? Explain your answer making reference to the data given above, and show the rule(s) you posit. [*Note: Your analysis need only account for the data given in (i)–(v). Don't worry about phrase types that aren't illustrated.*]

⚠ Problem 5: Assessing the Facts of English Case

As noted in Chapter 2, NPs appear in a variety of positions in English, including subject of a sentence, direct object of a verb, second object of a ditransitive verb like *give*, and object of a preposition. For each of these NP positions, determine which case the pronouns in that position must have. Give grammatical and ungrammatical examples of pronouns in the various positions to support your claims.

[*Note: Not all English pronouns show case distinctions, so be sure that the pronouns you use to answer this question are the kind that do.*]

[19] We would like to thank Bill Weigel for his help in constructing this problem. The data are from Campbell 1985, 102–103. He gives more detailed glosses for many of the words in these sentences.

⚠ Problem 6: A Lexical Analysis

Section 4.8 hinted that case marking can be handled in the same way that we handle agreement, i.e. without any changes to the grammar rules. Show how this can be done. Your answer should include a prose description of how the analysis works and lexical entries for *they*, *us*, *likes* and *with*.

[*Hint: Assume that there is a feature CASE with the values 'acc' and 'nom', and assume that English pronouns have CASE values specified in their lexical entries.*]

Problem 7: Case Marking in Icelandic

Background: Icelandic is closely related to English, but it has a much more elaborate and interesting case system. For one thing, it has four cases: nominative, accusative, genitive, and dative. Second, case is marked not just on pronouns, but also on nouns. A third difference is illustrated in the following examples:[20]

(i) Drengurinn *kyssti stúlkuna.*
the-boy.NOM kissed the-girl.ACC
'The boy kissed the girl.'

(ii) Drengina *vantar mat.*
the-boys.ACC lacks food.ACC
'The boys lack food.'

(iii) Verkjanna *gætir ekki.*
the-pains.GEN is-noticeable not
'The pains are not noticeable.'

(iv) Barninu *batnaði veikin.*
the-child.DAT recovered-from the-disease.NOM
'The child recovered from the disease.'

The case markings indicated in these examples are obligatory. Thus, for example, the following is ungrammatical because the subject should be accusative:

(v) *Drengurinn *vantar mat.*
the-boy.NOM lacks food.ACC

Your task: Explain how the examples in (i)–(iv) bear on the analysis of case marking in Icelandic. In particular, explain how they provide direct empirical evidence for treating case marking as a lexical phenomenon, rather than one associated with particular phrase structure positions. Be sure to sketch the lexical entry for at least one of these verbs.

[20] In the glosses, NOM stands for 'nominative', ACC for 'accusative', GEN for 'genitive', and DAT for 'dative'. Although it may not be obvious from these examples, there is in fact ample evidence (which we cannot present here) that the initial NPs in these examples are the subjects of the verbs that follow them.

The word-by-word glosses in (ii) and (iii) translate the verbs with third-person singular forms, but the translations below them use plural verbs that agree with the subjects. This is because verbs only agree with nominative subjects, taking a default third-person singular inflection with non-nominative subjects. This fact is not relevant to the central point of the problem.

Problem 8: Agreement and Case Marking in Wambaya

In Wambaya, a language of Northern Australia, nouns are divided into four genders: masculine (M), feminine (F), vegetable (V), and neuter (N). They are also inflected for case, such as ergative (E) and accusative (A). Consider the following Wambaya sentences, paying attention only to the agreement between the determiners and the nouns (you do not have to worry about accounting for, or understanding, the internal structure of these words or anything else in the sentence).[21]

(i) Ngankiyaga *bungmanyani ngiya-ngajbi yaniyaga darranggu.*
that.F.E woman.F.E she-saw that.N.A tree.N.A
'That woman saw that tree.'

(ii) Ngankiyaga *bungmanyani ngiya-ngajbi mamiyaga jigama.*
that.F.E woman.F.E she-saw that.V.A yam.V.A
'That woman saw that yam.'

(iii) Ngankiyaga *bungmanyani ngiya-ngajbi iniyaga bungmaji.*
that.F.E woman.F.E she-saw that.M.A man.M.A
'That woman saw that man.'

(iv) Ninkiyaga *bungmanyini gina-ngajbi naniyaga bungmanya.*
that.M.E man.M.E he-saw that.F.A woman.F.A
'That man saw that woman.'

(v) Ninkiyaga *bungmanyini gina-ngajbi yaniyaga darranggu.*
that.M.E man.M.E he-saw that.N.A tree.N.A
'That man saw that tree.'

(vi) Ninkiyaga *bungmanyini gina-ngajbi mamiyaga jigama.*
that.M.E man.M.E he-saw that.V.A yam.V.A
'That man saw that yam.'

Ergative is the standard name for the case of the subject of a transitive verb in languages like Wambaya, where intransitive and transitive subjects show different morphological patterns. Nothing crucial in this problem hinges on the distinction between nominative and ergative case. Note that the agreement patterns in (i)–(vi) are the only ones possible; for example, changing *mamiyaga* to *yaniyaga* in (vi) would be ungrammatical. Note also that the verbs are selecting for the case of the subject and object NPs, so, for example, *gina-ngajbi* must take an ergative subject and accusative object.

A. Verbs in Wambaya select subject and object NPs of a particular case and that case is morphologically expressed on the head nouns of the NPs. This means that we must get the information about which case the verb requires down from the NP to the N (or, alternatively, get the information about which case the N is in up from

[21] In fact, the Wambaya data presented here are simplified in various ways: only one of the numerous word-order patterns is illustrated and the auxiliary plus verb sequences (e.g. *ngiya-ngajbi*) are here presented as a single word, when in fact the auxiliary is an independent verb in 'second' position. We are grateful to Rachel Nordlinger, who constructed this problem, in addition to conducting the field work upon which it is based.

the N to the NP). Assuming that the relevant rules and principles from the Chapter 4 grammar of English apply in Wambaya, we could get this result automatically if we put the feature CASE in the right place in the feature structure (i.e. made it a feature of the right type of feature structure). Where should we put the feature CASE?

B. Given your answer to part (A), would our analysis of determiner-noun agreement in English work for Wambaya determiner-noun agreement? Explain your answer, giving lexical entries for *bungmanyani*, *ngankiyaga*, *bungmaji*, and *iniyaga*.

Problem 9: Agreement in NP Coordination

NP coordination exhibits some special properties. These properties are often taken as motivation for positing a second coordination rule just for NP coordination. However, there remains disagreement about the exact details of such a rule; in fact, this is an active area of current research. The purpose of this problem is to explore some of the special properties of NP coordination, and in particular, NP coordination with *and*.

We will focus on the agreement properties of coordinated NPs. The first thing to note is that the Coordination Rule doesn't specify any information about the value of the mother. This is clearly underconstrained. Consider first the feature NUM:

(i) Kim $\left\{\begin{array}{l}\text{walks}\\ \text{*walk}\end{array}\right\}$.

(ii) Sandy $\left\{\begin{array}{l}\text{walks}\\ \text{*walk}\end{array}\right\}$.

(iii) Kim and Sandy $\left\{\begin{array}{l}\text{*walks}\\ \text{walk}\end{array}\right\}$.

(iv) One dog and two cats $\left\{\begin{array}{l}\text{*lives}\\ \text{live}\end{array}\right\}$ here.

A. What conclusion can you draw from the data in (i)–(iv) about the NUM value of coordinate NPs?

Now consider the question of what the PER value of coordinate NPs is. Choice of verb form does not usually help very much in determining the person of the subject, because those whose AGR value is *non-3sing* are compatible with a subject of any person (except those whose AGR is *3sing*).

However, there is another way to detect the person of the subject NP. If the VP contains a direct object reflexive pronoun, then (as we saw in Chapter 1) the reflexive must agree in person and number with the subject. This co-occurrence pattern is shown by the following examples.

(iv) $\left\{\begin{array}{l}\text{You}\\ \text{*I}\\ \text{*She}\\ \text{*They}\\ \text{*We}\end{array}\right\}$ distinguished yourself. (2nd person singular)

(v) $\left\{\begin{array}{l}\text{She}\\ \text{*You}\\ \text{*I}\\ \text{*They}\\ \text{*We}\end{array}\right\}$ distinguished herself. (3rd person singular)

(vi) $\left\{\begin{array}{l}\text{We}\\ \text{*You}\\ \text{*I}\\ \text{*They}\\ \text{*She}\end{array}\right\}$ distinguished ourselves. (1st person plural)

(vii) $\left\{\begin{array}{l}\text{They}\\ \text{*We}\\ \text{*You}\\ \text{*I}\\ \text{*She}\end{array}\right\}$ distinguished themselves. (3rd person plural)

In light of this patterning, we can now consider the person of coordinate NPs by examining examples like the following:

(viii) You and she distinguished $\left\{\begin{array}{l}\text{yourselves}\\ \text{*themselves}\\ \text{*ourselves}\end{array}\right\}$.

(ix) You and I distinguished $\left\{\begin{array}{l}\text{*yourselves}\\ \text{*themselves}\\ \text{ourselves}\end{array}\right\}$.

B. Construct further examples of sentences with coordinate subjects (stick to the conjunction *and*) that could help you discover what the person value of the coordinate NP is for every combination of PER value on the conjuncts. State the principles for determining the PER value of a coordinate NP in as general terms as you can.

Problem 10: Case and Coordination

There is considerable variation among English speakers about case marking in coordinate NPs. Consult your own intuitions (or those of a friend, if you are not a native English speaker) to determine what rule you use to assign case to pronouns in coordinate structures.

- Start by carefully constructing the right examples that will bear on this issue (the pronouns have to show a case distinction, for example, and there are different syntactic environments to consider).
- In examining the relevant data, be sure you consider both acceptable and unacceptable examples in support of your rule.
- State the rule informally – that is, give a succinct statement, in English, of a generalization that covers case in coordinate NPs in your dialect.

5

Semantics

5.1 Introduction

Our first example of syntactic argumentation in Chapter 1 was the distribution of reflexive and nonreflexive pronouns. In Chapter 7 we will return to this topic and show how it can be analyzed in the grammar we are developing. Before we can do so, however, we need to consider the nature of reference and coreference – topics that are fundamentally semantic in nature (i.e. that have to do in large part with meaning). And before we can do that, we need to discuss meaning more generally, sketching how to represent meaning in our grammar.

Reflexive pronouns provide perhaps the clearest case in which a semantic factor – coreference, in this case – plays an essential role in the grammatical distribution of particular words. But there are many other syntactic phenomena that are closely linked to meaning. Consider, for example, subject-verb agreement, which we have discussed extensively in the past two chapters. The NUM value of a noun is often predictable from its referent. Singular nouns generally refer to individual objects, and plural nouns normally refer to collections of objects. Mass nouns (which are mostly singular) usually refer to substances – that is, entities that are not naturally packaged into discrete objects. Of course, nature doesn't fully determine how the world should be divided up conceptually into objects, collections, and substances, so there may be differences between languages, or even between individuals, as to how things are referred to. Hence the German word *Hose* means essentially the same thing as English *pants* or *trousers*, but the German is singular while the English is plural. Likewise, the French use the plural noun *cheveux* to refer to the same stuff that we call *hair*. And individual English speakers differ as to whether they can use *lettuce* as a count noun. Although the correspondences are usually imperfect, syntactic properties (including such basic ones as the part-of-speech distinctions) are often closely linked to semantic characteristics. Trying to do syntax without acknowledging the associated semantic regularities would lead to missing many fundamental generalizations about linguistic structure.

The study of meaning is at least as old as the study of grammar, and there is little hope of doing justice to problems of semantics in a textbook whose primary concern is grammatical structure. However, if the grammars we develop are going to play any role in modeling real language use, then grammar minimally has to include some information about the meaning of individual words and a treatment of how these combine with each other – that is, an account of how meanings of phrases and sentences are built up from the meanings of their parts. Let us begin by contemplating the nature of sentence meaning.

5.2 Semantics and Pragmatics

Meaning is inextricably bound up with actions – people use language intentionally to do many kinds of things. Some sentences are conventionally used to query; others to make simple assertions; still others are conventionally used to issue commands. Even a piece of a sentence, say an NP like *the student sitting behind Leslie*, can be used in isolation to perform the communicative act of referring to an individual.

The kind of meaning that a sentence can be used to convey depends crucially on its syntactic form. For example, a simple 'inverted' sentence like (1), with an auxiliary verb before the subject NP, is typically used to make a query:

(1) Is Sandy tall?

And the query posed by uttering (1) is closely related to the assertion made by an utterance of the noninverted sentence in (2):

(2) Sandy is tall.

In fact, uttering (2) is a perfectly good way of answering (1).

These observations about communication, or language use, have led researchers to the view that the conventional meanings of different kinds of sentences are different kinds of abstract objects. A declarative sentence like (2), for example, is usually associated with something called a PROPOSITION. A proposition is the kind of thing you can assert, deny, or believe. It is also something (the only kind of thing) that can be true or false. An interrogative sentence like (1) is associated with a semantic object called a QUESTION. Questions are the kind of thing that can be asked and answered. Similarly, we'll call the semantic object associated with an imperative sentence a DIRECTIVE. This is the kind of object that can be issued (by simply uttering an imperative sentence, for example), and fulfilled (by causing the conditions associated with the sentence to be met). Semantics is the study of abstract constructs like propositions, questions and directives, which are assumed to play a key role in a larger theory of communication.[1]

Semantic analysis provides just one part of the account of what people convey when they communicate using language, though. In this text, we make the standard assumption that communication has two components: linguistic meaning (as characterized by semantic analysis) and reasoning about communicative goals. When a linguistic expression is uttered, its linguistic meaning makes a significant contribution to, but does not fully determine, the communicative function of the utterance.

Consider, for example, an utterance of (3):

(3) Do you have a quarter?

As noted above, we take the linguistic meaning of this sentence to be a particular question. Once the identity of the hearer is determined in the relevant context of utterance, a

[1]When speaking informally, we will sometimes talk of a given sentence as conveying a given message (proposition, question, or directive). What we really mean is that our semantic analysis associates a particular message with a given sentence and that the communicative potential of that sentence (what it can be used to convey) is determined in large part by that message.

question of this form has a determinate answer: yes or no. However, an utterance of (3) might serve to communicate much more than such a simple factual inquiry. In particular, in addition to posing a financial query to a given hearer, an utterance of (3) is likely to convey a further message – that the speaker was making the following request of the hearer:

(4) Please give me a quarter!

The question asked by an utterance of (3) is generally referred to as its LITERAL or CONVENTIONAL meaning. A request like (4) is communicated by inference. Asking a certain question (the literal meaning of the interrogative sentence in (3)) in a certain kind of context can lead a hearer to reason that the deeper communicative goal of the speaker was to make a particular request, i.e. the one conveyed by (4). In a different context, i.e. a parent asking (3) of a child standing in a line of children waiting to pay a twenty-five cent admission fee for an amusement park ride, would not lead the hearer to infer (4), but rather to check to make sure that (s)he had the required admission fee. We will leave the account of such embellished communication (even the routine 'reading between the lines' that occurs more or less effortlessly in cases like this) to a more fully developed theory of language use, that is, to a theory of linguistic PRAGMATICS. The inference from query to request is pragmatic in nature.

By contrast, the fact that a sentence like (3) must express a question as its literal meaning is semantic in nature. SEMANTICS is the study of linguistic meaning, that is, the contribution to communication that derives directly from the conventions of the language. Pragmatics is a more general study, of how linguistic meaning interacts with situational factors and the plans and goals of conversational participants to achieve more subtle, often elaborate communicative effects.

The semantic analysis that a grammar provides serves as input for a theory of pragmatics or language use. Such a theory sets as its goal to explain what actually gets communicated via pragmatic inferences derived from the linguistic meaning of an utterance. For example, pragmatic theory might include a principle like (5):[2]

(5) Quantity Principle (simplified)

If *X* is weaker than *Y*, then asserting *X* implies the denial of *Y*.

This principle leads to pragmatic inference via 'proofs' of the following kind (justifications for steps of the proof are given in parentheses):

(6)
- A says to B: *Two things bother Pat.*
- A uttered something whose linguistic meaning is: 'At least two things bother Pat'. (semantic analysis)[3]

[2]The principle in (5), due to Grice (1989), relies on the undefined term 'weaker'. In some cases (such as the example that follows), it is intuitively obvious what 'weaker' means. But a full-fledged pragmatic theory that included (5) would have to provide a precise definition of this term.

[3]Note that the meaning of the word *two* is no stronger than the 'at least two' meaning, otherwise the following would be contradictory:

(i) [Kim: Do you have two dollars?]
Sandy: Yes, I have two dollars. In fact, I have five dollars.

- 'At least two things bother Pat'. is weaker than 'At least three things bother Pat'. (This is true in the context; possibly true more generally)
- B assumes that A also meant to communicate: 'It's not the case that there are three things that bother Pat'. (Quantity Principle)

Note that exactly the same pragmatic inference would arise from an utterance by A of any semantically equivalent sentence, such as *There are two things that bother Pat* or *Pat is bothered by two things.* This is because pragmatic theory works from the linguistic meaning of an utterance (as characterized by our semantic analysis) and hence is indifferent to the form by which such meanings are expressed.[4]

There is much more that could be said about the fascinating topic of pragmatic inference. Here, our only goal has been to show that the semantic analysis that must be included in any adequate grammar plays an essential role, albeit an indirect one, in explaining the communicative function of language in context.[5]

5.3 Linguistic Meaning

5.3.1 Compositionality

In order to even begin to deal with semantic issues like

- Which proposition is conveyed by a given declarative sentence?
- Which question is conveyed by a given interrogative sentence?

we first have to clarify what smaller semantic units propositions and questions are constructed from. Moreover, we will need to formulate constraints that specify how the meaning of a given sentence is determined by the meanings of its parts and the way that they are combined.

When we ask a question, make an assertion, or even issue a command, we are also making reference to something that is often called a SITUATION or EVENT.[6] If you utter

[4]This is not quite true. Sometimes the manner in which something is said (the form of an utterance) can make some pragmatic contribution to an utterance. Grice's theory also included a 'Maxim of Manner', which was intended to account for such cases, e.g. (i):

(i) X produced a series of sounds that corresponded closely with the score of 'Home sweet home'.

Here, A conveys that there was something deficient in X's rendition of the song. A does this by intentionally avoiding the more concise sentence: *X sang 'Home sweet home'.*

[5]There is more to meaning than the literal meanings and pragmatic inferences that we have discussed in this section. In particular, there are contrasts in form that correspond to differences in when it is appropriate to use a sentence. One such contrast involves 'honorific' forms in Japanese and other languages. The difference between (i) and (ii), is that (i) is familiar and (ii) is formal, so that (i) would be used when talking to a friend or subordinate and (ii) would be used when talking to a stranger or someone higher in a social hiearchy:

(i) Hon-wo yonda.
Book-ACC read.PAST.FAMILIAR
'I read a book.'

(ii) Hon-wo yomimashita.
Book-ACC READ.PAST.FORMAL
'I read a book.'

[6]Although the term 'event' is often used in a general sense in semantic discussions, this terminology can be misleading, especially in connection with circumstances like the following, where nothing very event-like is happening:

a declarative sentence like *Kim is running*, for example, you are claiming that there is some running situation in the world that involves something (usually a person) named Kim. The proposition that you assert is either true or false depending on a number of things, for example, whether this situation is a running event (maybe Kim is moving too slowly for it to really qualify as running), or whether the runner is someone named 'Kim' (maybe the person you have in mind is really named 'Nim'), whether the running situation is really happening now (maybe Kim has already run the race but your watch stopped several hours ago). If any of these 'maybes' turns out to be the case, then the proposition you have asserted is false – the situation you are describing as specified by the linguistic meaning of the sentence is not part of the real world.

An important part of the business of semantics is specifying truth conditions such as these, that is, specifying restrictions which must be satisfied by particular situations in order for assertions about them to be true. Consider what this means in the case of *Kim is running.* This sentence is associated with a proposition that has the following truth conditions:[7]

(7) a. there is a situation s
b. s is a running situation
c. the runner is some individual i
d. i is named Kim
e. s is temporally located around the time of utterance

If there is some situation s and some individual i such that all the conditions in (7) are satisfied, then the proposition expressed by *Kim is running* is true. If not, then that proposition is false.

Truth conditions are determined in large part by linguistic meaning, that is, the meaning associated with a sentence by the semantic component of the grammar. If our grammar consisted merely of a list of sentences, we could list the meanings of those sentences alongside their forms. However, as we saw in Chapter 2, lists do not provide plausible theories of the grammars of natural languages. Instead, we've developed a theory of grammar that allows us to systematically build up phrases and sentences from an inventory of words and phrase structure rules. Therefore we will need a semantic component to our grammar that systematically builds the meanings of sentences out of the meanings of words and the way they are put together (i.e. the phrase structure rules). In order to do this, we will need (i) some way of characterizing the linguistic meanings of words and (ii) a set of constraints that allows us to correctly specify the

(i) Bo knows baseball.
(ii) Dana is aggressive.
(iii) Sydney resembles Terry.
(iv) Chris is tall.
(v) 37 is a prime number.

It seems much more intuitive to discuss such sentences in terms of 'situations'; hence we have adopted this as our official terminology for the semantics of sentences.

[7]The exact meaning of the progressive (*be...-ing*) construction is a fascinating semantic topic with a considerable literature that we cannot do justice to here. We have adopted clause (7e) as a convenient first approximation of the truth conditional contribution of the present progressive in English.

linguistic meanings of phrase structures in terms of the meanings of their parts (their subconstituents).

In terms of the example *Kim is running*, we will need a way to ensure that the various pieces of this sentence – the noun *Kim*, the verb *is*, and the verb *running* – each make their appropriate contribution to the set of constraints summarized in (7), that the result is a proposition (not a question or a directive), and that the pieces of meaning get combined in the appropriate way (for example, that the same individual i has the properties of being named Kim and being the runner). In addition, our account must assign a meaning to *Sandy is running* that differs from that assigned to *Kim is running* only in the name of the individual i. Likewise, our account must analyze the sentence *Is Kim running?* as a question, and furthermore a question about whether or not there is a situation s and an individual i such that all the conditions in (7) are satisfied.

5.3.2 Semantic Features

The semantic objects of our grammar will be classified in terms of four SEMANTIC MODES – that is, the four basic kinds of meanings that are enumerated and illustrated in (8):

(8)

SEMANTIC MODE	KIND OF PHRASE	EXAMPLE
proposition	noninverted sentence	*Kim is happy.*
question	inverted sentence	*Is Kim happy?*
directive	imperative sentence	*Be happy!*
reference	NP	*Kim*

As we saw above, there are a number of differences among the various semantic modes. Despite these differences, the modes have something in common. Every kind of linguistic expression we have considered, irrespective of its semantic mode, refers to something that must satisfy an indicated list of restrictions for the expression to be correctly applicable. To express this generalization, we will model all expressions in terms of a single type of semantic object (a *sem-cat* or *semantic-category*) which bears three features: MODE, INDEX, and RESTR. The value of MODE provides the semantic mode of the object. The value of INDEX is an index corresponding to the situation or individual referred to. The value of RESTR (short for 'restriction') is a list of conditions that the situation or individual has to satisfy in order for the expression to be applicable to it. Semantic structures then will look like (9):

(9)
$$\begin{bmatrix} \textit{sem-cat} & \\ \text{MODE} & \left\{\text{prop, ques, dir, ref, none}\right\} \\ \text{INDEX} & \left\{i,\ j,\ k,\ \ldots,\ s_1,\ s_2,\ \ldots\right\} \\ \text{RESTR} & \langle \ldots \rangle \end{bmatrix}$$

There are a couple of things to note about the values of these features. The first is that, although we represent the value of RESTR as a list, the order of the elements on that list will not be semantically significant. The second is that the feature INDEX differs from other features we have encountered, in that it can take an unlimited number of different values. This is because there is no limit (in principle) to the number of different individuals or situations which can be referred to in a single sentence. Consequently, we must have (in principle, at least) an infinite number of indices available to serve as values of the feature INDEX. These values of INDEX will conventionally be written with lower-case letters; instead of tagging two occurrences of the same INDEX value, we will simply write the same lower-case letter in both places.

Propositions are analyzed in terms of feature structures like the one in (10) (where 'prop' is short for 'proposition').

(10)
$$\begin{bmatrix} \text{MODE} & \text{prop} \\ \text{INDEX} & s \\ \text{RESTR} & \langle \ldots \rangle \end{bmatrix}$$

A proposition like (10) will be true just in case there is some actual situation s (and there exist appropriate other individuals corresponding to whatever indices are present in (10)) such that the constraints specified in the RESTR value of (10) are all satisfied. These restrictions, the nature of which will be explained in Section 5.3.3, must include all those that are relevant to the meaning of the sentence, for example, all the constraints just mentioned in conjunction with the truth or falsity of *Kim is running*. Our grammatical analysis needs to ensure that we end up with exactly the right constraints in the RESTR list of a sentence's semantics, so that we associate exactly the right meaning with any sentence sanctioned by our grammar.

A question like *Is Kim running?* is assigned a semantics just like the one assigned to *Kim is running*, except that the MODE value must be 'question' ('ques' for short), rather than 'prop':

(11)
$$\begin{bmatrix} \text{MODE} & \text{ques} \\ \text{INDEX} & s \\ \text{RESTR} & \langle \ldots \rangle \end{bmatrix}$$

In this case, the value of RESTR is again interpreted as the set of conditions placed on the situation s, but if someone poses a question, they are merely inquiring as to whether s satisfies those conditions.

Directives ('dir' for short) are represented as in (12):

(12)
$$\begin{bmatrix} \text{MODE} & \text{dir} \\ \text{INDEX} & s \\ \text{RESTR} & \langle \ldots \rangle \end{bmatrix}$$

What the RESTR list does in the case of a directive is to specify what conditions have to be satisfied in order for a directive to be fulfilled.

A reference ('ref' for short) is similar to the kinds of meanings just illustrated, except that it can be used to pick out all kinds of entities – not just situations. So the semantics we assign to a referring NP has the following form:[8]

[8] There are any number of intriguing referential puzzles that are the subject of ongoing inquiry by semanticists. For example, what does an NP like *a page* refer to in the sentence: *A page is missing from this book?* And what does *the unicorn that Chris is looking for* refer to in the sentence: *The unicorn that Chris is looking for doesn't exist?*

(13) $$\begin{bmatrix} \text{MODE} & \text{ref} \\ \text{INDEX} & i \\ \text{RESTR} & \langle \ldots \rangle \end{bmatrix}$$

In this case, the RESTR list contains the conditions that the entity must meet in order for it to be legitimately referred to by the expression.

Note that we write INDICES in terms of the letters i, j, k, etc. when we are specifying the semantics of nominal expressions. The INDEX values written as s, s_1, s_2, etc. always refer to situations.

The differing values of MODE that we have just seen serve to differentiate between the kinds of meaning that are associated with various syntactic categories (like declarative, interrogative or imperative sentences or noun phrases). Many words and phrases that cannot be used by themselves to express a proposition, ask a question, refer to an individual, etc. (e.g. determiners and conjunctions) will be treated here in terms of the specification [MODE none].

5.3.3 Predications

We now turn to the question of what kind of entities make up the value of the RESTR list. Semantic restrictions associated with expressions come in many varieties, which concern what properties some individual has, who did what to whom in some situation, when, where, or why some situation occurred, and so forth. That is, semantically relevant restrictions specify which properties must hold of individuals and situations, and which relations must hold among them, in order for an expression to be applicable.

To represent this sort of information, we must introduce into our semantics some way of specifying relations among entities quite generally. We do this by introducing a type of feature structure called *predication*. The features of a *predication* specify (i) what kind of relation is involved and (ii) who or what is participating in the relation. Examples of feature structures of type *predication* are given in (14):[9]

(14) a. $$\begin{bmatrix} \textit{predication} & \\ \text{RELN} & \textbf{love} \\ \text{SIT(UATION)} & s \\ \text{LOVER} & i \\ \text{LOVED} & j \end{bmatrix}$$

b. $$\begin{bmatrix} \textit{predication} & \\ \text{RELN} & \textbf{walk} \\ \text{SIT} & s \\ \text{WALKER} & i \end{bmatrix}$$

[9]The kind of event-based semantic analysis we employ was pioneered by the philosopher Donald Davidson in a number of papers. (See, for example, Davidson 1980.) Our simplified representations differ from other work in this tradition where all talk of existence is represented via explicit existential quantification, i.e. in terms of representations like (i):

(i) there is an event s and an individual i such that: s is a running event, the runner of s is i, i is named Kim, and s is temporally located around the time of utterance

We will treat all such existential quantification as implicit in our semantic descriptions.

c. $$\begin{bmatrix} \textit{predication} & \\ \text{RELN} & \textbf{give} \\ \text{SIT} & s \\ \text{GIVER} & i \\ \text{RECIPIENT} & j \\ \text{GIFT} & k \end{bmatrix}$$

d. $$\begin{bmatrix} \textit{predication} & \\ \text{RELN} & \textbf{book} \\ \text{SIT} & s \\ \text{INST} & k \end{bmatrix}$$

e. $$\begin{bmatrix} \textit{predication} & \\ \text{RELN} & \textbf{happy} \\ \text{SIT} & s \\ \text{INST} & i \end{bmatrix}$$

f. $$\begin{bmatrix} \textit{predication} & \\ \text{RELN} & \textbf{under} \\ \text{SIT} & s \\ \text{LOWER} & i \\ \text{HIGHER} & j \end{bmatrix}$$

The predications in (14) are meant to correspond to conditions such as: 's is a situation wherein i loves j', 's is a situation wherein i walks', 's is a situation wherein i gives k to j', 's is a situation wherein k is an instance of bookhood (i.e. where k is a book)', 's is a situation wherein i is happy', and 's is a situation wherein i is under j', respectively. We will henceforth make frequent use of predications like these, without taking the time to present a proper theory of relations, predications, and the features that go with them. Note that the restriction associated with many nouns and adjectives (*book*, *happy*, etc.) includes a predication of only one (nonsituation) argument. In such cases – for example, (14d,e) – we use the feature INST(ANCE).

As indicated in (14), we are assuming that all predications are in principle 'situated', i.e. that they make reference to some particular situation (the index that is the value of the feature SIT inside each predication). This provides a semantic flexibility that allows us to analyze sentences like (15):

(15) The senator visited a classmate a week before being sworn in.

That is, one way to understand this (perhaps the most natural way) is in terms of the proposition that some person i who is now a senator was part of a visiting situation where the person who got visited – j – was once part of a certain academic situation that also included the senator. The three situations are all distinct: the situation where i instantiates senatorhood comes after the visiting situation and both these situations could come long after the situation where i and j were classmates. Yet the proposition expressed by (15) is making reference to all three situations at once, and the situational predications we have assumed give us a way to model this.[10] Though this use of multiple situations in the semantics of a single proposition is fascinating and may well be essential for semantic analysis to be successful,[11] secondary situations bring unwanted complexity

[10]Of course, sometimes we refer to someone as a senator even after they have left office. This could be analyzed as making reference to a past situation in which the individual referred to instantiated senatorhood.

[11]There is, of course, an issue as to how far to take the situation-based kind of analysis. General statements like *All cows eat grass* or *Two plus two is four* seem not to make reference to any particular situations.

and hence will be suppressed in subsequent discussion, unless they bear directly on a particular discussion. In general, we will only display the SIT feature on predications contributed by the head of a given phrase or when its value is identified with the value of some other feature.

Almost all words specify restrictions that involve predications of one kind or another, including verbs, adjectives, adverbs, prepositions, and nouns. In order for phrases containing such words to inherit these restrictions, there must be constraints that (minimally) guarantee that the RESTR values of a phrase's daughters are part of that phrase's RESTR value. Only in this way will we end up with a sentence whose meaning is a proposition (or question or directive) whose RESTR value includes all the necessary restrictions on the relevant event participants.

For example, we will want our grammar to ensure that a simple sentence like (16) is associated with a proposition like the one described in (17):

(16) Chris saved Pat.

(17)
$$\begin{bmatrix} \text{MODE} & \text{prop} \\ \text{INDEX} & s \\ \text{RESTR} & \left\langle \begin{bmatrix} \text{RELN} & \textbf{save} \\ \text{SIT} & s \\ \text{SAVER} & i \\ \text{SAVED} & j \end{bmatrix}, \begin{bmatrix} \text{RELN} & \textbf{name} \\ \text{NAME} & \text{Chris} \\ \text{NAMED} & i \end{bmatrix}, \begin{bmatrix} \text{RELN} & \textbf{name} \\ \text{NAME} & \text{Pat} \\ \text{NAMED} & j \end{bmatrix} \right\rangle \end{bmatrix}$$

The restriction that s is a saving situation comes from the lexical entry for the verb *save*, the constraint that i – the saver – must be named Chris comes from the proper noun *Chris*, and the constraint that j – the saved (person) – must be named Pat comes from the lexical entry for the proper noun *Pat*. By associating (16) with the feature structure in (17), our semantic analysis says that the linguistic meaning of (16) is the proposition that will be true just in case there is an actual situation that involves the saving of someone named Pat by someone named Chris. But in order to produce the right set of restrictions in the sentence's semantic description, the restrictions of the parts of the sentence have to be amalgamated into a single list of restrictions. Note in addition that the main situation of the sentence is derived from that introduced by the verb. It is true in general that the semantics of a phrase will crucially involve the semantics of its head daughter. We will capture these semantic relationships between the parts of the sentence with two general principles, introduced in Section 5.5 below. First, however, we must consider how semantic structures fit into the tree structures our grammar licenses.

5.4 How Semantics Fits In

In earlier chapters, we considered only the syntactic properties of linguistic expressions. To accommodate the basic analysis of linguistic meaning just introduced, we need some way of introducing semantic structures into the feature structures we use to analyze words and phrases. We do this by adding two new features – SYN(TAX) and SEM(ANTICS) – and adding a level of embedding within our feature structures, as illustrated in (18):

(18)
$$\begin{bmatrix} \textit{expression} & \\ \text{SYN} & \begin{bmatrix} \textit{syn-cat} & \\ \text{HEAD} & [\ldots] \\ \text{VAL} & \begin{bmatrix} \text{SPR} & \ldots \\ \text{COMPS} & \ldots \end{bmatrix} \end{bmatrix} \\ \text{SEM} & \begin{bmatrix} \textit{sem-cat} & \\ \text{MODE} & \ldots \\ \text{INDEX} & \ldots \\ \text{RESTR} & \langle \ldots \rangle \end{bmatrix} \end{bmatrix}$$

There is now a syntactic side and a semantic side to all feature structures like (18), i.e. to all feature structures of type *expression*. Note that we have created another type – *syntactic-category* (*syn-cat*) – which is parallel to *sem-cat*, and which classifies the values of the feature SYN, just as *sem-cat* classifies the values of the feature SEM. Although we will add a few more features as we progress, this is in essence the feature geometry that we will adopt in the remainder of the book.

This changes the way lexical entries look, of course; their new feature geometry is illustrated in (19), though some details are not yet included:[12]

(19) a.
$$\left\langle \text{dog}, \begin{bmatrix} \text{SYN} & \begin{bmatrix} \text{HEAD} & \begin{bmatrix} \textit{noun} & \\ \text{AGR} & \textit{3sing} \end{bmatrix} \\ \text{VAL} & \begin{bmatrix} \text{SPR} & \langle [\text{HEAD } \textit{det}] \rangle \\ \text{COMPS} & \langle\ \rangle \end{bmatrix} \end{bmatrix} \\ \text{SEM} & \begin{bmatrix} \text{MODE} & \text{ref} \\ \text{INDEX} & i \\ \text{RESTR} & \left\langle \begin{bmatrix} \text{RELN} & \textbf{dog} \\ \text{INST} & i \end{bmatrix} \right\rangle \end{bmatrix} \end{bmatrix} \right\rangle$$

[12] It should be noted that our semantic analysis of proper nouns (one of many that have been proposed over the centuries) treats them as simple referring expressions whose referent must be appropriately named. In a more precise account, we might add the further condition that the speaker must intend to refer to the referent. Under this analysis, the proposition expressed by a sentence like *Kim walks* would be regarded as true just in case there is a walking event involving a certain individual that the speaker intends to refer to who is named 'Kim'.

b.
$$\left\langle \text{Kim}\ , \begin{bmatrix} \text{SYN} & \begin{bmatrix} \text{HEAD} & \begin{bmatrix} \textit{noun} & \\ \text{AGR} & \textit{3sing} \end{bmatrix} \\ \text{VAL} & \begin{bmatrix} \text{SPR} & \langle\ \rangle \\ \text{COMPS} & \langle\ \rangle \end{bmatrix} \end{bmatrix} \\ \text{SEM} & \begin{bmatrix} \text{MODE} & \text{ref} \\ \text{INDEX} & i \\ \text{RESTR} & \left\langle \begin{bmatrix} \text{RELN} & \textbf{name} \\ \text{NAME} & \text{Kim} \\ \text{NAMED} & i \end{bmatrix} \right\rangle \end{bmatrix} \end{bmatrix} \right\rangle$$

c.
$$\left\langle \text{love}\ , \begin{bmatrix} \text{SYN} & \begin{bmatrix} \text{HEAD} & \textit{verb} \\ \text{VAL} & \begin{bmatrix} \text{SPR} & \langle\ \text{NP}\ \rangle \\ \text{COMPS} & \langle\ \text{NP[acc]}\ \rangle \end{bmatrix} \end{bmatrix} \\ \text{SEM} & \begin{bmatrix} \text{MODE} & \text{prop} \\ \text{INDEX} & s \\ \text{RESTR} & \left\langle \begin{bmatrix} \text{RELN} & \textbf{love} \\ \text{SIT} & s \\ \text{LOVER} & i \\ \text{LOVED} & j \end{bmatrix} \right\rangle \end{bmatrix} \end{bmatrix} \right\rangle$$

These entries also illustrate the function of the INDEX feature in fitting together the different pieces of the semantics. Notice that the INDEX value of *love* is identified with the SIT argument of the loving predication in its RESTR list. Similarly, the INDEX value of *dog* is the same as the INST value in the predication introduced by *dog*, and that the INDEX value of *Kim* is the same as the NAMED value in the predication introduced by *Kim*. By identifying these values, we enable the NPs to 'expose' those indices to other words that might select the NPs as arguments. Those words, in turn, can associate those indices with the appropriate role arguments within their predications (i.e. features like WALKER, LOVED, etc.). This is illustrated in (20) for the verb *love*:

(20)
$$\left\langle \text{love}\ , \begin{bmatrix} \text{SYN} & \begin{bmatrix} \text{HEAD} & \textit{verb} \\ \text{VAL} & \begin{bmatrix} \text{SPR} & \left\langle \begin{matrix} \text{NP} \\ \begin{bmatrix} \text{INDEX}\ i \end{bmatrix} \end{matrix} \right\rangle \\ \text{COMPS} & \left\langle \begin{matrix} \text{NP} \\ \begin{bmatrix} \text{CASE acc} \\ \text{INDEX}\ j \end{bmatrix} \end{matrix} \right\rangle \end{bmatrix} \end{bmatrix} \\ \text{SEM} & \begin{bmatrix} \text{MODE} & \text{prop} \\ \text{INDEX} & s \\ \text{RESTR} & \left\langle \begin{bmatrix} \text{RELN} & \textbf{love} \\ \text{SIT} & s \\ \text{LOVER} & i \\ \text{LOVED} & j \end{bmatrix} \right\rangle \end{bmatrix} \end{bmatrix} \right\rangle$$

In this way, as the verb combines with a particular NP object, the index of that NP is identified with the value of the feature LOVED in the verb's semantics. Likewise, since the verb's specifier requirement is identified with the VP's specifier requirement (by the Valence Principle), when the VP combines with a particular NP subject, the index of that NP will be identified with the value of the feature LOVER in the verb's semantics. All that is left is to ensure that the predications introduced by each word are collected together to give the RESTR list of the whole sentence, and to ensure that the INDEX and MODE values of phrases are appropriately constrained. These are the topics of the next section.

Note that the addition of semantic information to our grammar has changed the way we use abbreviations in two ways. First, the labels NP, S, V, etc. now abbreviate feature structures that include both semantic and syntactic information, i.e. *expressions* which bear the features SYN and SEM. Second, we will add a notation to our system of abbreviations to allow us to refer to the INDEX value of an abbreviated expression: NP_i will be used as a shorthand for an NP whose SEM value's INDEX is *i*. We occasionally use this same subscript notation with other categories, too, e.g. PP_i. (The abbreviations are summarized in the grammar summary in Section 5.10.)

5.5 The Semantic Principles

We are now not only able to analyze the form of sentences of considerable complexity using our grammar, but in addition we can analyze the meanings of complex sentences by adding semantic constraints on the structures defined by our rules. The most general of these semantic constraints is given in (21):

(21) Semantic Compositionality Principle

In any well-formed phrase structure, the mother's RESTR value is the sum of the RESTR values of the daughters.

In other words, all restrictions from all the daughters in a phrase are collected into the RESTR value of the mother. The term 'sum' has a straightforward meaning here: the sum of the RESTR values of the daughters is the list whose members are those values, taken in order.[13] We will use the symbol '⊕' to designate the sum operator.[14]

In addition to the Semantic Compositionality Principle, we introduce the following constraint on the MODE and INDEX values of headed phrases:

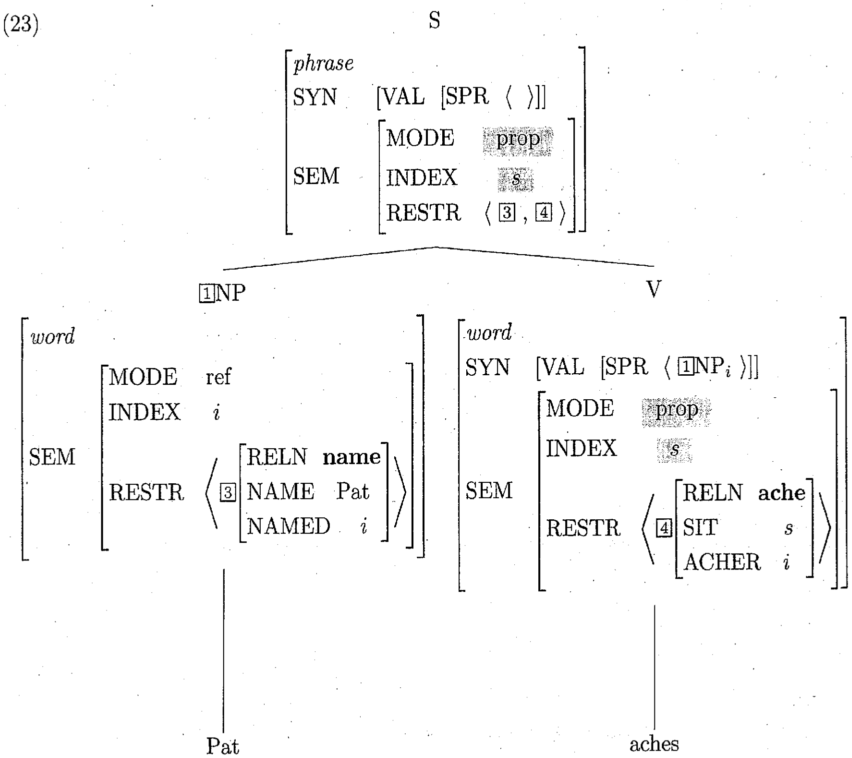
(22) Semantic Inheritance Principle

In any headed phrase, the mother's MODE and INDEX values are identical to those of the head daughter.

The Semantic Inheritance Principle guarantees that the semantic MODE and INDEX of a phrase are identified with those of the head daughter, giving the semantics, like the syntax, a 'head-driven' character.

The effect of these two semantic principles is illustrated in the simple example, (23):

(23)



[13] That is, the sum of lists ⟨ A ⟩, ⟨ B, C ⟩, and ⟨ D ⟩ is the list ⟨ A, B, C, D ⟩.

[14] Notice that, unlike the familiar arithmetic sum operator, ⊕ is not commutative: ⟨ A ⟩ ⊕ ⟨ B ⟩ = ⟨ A, B ⟩, but ⟨ B ⟩ ⊕ ⟨ A ⟩ = ⟨ B, A ⟩. And ⟨ A, B ⟩ ≠ ⟨ B, A ⟩, because the order of the elements matters. Although, as noted above, the order of elements in RESTR lists has no semantic significance, we will later use ⊕ to construct lists in which the ordering does matter (specifically, the ARG-ST lists introduced in Chapter 7 as part of our account of reflexive binding).

The effect of both semantic principles can be clearly observed in the S node at the top of this tree. The MODE is 'prop', inherited from its head daughter, the V node *aches*, by the Semantic Inheritance Principle. Similarly (as indicated by shading in (23)), the INDEX value *s* comes from the verb. The RESTR value of the S node, [RESTR ⟨ 3 , 4 ⟩], is the sum of the RESTR values of the NP and VP nodes, as specified by the Semantic Compositionality Principle.

In this way, our analysis provides a general account of how meanings are constructed. The Semantic Compositionality Principle and the Semantic Inheritance Principle together embody a simple yet powerful theory of the relation between the structures of our grammar and the meanings they convey.

5.6 Modification

The principles in Section 5.5 account for the semantics of head-complement and head-specifier phrases. We still need to consider the Coordination Rule (which, as a non-headed rule, isn't subject to the Semantic Inheritance Principle) and the Head-Modifier Rule, which hadn't yet reached its final form in the Chapter 4 grammar. This section addresses the Head-Modifier Rule. The Coordination Rule will be the subject of the next section.

The Head-Modifier Rule of the Chapter 4 grammar looked like this:

(24) Head-Modifier Rule (Chapter 4 version)

$$\left[\textit{phrase}\right] \rightarrow \mathbf{H}\left[\text{VAL} \;\left[\text{COMPS} \;\;\langle\;\rangle\right]\right] \;\; \text{PP}$$

The only kind of modifier this rule accounts for is, of course, PPs. We'd like to extend it to adjectives and adverbs as well. Adverbs and adjectives, however, present a complication. Compared to PPs, they are relatively fussy about what they will modify. Adverbs modify verbs and not nouns (as illustrated in (25)) and adjectives modify nouns, but not verbs, (as illustrated in (26)).

(25) a. A rat died yesterday.
b.*A rat yesterday died.

(26) a. The person responsible confessed.
b.*The person confessed responsible.

In order to capture these facts, we introduce a feature called MOD which will allow modifiers to specify what kind of expressions they can modify. The value of MOD will be a (possibly empty) list of *expressions*. For elements that can be modifiers, this list contains just one *expression*. For elements that can't be modifiers, the list is empty. This allows us to make it a lexical property of adjectives that they are [MOD ⟨ NOM ⟩] (or [MOD ⟨ NP ⟩]) and a lexical property of adverbs that they were [MOD ⟨ VP ⟩] (or [MOD ⟨ S ⟩]).

MOD will be a VAL feature, like SPR and COMPS. The intuitive connection between these three features is that they all specify what the head can combine with, although the means of combination is somewhat different for MOD as opposed to SPR and COMPS. Like SPR and COMPS, MOD is passed up from the head daughter to the mother via the Valence Principle, as adjusted in (27):

(27) The Valence Principle
Unless the rule says otherwise, the mother's values for the VAL features (SPR, COMPS, MOD) are identical to those of the head daughter.

Unlike with SPR and COMPS, no rule will contradict the Valence Principle with respect to the value of MOD. This means that the MOD value of the mother will always be the same as the MOD value of the head daughter. This is desirable, as the kind of expression a phrasal modifier (such as *responsible for the mess* or *on the table*) can modify is determined by the head of the modifier (in this case, the adjective *responsible* or the preposition *on*).

Furthermore, MOD, like SPR and COMPS, must be shared between conjuncts in a coordinate structure. If it weren't, we would mistakenly license ungrammatical strings such as those in (28):

(28) a.*The cat slept soundly and furry.
b.*The soundly and furry cat slept.

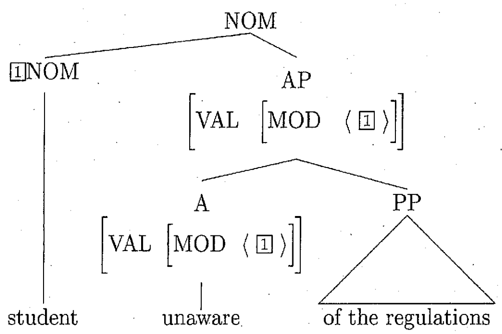
Since the Coordination Rule identifies the VAL values of the conjuncts, making MOD a VAL feature immediately captures these facts.

With modifiers now specifying what they can modify, the Head-Modifier Rule can be reformulated as in (29):[15]

(29) Head-Modifier Rule (Near-Final Version)

$$[\textit{phrase}] \rightarrow \mathbf{H}\boxed{1}\Big[\text{VAL}\ \big[\text{COMPS}\ \ \langle\ \rangle\big]\Big]\ \ \left[\text{VAL}\begin{bmatrix}\text{COMPS} & \langle\ \rangle\\ \text{MOD} & \langle\ \boxed{1}\ \rangle\end{bmatrix}\right]$$

The rule in (29) will license a phrase structure tree whose mother is, for example, a NOM just in case the head daughter is an expression of category NOM and the modifier daughter's MOD value is also of category NOM:

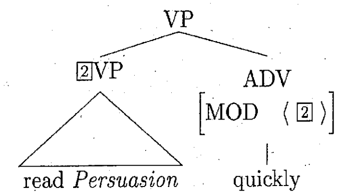
(30)


This NOM can combine with a determiner as its specifier to build an NP like (31):

[15]In this rule, and in the A and AP nodes of (30), we have omitted the feature name 'SYN' to the left of 'VAL'. In the remainder of the book, we will often simplify our feature structure descriptions in this way, leaving out some of the outer layers of feature names when the information of interest is embedded within the feature structure description. We will only simplify in this way when no ambiguity about our intended meaning can arise.
This is the 'near-final version' of the Head-Modifier Rule. It will receive a further minor modification in Chapter 14.

(31) a student unaware of the regulations

The Head-Modifier Rule in (29) will also license the verb phrase in (32), under the assumption that adverbs are lexically specified as [MOD ⟨ VP ⟩]:

(32)


And a VP satisfying this description can combine with a subject like the one in (31) to build sentence (33):

(33) A student unaware of the regulations read *Persuasion* quickly.

Note that the value of MOD is an *expression*, which contains semantic as well as syntactic information. This will allow us to give an analysis of how the semantics of modifiers work. We will illustrate this analysis with the sentence in (34):

(34) Pat aches today.

Let us assume that an adverb like *today* has a lexical entry like the one in (35):[16] (We assume here that there is a subtype of *pos* for adverbs (*adv*).)

(35)

$$\left\langle \text{today}\ ,\ \begin{bmatrix}\text{SYN} & \begin{bmatrix}\text{HEAD} & \textit{adv}\\ \text{VAL} & \begin{bmatrix}\text{MOD} & \left\langle \begin{matrix}\text{VP}\\ \big[\text{INDEX}\ \ s_1\big]\end{matrix}\right\rangle\\ \text{SPR} & \langle\ \rangle\\ \text{COMPS} & \langle\ \rangle\end{bmatrix}\end{bmatrix}\\ \text{SEM} & \begin{bmatrix}\text{MODE} & \text{none}\\ \text{RESTR} & \left\langle \begin{bmatrix}\text{RELN} & \textbf{today}\\ \text{ARG} & s_1\end{bmatrix}\right\rangle\end{bmatrix}\end{bmatrix}\right\rangle$$

The key point here is that the MOD value identifies the index of the VP to be modified as 's_1', the same situation that is the argument of the relation 'today' in the semantic restriction. This means that once the adverb combines with a VP, the (situational) index of that VP is the argument of 'today'.

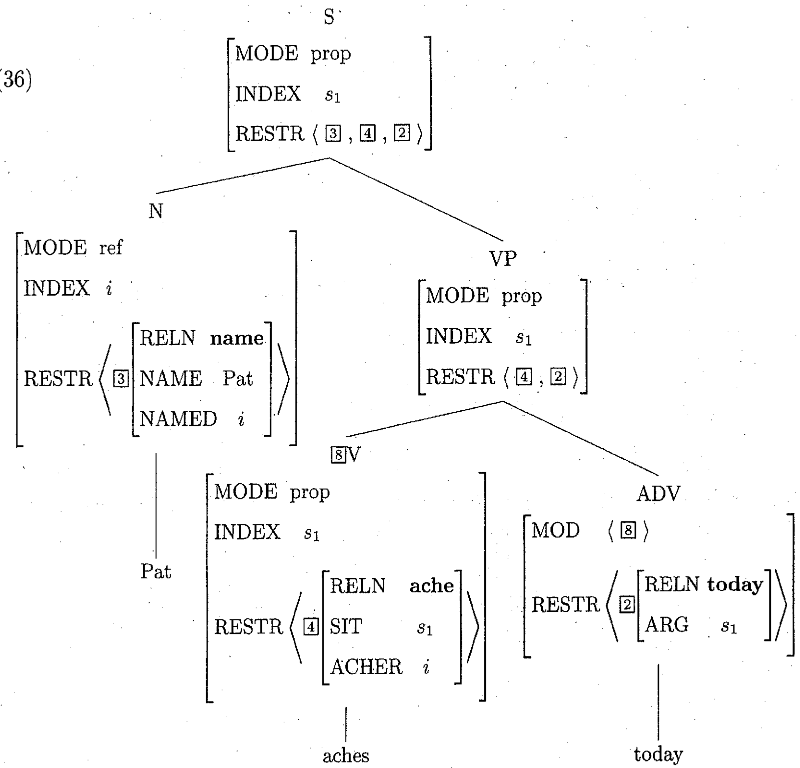
[16]We are suppressing the feature INDEX (along with SIT) here for clarity. For a more detailed analysis of adverbial modification, see Bender et al. 2002.

Exercise 1: The Missing INDEX

We have omitted INDEX from the SEM value in (35), although we said earlier that the value of SEM always consists of MODE, INDEX, and RESTR. Our omission was to simplify the presentation. Including INDEX under SEM would only have cluttered up the feature structure, without adding any useful information. In fact, we could assign any value we want to the missing INDEX, and the semantics of VPs like *aches today* would still be the same. Why?

Our two semantic principles, the Head-Modifier Rule, and the lexical entry in (35) as well as appropriate lexical entries for *aches* and *Pat* thus interact to define structure like (36) (only SEM values are indicated):

(36)



Exercise 2: VP or Not VP?

The lexical entry in (35) has a VP on the MOD list, but the corresponding node in the tree (36) is labeled V. Why isn't this an inconsistency? [*Hint: Remember that VP and V are abbreviations for feature structures, and check what they are abbreviations for.*]

5.7 Coordination Revisited

The analysis of the previous sections specifies how meanings are associated with the headed structures of our grammar, by placing appropriate constraints on those trees that result from our headed rules. It also covers the composition of the RESTR values in nonheaded rules. But nothing in the previous discussion specifies the MODE or INDEX values of coordinate phrases – the kind of phrase licensed by the Coordination Rule, a nonheaded rule.

In the previous chapter, we wrote this rule as follows:

(37) $$\begin{bmatrix}\text{VAL } \boxed{1}\end{bmatrix} \rightarrow \begin{bmatrix}\text{VAL } \boxed{1}\end{bmatrix}^{+} \begin{bmatrix}\textit{word} & \\ \text{HEAD} & \textit{conj}\end{bmatrix} \begin{bmatrix}\text{VAL } \boxed{1}\end{bmatrix}$$

This is equivalent to the following formulation, where the Kleene plus has been replaced by a schematic enumeration of the conjunct daughters:

(38) $$\begin{bmatrix}\text{VAL } \boxed{1}\end{bmatrix} \rightarrow \begin{bmatrix}\text{VAL } \boxed{1}\end{bmatrix}_1 \ldots \begin{bmatrix}\text{VAL } \boxed{1}\end{bmatrix}_{n-1} \begin{bmatrix}\textit{word} & \\ \text{HEAD} & \textit{conj}\end{bmatrix} \begin{bmatrix}\text{VAL } \boxed{1}\end{bmatrix}_n$$

We will employ this new notation because it lets us enumerate schematically the arguments that the semantic analysis of conjunctions requires.

Unlike the other predications we have used for semantic analysis, where each predication specifies a fixed (and small) number of roles, the predications that express the meanings of conjunctions like *and* and *or* allow any number of arguments. Thus each conjunct of coordinate structures like the following is a semantic argument of the conjunction:

(39) a. Chris [[walks]$_1$, [eats broccoli]$_2$, and [plays squash]$_3$].

b. [[Chris walks]$_1$, [Pat eats broccoli]$_2$, and [Sandy plays squash]$_3$].

Because the number of arguments is not fixed, the predications for conjunctions allow not just indices as arguments, but lists of indices. Consequently, the sentences in (39) may be represented in terms of a semantic structure like the following:

(40) $$\begin{bmatrix}\text{MODE} & \text{prop} \\ \text{INDEX} & s_0 \\ \text{RESTR} & \left\langle \begin{bmatrix}\text{RELN} & \textbf{and} \\ \text{SIT} & s_0 \\ \text{ARGS} & \langle s_1, s_2, s_3\rangle\end{bmatrix}, \begin{bmatrix}\text{RELN} & \textbf{walk} \\ \text{SIT} & s_1 \\ & \ldots\end{bmatrix}, \begin{bmatrix}\text{RELN} & \textbf{eat} \\ \text{SIT} & s_2 \\ & \ldots\end{bmatrix}, \begin{bmatrix}\text{RELN} & \textbf{play} \\ \text{SIT} & s_3 \\ & \ldots\end{bmatrix} \right\rangle\end{bmatrix}$$

In (40), the situations s_1, s_2, and s_3 are the simplex situations of walking, eating and playing, respectively. The situation s_0, on the other hand, is the complex situation that involves all three of the simplex situations. Note that it is this situation (s_0) that is the INDEX of the whole coordinated phrase. That way, if a modifier attaches to the coordinated phrase, it will take the index of the complex situation as its semantic argument.

In order to be sure our grammar assigns semantic representations like (40) to sentences like (39), we need to update our lexical entries for conjunctions and revise the Coordination Rule. Let us assume then that the lexical entry for a conjunction looks roughly as shown in (41):

(41)
$$\left\langle \text{and}\ ,\ \begin{bmatrix} \text{SYN} & \begin{bmatrix} \text{HEAD} & \textit{conj} \end{bmatrix} \\ \text{SEM} & \begin{bmatrix} \text{INDEX} & s \\ \text{MODE} & \text{none} \\ \text{RESTR} & \left\langle \begin{bmatrix} \text{RELN} & \textbf{and} \\ \text{SIT} & s \end{bmatrix} \right\rangle \end{bmatrix} \end{bmatrix} \right\rangle$$

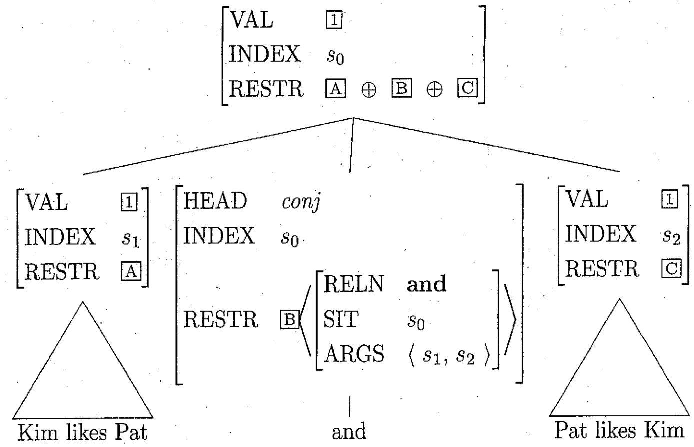
As for the Coordination Rule, we need to revise it so that it relates the indices of the conjuncts to the predication introduced by the conjunction. In addition, we need to say something about the index of the mother. This leads us to the following reformulation of our Coordination Rule (where 'IND' is short for 'INDEX'):

(42) Coordination Rule
$$\begin{bmatrix} \text{SYN [VAL } \boxed{0}] \\ \text{SEM [IND } s_0] \end{bmatrix} \rightarrow \begin{bmatrix} \text{SYN [VAL } \boxed{0}] \\ \text{SEM [IND } s_1] \end{bmatrix} \ldots \begin{bmatrix} \text{SYN [VAL } \boxed{0}] \\ \text{SEM [IND } s_{n-1}] \end{bmatrix}$$
$$\begin{bmatrix} \text{SYN} & \begin{bmatrix} \text{HEAD } \textit{conj} \end{bmatrix} \\ \text{SEM} & \begin{bmatrix} \text{IND} & s_0 \\ \text{RESTR} & \langle [\text{ARGS } \langle s_1, \ldots, s_n \rangle] \rangle \end{bmatrix} \end{bmatrix} \begin{bmatrix} \text{SYN [VAL } \boxed{0}] \\ \text{SEM [IND } s_n] \end{bmatrix}$$

This rule accomplishes a number of goals, including:

- requiring that all conjuncts of a coordinate structure have identical values for SPR, COMPS, and MOD.
- collecting the RESTR values of all daughters into the RESTR list of the mother (guaranteed because the structures built in accordance with this rule must satisfy the Semantic Compositionality Principle),
- identifying the indices of the conjuncts with the semantic arguments of the conjunction, and
- identifying the index of the conjunction with that of the coordinate structure.

These effects are illustrated in the following tree, which shows a (coordinate) phrase structure satisfying the Coordination Rule:

(43)


Our revised Coordination Rule goes a long way toward accounting for sentences containing coordinate structures and associating them with appropriate meanings. We will return to coordination in Chapters 8 and 14 to add further refinements.

5.8 Quantifiers

The final semantic topic we will address in this chapter is quantifiers and quantifier scope ambiguities. Consider the example in (44):

(44) A dog saved every family.

Sentences like this are usually treated as ambiguous, the two distinct READINGS being paraphrased roughly as (45a,b):

(45) a. There was some particular dog who saved every family.
  b. Every family was saved by some dog or other (not necessarily the same dog).

Ambiguities of this kind might be familiar from the study of predicate logic, where the two readings in question are often represented in the fashion shown in (46a.b):

(46) a. (**Exist** i: **dog**(i))[(**All** j: **family**(j))[**save**(i,j)]]
  b. (**All** j: **family**(j))[(**Exist** i: **dog**(i))[**save**(i,j)]]

The first three parts of these representations are a quantificational relation (e.g. **Exist**, **All**), a variable (e.g. i, j), and a formula called the quantifier's RESTRICTION (e.g. **dog**(i), **family**(j)). The expression in square brackets that follows a quantifier is its SCOPE. In (46a), the scope of the quantifier (**All** j: **family**(j)) is the expression repeated in (47):

(47) [**save**(i,j)]

In the same example, the scope of the quantifier (**Exist** i: **dog**(i)) is the expression repeated in (48):

(48) [(**All** j: **family**(j))[**save**(i,j)]]

The two distinct semantic analyses associated with a sentence like (44) thus differ only in terms of scope: in (46a), the existential quantifier has 'wide' scope; in (46b), the universal quantifier has wide scope.

The semantics we adopt in this book is compatible with recent work on quantification known as the theory of generalized quantifiers. This theory models the interpretation of quantifiers set-theoretically in a way that makes it possible to represent nonstandard quantifiers like '**most**', as well as the standard universal and existential quantifiers of predicate logic. Although our representations look different from those in (46), we can express the notions of quantifier, variable, restriction and scope using feature structures. We achieve this by treating quantifiers in terms of predications like (49):

(49) $$\begin{bmatrix} \textit{predication} & \\ \text{RELN} & \textbf{exist} \\ \text{BV} & i \\ \text{QRESTR} & \textit{predication} \\ \text{QSCOPE} & \textit{predication} \end{bmatrix}$$

In (49), the quantifier predication has three new features: BOUND-VARIABLE (BV), QUANTIFIER-RESTRICTION (QRESTR) and QUANTIFIER-SCOPE (QSCOPE). The values of the latter two features can be identified with other predications in the RESTR list.

We can then identify the two quantifiers' QSCOPE values in different ways to express the two different scopal readings of (44). If the existential quantifier has wide scope, as in (46a), we can identify the QSCOPE values as shown in (50):

(50) $$\begin{bmatrix} \text{RESTR} & \left\langle \begin{bmatrix} \text{RELN} & \textbf{exist} \\ \text{BV} & i \\ \text{QRESTR} & \boxed{1} \\ \text{QSCOPE} & \boxed{2} \end{bmatrix}, \boxed{1}\begin{bmatrix} \text{RELN} & \textbf{dog} \\ \text{INST} & i \end{bmatrix}, \boxed{2}\begin{bmatrix} \text{RELN} & \textbf{all} \\ \text{BV} & j \\ \text{QRESTR} & \boxed{3} \\ \text{QSCOPE} & \boxed{4} \end{bmatrix}, \right. \\ & \left. \boxed{3}\begin{bmatrix} \text{RELN} & \textbf{family} \\ \text{INST} & j \end{bmatrix}, \boxed{4}\begin{bmatrix} \text{RELN} & \textbf{save} \\ \text{SAVER} & i \\ \text{SAVED} & j \end{bmatrix} \right\rangle \end{bmatrix}$$

And to represent the reading where the universal quantifier outscopes the existential, as in (46b), we can simply identify the QSCOPE values differently, as shown in (51):

(51) $$\begin{bmatrix} \text{RESTR} & \left\langle \boxed{2}\begin{bmatrix} \text{RELN} & \textbf{exist} \\ \text{BV} & i \\ \text{QRESTR} & \boxed{1} \\ \text{QSCOPE} & \boxed{4} \end{bmatrix}, \boxed{1}\begin{bmatrix} \text{RELN} & \textbf{dog} \\ \text{INST} & i \end{bmatrix}, \begin{bmatrix} \text{RELN} & \textbf{all} \\ \text{BV} & j \\ \text{QRESTR} & \boxed{3} \\ \text{QSCOPE} & \boxed{2} \end{bmatrix}, \right. \\ & \left. \boxed{3}\begin{bmatrix} \text{RELN} & \textbf{family} \\ \text{INST} & j \end{bmatrix}, \boxed{4}\begin{bmatrix} \text{RELN} & \textbf{save} \\ \text{SAVER} & i \\ \text{SAVED} & j \end{bmatrix} \right\rangle \end{bmatrix}$$

Notice that only the QSCOPE specifications have changed; the order of quantifiers on the RESTR list remains constant. That is because there is no semantic significance attached to the order of elements on the RESTR list. But (50) and (51) differ crucially in that the existential quantifier in (50) is not within the scope of any other quantifier, while in (51) it is the universal quantifier that has wide scope.

The differing constraints on QSCOPE values thus carry considerable semantic significance. Our grammar imposes constraints on the RESTR list of a multiply quantified sentence like (44) that can be satisfied in more than one way. Feature structures satisfying either (50) or (51) are allowed by the grammar. Moreover, if we make the further assumption that each index (variable) introduced by a quantificational NP (e.g. *every family*, *a dog*) must be BOUND, i.e. must occur within a feature structure that serves as the QSCOPE value of some quantificational predication with that index as its BV value, then these two are in fact the only possible RESTR lists that will satisfy the constraints of our grammar for a sentence like (44).

Though the feature structures satisfying our sentence descriptions must resolve the scope of quantifiers, note that the descriptions themselves need not. Our semantic representations thus enjoy an advantage that is not shared by standard predicate logic: if we don't specify any constraints on the QSCOPE values, we can essentially leave the quantifier scope unspecified. This kind of underspecification may have considerable appeal from a processing point of view: not only is it difficult for computational natural language applications to resolve the precise scope of quantifiers in even simple sentences, there is also psycholinguistic evidence that people don't always resolve scope.[17] Thus from the perspective of embedding our grammar within a model of human sentence processing or within a computational language processing system, it is significant that we can express generalized quantification in a way that allows unresolved, or even partially resolved, quantifier scope, depending on how many constraints are imposed on the values of QSCOPE.

Despite the interest and importance of these issues, we will leave quantification out of the picture in the semantic analyses we develop in the rest of the book. It will become apparent that we have our hands full with other aspects of meaning that interact in crucial ways with the syntactic phenomena that are our primary focus here.[18] We will therefore use simplified semantic representations for quantifiers as placeholders for the more complete analysis sketched. An example of how this would look for the determiner *a* is given in (52):

[17] See for example Kurtzman and MacDonald 1993.

[18] See the further reading section at the end of this chapter for references to recent work that integrates a view of quantification like the one just sketched with grammars of the sort we will motivate in subsequent chapters.

(52)
$$\left\langle \text{a}, \begin{bmatrix} \textit{word} & \\ \text{SYN} & \begin{bmatrix} \text{HEAD} & \begin{bmatrix} \textit{det} & \\ \text{AGR} & \textit{3sing} \\ \text{COUNT} & + \end{bmatrix} \\ \text{VAL} & \begin{bmatrix} \text{COMPS} & \langle\ \rangle \\ \text{SPR} & \langle\ \rangle \\ \text{MOD} & \langle\ \rangle \end{bmatrix} \end{bmatrix} \\ \text{SEM} & \begin{bmatrix} \text{MODE} & \text{none} \\ \text{INDEX} & i \\ \text{RESTR} & \left\langle \begin{bmatrix} \text{RELN} & \textbf{exist} \\ \text{BV} & i \end{bmatrix} \right\rangle \end{bmatrix} \end{bmatrix} \right\rangle$$

Even with this simplified representation, there remains an interesting issue of compositional semantics: the value of the feature BV should end up being the same as the INDEX of the noun for which *a* is the specifier. However, this identity cannot be expressed as a constraint within the lexical entry for the determiner, since the determiner does not select for the noun (note that its COMPS and SPR lists are both empty). Instead, the determiner identifies its OWN index with the value of BV (i), and the lexical entry for a noun identifies its INDEX value with that of its SPR:

(53)
$$\left\langle \text{dog}, \begin{bmatrix} \textit{word} & \\ \text{SYN} & \begin{bmatrix} \text{HEAD} & \begin{bmatrix} \textit{noun} & \\ \text{AGR} & \textit{3sing} \end{bmatrix} \\ \text{VAL} & \begin{bmatrix} \text{SPR} & \left\langle \begin{bmatrix} \text{HEAD} & \textit{det} \\ \text{INDEX} & i \end{bmatrix} \right\rangle \\ \text{COMPS} & \langle\ \rangle \\ \text{MOD} & \langle\ \rangle \end{bmatrix} \end{bmatrix} \\ \text{SEM} & \begin{bmatrix} \text{MODE} & \text{ref} \\ \text{INDEX} & i \\ \text{RESTR} & \left\langle \begin{bmatrix} \text{RELN} & \textbf{dog} \\ \text{INST} & i \end{bmatrix} \right\rangle \end{bmatrix} \end{bmatrix} \right\rangle$$

This means that the noun's INDEX value and the determiner's BV value end up being the same. Because *dog* identifies its own index (and the INST value of the **dog** predication) with the index of its specifier, and *a* identifies its index with the BV value of the **exist** predication, the lexical entries together with the grammar rules produce semantic representations like the one shown in (54) for the noun phrase *a dog*, with the value of BV correctly resolved:

(54)
$$\begin{bmatrix} \text{MODE} & \text{ref} \\ \text{INDEX} & i \\ \text{RESTR} & \left\langle \begin{bmatrix} \text{RELN} & \textbf{exist} \\ \text{BV} & i \end{bmatrix}, \begin{bmatrix} \text{RELN} & \textbf{dog} \\ \text{INST} & i \end{bmatrix} \right\rangle \end{bmatrix}$$

Because the Semantic Inheritance Principle passes the head's INDEX value up to the phrasal level, this analysis generalizes naturally to syntactically complex specifiers, such as possessive NPs (see Problem 5 of Chapter 6).

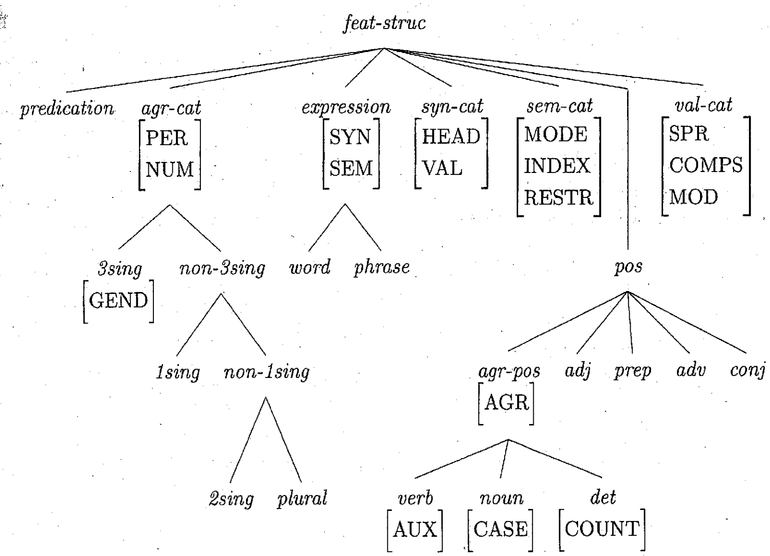
5.9 Summary

In this chapter, we introduced fundamental issues in the study of linguistic meaning and extended our grammar to include semantic descriptions. We then provided a systematic account of the relation between syntactic structure and semantic interpretation based on two constraints: the Semantic Compositionality Principle and the Semantic Inheritance Principle. These principles together provide a general account of how the semantics of a phrase is related to the semantics of its daughters. This chapter also extended the treatments of modification and coordinate structures to include an account of their linguistic meaning.

5.10 The Chapter 5 Grammar

5.10.1 The Type Hierarchy

The current version of our type hierarchy is summarized in (55):



5.10.2 Feature Declarations and Type Constraints

TYPE	FEATURES/CONSTRAINTS	IST
feat-struc		
expression	$\begin{bmatrix}\text{SYN} & \textit{syn-cat}\\ \text{SEM} & \textit{sem-cat}\end{bmatrix}$	*feat-struc*
syn-cat	$\begin{bmatrix}\text{HEAD} & \textit{pos}\\ \text{VAL} & \textit{val-cat}\end{bmatrix}$	*feat-struc*
sem-cat	$\begin{bmatrix}\text{MODE} & \{\text{prop, ques, dir, ref, none}\}\\ \text{INDEX} & \{i, j, k, \ldots, s_1, s_2, \ldots\}^{19}\\ \text{RESTR} & \textit{list(predication)}\end{bmatrix}$	*feat-struc*
predication	$\begin{bmatrix}\text{RELN} & \{\textbf{love}, \textbf{walk}, \ldots\}\\ \ldots & \end{bmatrix}$	*feat-struc*
word, phrase		*expression*
val-cat	$\begin{bmatrix}\text{SPR} & \textit{list(expression)}\\ \text{COMPS} & \textit{list(expression)}\\ \text{MOD} & \textit{list(expression)}\end{bmatrix}$	*feat-struc*
pos		*feat-struc*
agr-pos	$\begin{bmatrix}\text{AGR} & \textit{agr-cat}\end{bmatrix}$	*pos*
verb	$\begin{bmatrix}\text{AUX} & \{+,-\}\end{bmatrix}$	*agr-pos*
noun	$\begin{bmatrix}\text{CASE} & \{\text{nom, acc}\}\end{bmatrix}$	*agr-pos*
det	$\begin{bmatrix}\text{COUNT} & \{+,-\}\end{bmatrix}$	*agr-pos*
adj, prep, adv, conj		*pos*
agr-cat	$\begin{bmatrix}\text{PER} & \{\text{1st, 2nd, 3rd}\}\\ \text{NUM} & \{\text{sg, pl}\}\end{bmatrix}$	*feat-struc*
3sing	$\begin{bmatrix}\text{PER} & \text{3rd}\\ \text{NUM} & \text{sg}\\ \text{GEND} & \{\text{fem, masc, neut}\}\end{bmatrix}$	*agr-cat*
non-3sing		*agr-cat*
1sing	$\begin{bmatrix}\text{PER} & \text{1st}\\ \text{NUM} & \text{sg}\end{bmatrix}$	*non-3sing*
non-1sing		*non-3sing*
2sing	$\begin{bmatrix}\text{PER} & \text{2nd}\\ \text{NUM} & \text{sg}\end{bmatrix}$	*non-1sing*
plural	$\begin{bmatrix}\text{NUM} & \text{pl}\end{bmatrix}$	*non-1sing*

[19] The possible values of the feature INDEX will be grouped together as the type *index* in the formal appendix to Chapter 6.

5.10.3 Abbreviations

(55)

$$\text{S} = \begin{bmatrix}\text{SYN} & \begin{bmatrix}\text{HEAD} & \textit{verb}\\ \text{VAL} & \begin{bmatrix}\text{COMPS} & \langle\ \rangle\\ \text{SPR} & \langle\ \rangle\end{bmatrix}\end{bmatrix}\end{bmatrix} \qquad \text{NP}_i = \begin{bmatrix}\text{SYN} & \begin{bmatrix}\text{HEAD} & \textit{noun}\\ \text{VAL} & \begin{bmatrix}\text{COMPS} & \langle\ \rangle\\ \text{SPR} & \langle\ \rangle\end{bmatrix}\end{bmatrix}\\ \text{SEM} & \begin{bmatrix}\text{INDEX} & i\end{bmatrix}\end{bmatrix}$$

$$\text{VP} = \begin{bmatrix}\text{SYN} & \begin{bmatrix}\text{HEAD} & \textit{verb}\\ \text{VAL} & \begin{bmatrix}\text{COMPS} & \langle\ \rangle\\ \text{SPR} & \langle \text{X} \rangle\end{bmatrix}\end{bmatrix}\end{bmatrix} \qquad \text{NOM} = \begin{bmatrix}\text{SYN} & \begin{bmatrix}\text{HEAD} & \textit{noun}\\ \text{VAL} & \begin{bmatrix}\text{COMPS} & \langle\ \rangle\\ \text{SPR} & \langle \text{X} \rangle\end{bmatrix}\end{bmatrix}\end{bmatrix}$$

$$\text{V} = \begin{bmatrix}\textit{word}\\ \text{SYN} & \begin{bmatrix}\text{HEAD} & \textit{verb}\end{bmatrix}\end{bmatrix} \qquad \text{N} = \begin{bmatrix}\textit{word}\\ \text{SYN} & \begin{bmatrix}\text{HEAD} & \textit{noun}\end{bmatrix}\end{bmatrix}$$

$$\text{PP} = \begin{bmatrix}\text{SYN} & \begin{bmatrix}\text{HEAD} & \textit{prep}\\ \text{VAL} & \begin{bmatrix}\text{COMPS} & \langle\ \rangle\end{bmatrix}\end{bmatrix}\end{bmatrix} \qquad \text{AP} = \begin{bmatrix}\text{SYN} & \begin{bmatrix}\text{HEAD} & \textit{adj}\\ \text{VAL} & \begin{bmatrix}\text{COMPS} & \langle\ \rangle\end{bmatrix}\end{bmatrix}\end{bmatrix}$$

$$\text{P} = \begin{bmatrix}\textit{word}\\ \text{SYN} & \begin{bmatrix}\text{HEAD} & \textit{prep}\end{bmatrix}\end{bmatrix} \qquad \text{A} = \begin{bmatrix}\textit{word}\\ \text{SYN} & \begin{bmatrix}\text{HEAD} & \textit{adj}\end{bmatrix}\end{bmatrix}$$

$$\text{DP}^{20} = \begin{bmatrix}\text{SYN} & \begin{bmatrix}\text{HEAD} & \textit{det}\\ \text{VAL} & \begin{bmatrix}\text{COMPS} & \langle\ \rangle\\ \text{SPR} & \langle\ \rangle\end{bmatrix}\end{bmatrix}\end{bmatrix}$$

5.10.4 The Grammar Rules

In this summary, we give fully explicit versions of the grammar rules. In later chapters and the summary in Appendix A, we will abbreviate by supressing levels of embedding, e.g. by mentioning features such as SPR and COMPS without mentioning SYN or VAL.

(56) Head-Specifier Rule

$$\begin{bmatrix}\textit{phrase}\\ \text{SYN} & \begin{bmatrix}\text{VAL} & \begin{bmatrix}\text{SPR} & \langle\ \rangle\end{bmatrix}\end{bmatrix}\end{bmatrix} \rightarrow \boxed{1} \quad \mathbf{H}\begin{bmatrix}\text{SYN} & \begin{bmatrix}\text{VAL} & \begin{bmatrix}\text{SPR} & \langle \boxed{1} \rangle\\ \text{COMPS} & \langle\ \rangle\end{bmatrix}\end{bmatrix}\end{bmatrix}$$

A phrase can consist of a (lexical or phrasal) head preceded by its specifier.

[20] We replace our old abbreviation D with a new abbreviation DP in anticipation of Problem 4 of Chapter 6, which introduces the possibility of determiner phrases. The abbreviation DP, like NP and VP, is underspecified and may represent either a *word* or a *phrase*.

(57) Head-Complement Rule

$$\begin{bmatrix} \textit{phrase} \\ \text{SYN} \begin{bmatrix}\text{VAL}\begin{bmatrix}\text{COMPS}\ \langle\ \rangle\end{bmatrix}\end{bmatrix}\end{bmatrix} \rightarrow \mathbf{H}\begin{bmatrix}\textit{word}\\ \text{SYN}\begin{bmatrix}\text{VAL}\begin{bmatrix}\text{COMPS}\ \langle \boxed{1},\ldots,\boxed{n}\rangle\end{bmatrix}\end{bmatrix}\end{bmatrix}\ \boxed{1}\ \ldots\ \boxed{n}$$

A phrase can consist of a lexical head followed by all its complements.

(58) Head-Modifier Rule

$$[\textit{phrase}] \rightarrow \mathbf{H}\boxed{1}\begin{bmatrix}\text{SYN}\begin{bmatrix}\text{VAL}\begin{bmatrix}\text{COMPS}\ \langle\ \rangle\end{bmatrix}\end{bmatrix}\end{bmatrix}\ \begin{bmatrix}\text{SYN}\begin{bmatrix}\text{VAL}\begin{bmatrix}\text{COMPS} & \langle\ \rangle\\ \text{MOD} & \langle\boxed{1}\rangle\end{bmatrix}\end{bmatrix}\end{bmatrix}$$

A phrase can consist of a (lexical or phrasal) head followed by a compatible modifier.

(59) Coordination Rule

$$\begin{bmatrix}\text{SYN}\ [\text{VAL}\ \boxed{0}]\\ \text{SEM}\ [\text{IND}\ s_0]\end{bmatrix} \rightarrow \begin{bmatrix}\text{SYN}\ [\text{VAL}\ \boxed{0}]\\ \text{SEM}\ [\text{IND}\ s_1]\end{bmatrix} \ldots \begin{bmatrix}\text{SYN}\ [\text{VAL}\ \boxed{0}]\\ \text{SEM}\ [\text{IND}\ s_{n-1}]\end{bmatrix}$$
$$\begin{bmatrix}\text{SYN} & \begin{bmatrix}\text{HEAD}\ \textit{conj}\end{bmatrix}\\ \text{SEM} & \begin{bmatrix}\text{IND} & s_0\\ \text{RESTR} & \langle[\text{ARGS}\ \langle s_1,\ldots,s_n\rangle]\rangle\end{bmatrix}\end{bmatrix} \begin{bmatrix}\text{SYN}\ [\text{VAL}\ \boxed{0}]\\ \text{SEM}\ [\text{IND}\ s_n]\end{bmatrix}$$

Any number of elements with matching valence specifications can form a coordinate phrase with identical valence specifications.

5.10.5 The Principles

(60) Head Feature Principle (HFP)

In any headed phrase, the HEAD value of the mother and the HEAD value of the head daughter must be identical.

(61) Valence Principle

Unless the rule says otherwise, the mother's values for the VAL features (SPR, COMPS, and MOD) are identical to those of the head daughter.

(62) Specifier-Head Agreement Constraint (SHAC)

Verbs and common nouns must be specified as:

$$\begin{bmatrix}\text{SYN} & \begin{bmatrix}\text{HEAD} & \begin{bmatrix}\text{AGR}\ \boxed{1}\end{bmatrix}\\ \text{VAL} & \begin{bmatrix}\text{SPR}\ \langle\begin{bmatrix}\text{AGR}\ \boxed{1}\end{bmatrix}\rangle\end{bmatrix}\end{bmatrix}\end{bmatrix}$$

(63) Semantic Inheritance Principle

In any headed phrase, the mother's MODE and INDEX values are identical to those of the head daughter.

(64) Semantic Compositionality Principle

In any well-formed phrase structure, the mother's RESTR value is the sum of the RESTR values of the daughters.

5.10.6 Sample Lexical Entries

(65)
$$\left\langle \text{dog}\ ,\ \begin{bmatrix}\text{SYN} & \begin{bmatrix}\text{HEAD} & \begin{bmatrix}\textit{noun}\\ \text{AGR} & \textit{3sing}\end{bmatrix}\\ \text{VAL} & \begin{bmatrix}\text{SPR} & \langle\ \text{DP}_i\ \rangle\\ \text{COMPS} & \langle\ \rangle\\ \text{MOD} & \langle\ \rangle\end{bmatrix}\end{bmatrix}\\ \text{SEM} & \begin{bmatrix}\text{MODE} & \text{ref}\\ \text{INDEX} & i\\ \text{RESTR} & \left\langle\begin{bmatrix}\text{RELN} & \textbf{dog}\\ \text{INST} & i\end{bmatrix}\right\rangle\end{bmatrix}\end{bmatrix}\right\rangle$$

(66)
$$\left\langle \text{Kim}\ ,\ \begin{bmatrix}\text{SYN} & \begin{bmatrix}\text{HEAD} & \begin{bmatrix}\textit{noun}\\ \text{AGR} & \textit{3sing}\end{bmatrix}\\ \text{VAL} & \begin{bmatrix}\text{SPR} & \langle\ \rangle\\ \text{COMPS} & \langle\ \rangle\\ \text{MOD} & \langle\ \rangle\end{bmatrix}\end{bmatrix}\\ \text{SEM} & \begin{bmatrix}\text{MODE} & \text{ref}\\ \text{INDEX} & i\\ \text{RESTR} & \left\langle\begin{bmatrix}\text{RELN} & \textbf{name}\\ \text{NAME} & \text{Kim}\\ \text{NAMED} & i\end{bmatrix}\right\rangle\end{bmatrix}\end{bmatrix}\right\rangle$$

(67)
$$\left\langle \text{love}\ ,\ \begin{bmatrix}\text{SYN} & \begin{bmatrix}\text{HEAD} & \textit{verb}\\ \text{VAL} & \begin{bmatrix}\text{SPR} & \langle\ \text{NP}_i\ \rangle\\ \text{COMPS} & \langle\ \text{NP[acc]}_j\ \rangle\\ \text{MOD} & \langle\ \rangle\end{bmatrix}\end{bmatrix}\\ \text{SEM} & \begin{bmatrix}\text{MODE} & \text{prop}\\ \text{INDEX} & s\\ \text{RESTR} & \left\langle\begin{bmatrix}\text{RELN} & \textbf{love}\\ \text{SIT} & s\\ \text{LOVER} & i\\ \text{LOVED} & j\end{bmatrix}\right\rangle\end{bmatrix}\end{bmatrix}\right\rangle$$

(68)
$$\left\langle \text{today}\ ,\ \begin{bmatrix} \text{SYN} & \begin{bmatrix} \text{HEAD} & \textit{adv} \\ \text{VAL} & \begin{bmatrix} \text{SPR} & \langle\ \rangle \\ \text{COMPS} & \langle\ \rangle \\ \text{MOD} & \left\langle \begin{bmatrix} \text{VP} \\ \text{INDEX} & s \end{bmatrix} \right\rangle \end{bmatrix} \end{bmatrix} \\ \text{SEM} & \begin{bmatrix} \text{MODE} & \text{none} \\ \text{RESTR} & \left\langle \begin{bmatrix} \text{RELN} & \textbf{today} \\ \text{ARG} & s \end{bmatrix} \right\rangle \end{bmatrix} \end{bmatrix} \right\rangle$$

(69)
$$\left\langle \text{and}\ ,\ \begin{bmatrix} \text{SYN} & \begin{bmatrix} \text{HEAD} & \textit{conj} \end{bmatrix} \\ \text{SEM} & \begin{bmatrix} \text{INDEX} & s \\ \text{MODE} & \text{none} \\ \text{RESTR} & \left\langle \begin{bmatrix} \text{RELN} & \textbf{and} \\ \text{SIT} & s \end{bmatrix} \right\rangle \end{bmatrix} \end{bmatrix} \right\rangle$$

(70)
$$\left\langle \text{a}\ ,\ \begin{bmatrix} \textit{word} \\ \text{SYN} & \begin{bmatrix} \text{HEAD} & \begin{bmatrix} \textit{det} \\ \text{AGR} & \textit{3sing} \\ \text{COUNT} & + \end{bmatrix} \\ \text{VAL} & \begin{bmatrix} \text{COMPS} & \langle\ \rangle \\ \text{SPR} & \langle\ \rangle \\ \text{MOD} & \langle\ \rangle \end{bmatrix} \end{bmatrix} \\ \text{SEM} & \begin{bmatrix} \text{MODE} & \text{none} \\ \text{INDEX} & i \\ \text{RESTR} & \left\langle \begin{bmatrix} \text{RELN} & \textbf{exist} \\ \text{BV} & i \end{bmatrix} \right\rangle \end{bmatrix} \end{bmatrix} \right\rangle$$

5.11 Further Reading

Much work on linguistic pragmatics builds directly on the pioneering work of the philosopher H. Paul Grice (see Grice 1989). A seminal work in modern research on natural language semantics is Frege's (1892) essay, 'Über Sinn und Bedeutung' (usually translated as 'On Sense and Reference'), which has been translated and reprinted in many anthologies (e.g. Geach and Black 1980). More recently, the papers of Richard Montague (Thomason, ed. 1974) had a revolutionary influence, but they are extremely technical. An elementary presentation of his theory is given by Dowty et al. (1981). General introductory texts in semantics include Chierchia and McConnell-Ginet 1990, Gamut 1991, and de Swart 1998. All of these textbooks cover generalized quantifiers. For a more recent, more technical overview of generalized quantifiers, see Keenan and Westerståhl 1997. Shorter overviews of semantics include Bach 1989, Barwise and Etchemendy 1989 and Partee 1995. A short and very elementary introduction to generalized quantifiers is given in Larson 1995. The treatment of quantification sketched in Section 5.3 is developed more fully in Copestake et al. 1995, Copestake et al. 1999, and Copestake et al. 2001.

5.12 Problems

Problem 1: Two Kinds of Modifiers in English

In English, modifiers of nouns can appear either before or after the noun, although any given modifier is usually restricted to one position or the other.

(i) The red dog on the roof

(ii)*The on the roof dog

(iii)*The dog red

Our current Head-Modifier Rule only licenses post-head modifiers (like *on the roof* in (i)).

A. Write a second Head-Modifier Rule that licenses pre-head modifiers (e.g., *red* in (i)).

B. Modify the Head-Modifier 1 and Head-Modifier 2 Rules so that they are sensitive to which kind of modifier is present and don't generate (ii) or (iii). [*Hint: Use a feature [POST-HEAD {+,−}] to distinguish* red *and* on the roof.]

C. Is POST-HEAD a HEAD feature? Why or why not?

D. Give lexical entries for *red* and *on* that show the value of POST-HEAD. (You may omit the SEM features in these entries.)

E. Is (i) ambiguous according to your grammar (i.e. the Chapter 5 grammar modified to include the two Head-Modifier Rules, instead of just one)? Explain your answer.

This problem assumed that we don't want to make the two Head-Modifier Rules sensitive to the part of speech of the modifier. One reason for this is that modifiers of the same part of speech can occur before and after the head, even though individual modifiers might be restricted to one position or the other.

F. Provide three examples of English NPs with adjectives or APs after the noun.

G. Provide three examples of adverbs that can come before the verbs they modify.

H. Provide three examples of adverbs that can come after the verbs they modify.

Problem 2: Modes of Coordination

Consider the following data:

(i) Kim left and Sandy left.
(ii) ?*Kim left and did Sandy leave.
(iii) ?*Did Sandy leave and Kim left.
(iv) Did Sandy leave and did Kim leave?
(v) Go away and leave me alone!
(vi) ?*Kim left and leave me alone!
(vii) ?*Leave me alone and Kim left.
(viii) ?*Leave me alone and did Kim leave?
(ix) ?*Did Kim leave and leave me alone!

A. Formulate a generalization about the MODE value of conjuncts (and their mother) that could account for these data.

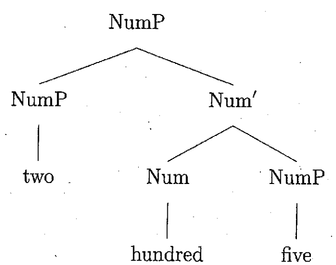
B. Modify the Coordination Rule in (42) so that it enforces the generalization you formulated in (A).

Problem 3: Semantics of Number Names

In Problem 5 of Chapter 3, we considered the syntax of English number names, and in particular how to find the head of a number name expression. Based on the results of that problem, the lexical entry for *hundred* in a number name like *two hundred five* should include the constraints in (i): (Here we are assuming a new subtype of *pos*, *number*, which is appropriate for number name words.)

(i)
$$\left\langle \text{hundred}\ ,\ \begin{bmatrix} \text{SYN} & \begin{bmatrix} \text{HEAD} & \textit{number} \\ \text{VAL} & \begin{bmatrix} \text{SPR} & \langle [\text{HEAD} \ \ \textit{number}] \rangle \\ \text{COMPS} & \langle [\text{HEAD} \ \ \textit{number}] \rangle \end{bmatrix} \end{bmatrix} \end{bmatrix} \right\rangle$$

This lexical entry interacts with our ordinary Head-Complement and Head-Specifier Rules to give us the phrase structure shown in (ii):

(ii)


Smith (1999) provides a compositional semantics of number names. The semantics of the top node in this small tree should be (iii):

(iii)
$$\begin{bmatrix} \text{INDEX} & i \\ \text{MODE} & \text{ref} \\ \text{RESTR} & \left\langle \begin{bmatrix} \text{RELN} & \textbf{constant} \\ \text{INST} & l \\ \text{VALUE} & 2 \end{bmatrix}, \begin{bmatrix} \text{RELN} & \textbf{times} \\ \text{RESULT} & k \\ \text{FACTOR1} & l \\ \text{FACTOR2} & m \end{bmatrix}, \begin{bmatrix} \text{RELN} & \textbf{constant} \\ \text{INST} & m \\ \text{VALUE} & 100 \end{bmatrix}, \begin{bmatrix} \text{RELN} & \textbf{plus} \\ \text{RESULT} & i \\ \text{TERM1} & j \\ \text{TERM2} & k \end{bmatrix}, \begin{bmatrix} \text{RELN} & \textbf{constant} \\ \text{INST} & j \\ \text{VALUE} & 5 \end{bmatrix} \right\rangle \end{bmatrix}$$

This may seem long-winded, but it is really just a way of expressing "(two times one hundred) plus five" (i.e. 205) in our feature structure notation.

A. Assume that the two constant predications with the values 2 and 5 are contributed by the lexical entries for *two* and *five*. What predications must be on the RESTR list of the lexical entry for *hundred* in order to build (iii) as the SEM value of *two hundred five*?

B. The lexical entry for *hundred* will identify the indices of its specifier and complement with the value of some feature of a predication on its RESTR list. Which feature of which predication is the index of the specifier identified with? What about the index of the complement?

C. The lexical entry for *hundred* will identify its own INDEX with the value of some feature of some predication on its RESTR list. Which feature of which predication must this be, in order for the grammar to build (iii) as the SEM value of *two hundred five*?

D. Based on your answers in parts (A)–(C), give a lexical entry for *hundred* that includes the constraints in (i) and a fully specified SEM value. [*Note: Your lexical entry need only account for hundred as it is used in two hundred five. Don't worry about other valence possibilities, such as two hundred, two hundred and five, or a hundred.*]

E. The syntax and semantics of number names do not line up neatly: In the syntax, *hundred* forms a constituent with *five*, and *two* combines with *hundred five* to give a larger constituent. In the semantics, the constant predications with the values 2 and 100 are related via the times predication. The result of that is related to the constant predication with the value 5, via the plus predication Why is this mismatch not a problem for the grammar?