

## 6 Structural disambiguation

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### 6.1 Introduction

In this chapter, I discuss the problem of syntactic, or structural, disambiguation, which was first introduced in section 1.1.3. I will provide the background for the discussion in chapter 7 of the Semantic Enquiry Desk, a structural disambiguator that works with Absity and Polaroid Words.

### 6.2 Types of structural ambiguity

Structural disambiguation is necessary whenever a sentence has more than one possible parse. There are many classes of structurally ambiguous sentence; below I show some of the more common, but do not attempt to produce an exhaustive list. Included in the list are some local ambiguities (*see section 1.1.3*) that people can be garden-pathed by.

I will use two methods of demonstrating structural ambiguity. In some cases, I will give one sentence and show its several parses; in others, I will give two sentences such that each has a different preferred parse but each could clearly also have the structure of the other. For simplicity, when I show a parse, I will often show it only for the part of the sentence that contains the ambiguity; pseudo-prepositions (*see section 3.4*) are not usually inserted, except where necessary to make a point.

#### 6.2.1 Attachment problems

The first class of structural ambiguity is that of ATTACHMENT AMBIGUITY: there being more than one node to which a particular syntactic constituent may legally be attached. Attachment problems are mostly problems of MODIFIER PLACEMENT. The most common example is that of a prepositional phrase that may either modify a verb (*i.e.*, be a case-slot filler) or an immediately preceding noun phrase. For example:

(6-1) Ross wanted to phone the man with the limp.

(6-2) Ross wanted to wash the dog with Hoary Marmot™ brand pet shampoo.

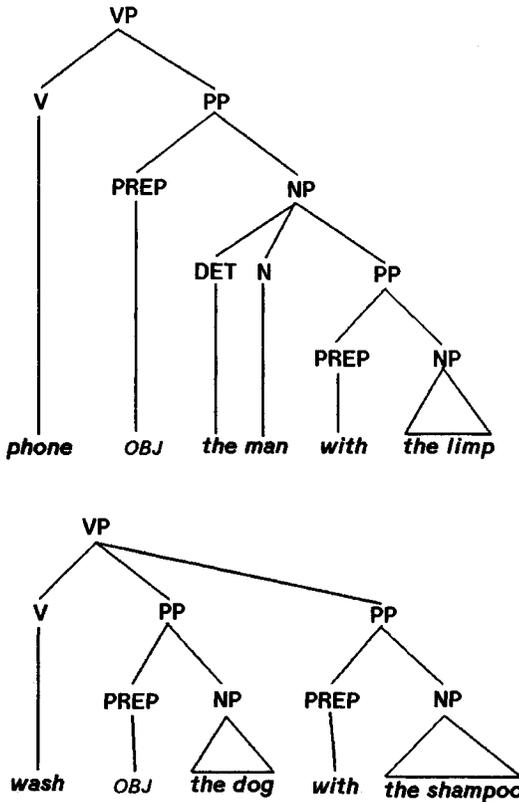


Figure 6.1. Parses of *phone the man with the limp* and *wash the dog with the shampoo*.

In sentence (6-1), the final PP is attached to the NP *the man* as a modifier: it is the man who has the limp and the preposition *with* flags an attribute of the man. In (6-2), the dog doesn't have the shampoo; rather, *with* is a case flag marking the shampoo as the INSTRUMENT of the washing action. The differing parse of each sentence reflects this; see figure 6.1. Note, however, that it is only semantic constraints that prevent each sentence from being parsed like the other.

Below I list some of the other occasions on which attachment ambiguities may occur.

1. A prepositional phrase may have more than one noun phrase available to attach it to (as well as, possibly, a verb):

(6-3) The door near the stairs with the "Members Only" sign had tempted Nadia from the moment she first entered the club.

(The sign could be on the door or on the stairs.)

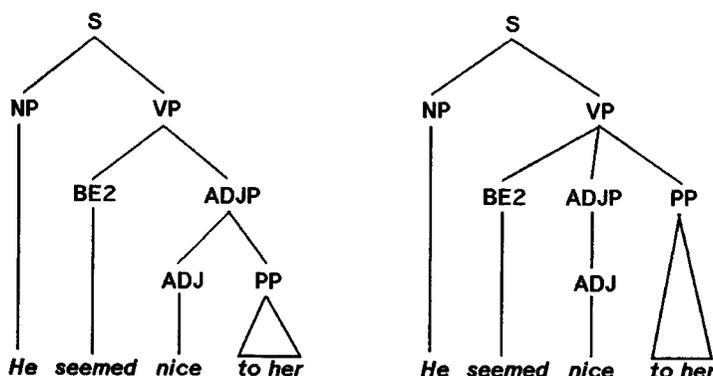


Figure 6.2. Alternative parses for *He seemed nice to her*.

2. Relative clauses have similar attachment ambiguities:

(6-4) The door near the stairs that had the “Members Only” sign had tempted Nadia from the moment she first entered the club.

(Again, there are two possible locations for the sign.)

3. A prepositional phrase can also be attached to an adjective phrase:

(6-5) He seemed nice to her.<sup>1</sup>

Depending on the parse, this could mean **he seemed to act nicely towards her** (attachment to the adjective phrase) or **he seemed to her to be nice** (attachment to the verb phrase). These parses are shown in figure 6.2.

4. When a sentence contains a subsentence, both may contain places for the attachment of a prepositional phrase or adverb:

(6-6) Ross said that Nadia had taken the cleaning out yesterday.<sup>2</sup>

The word *yesterday* may qualify the saying action of the matrix sentence, or the taking action of the subsentence.

(6-7) Nadia knew that Ross fried the chicken with garlic.

(6-8) Nadia ate the dinner that Ross had prepared with a grace that belied her intense dislike of Venezuelan cuisine.

The preferred attachment for *with garlic* is *fried*, not *knew* or *chicken*; the preferred attachment for *with a grace . . .* is *ate*, not *prepared*.

5. An attachment ambiguity also occurs when an adverbial may modify the sentence verb or the whole sentence:

<sup>1</sup>This example is from Ford, Bresnan, and Kaplan 1982.

<sup>2</sup>From an example in Ford, Bresnan, and Kaplan 1982.

(6-9) Happily, Nadia cleaned up the mess Ross had left.

The adverb *happily* could be attached to the sentence, meaning that the event was a fortunate occurrence, or it could be attached to the VP, meaning that Nadia was quite happy to clean up the mess; compare:

(6-10) Fortunately, Nadia cleaned up the mess Ross had left.

(6-11) Grudgingly, Nadia cleaned up the mess Ross had left.

Note, however, that some adverbs modify neither the sentence nor the VP, but rather make a pragmatic comment upon the discourse (*cf.* Whitley 1983):

(6-12) Frankly, my dear, I don't give a damn.<sup>3</sup>  
(*i.e., I don't give a damn, my dear, and I am being frank when I say that.*)

6. Certain participles may be attached to either the surface subject of the sentence or to the sentence node itself (Follett 1966: 121–124; see also Fowler 1965: 659–661):

(6-13) Considering his situation likely to go from bad to worse, he decided to offer his resignation.

(6-14) Considering the deficiencies of his education, his career has been extraordinary.

7. On occasions, an adverbial placed between two clauses can be attached to the verb of either:

(6-15) The lady you met now and then came to visit us.  
(*i.e., We were visited by the lady you met now and then, or We were visited now and then by the lady you met.*)

(6-16) The friends you praise sometimes deserve it.  
(*i.e., Sometimes the friends you praise deserve it, or The friends you sometimes praise deserve it.*)<sup>4</sup>

Stress would disambiguate the sentences in spoken English, as may the insertion of commas in the written form. The ambiguity is restricted by permissible adverb movements; see my remarks below.

A summary of our list of attachment ambiguities in English appears in table 6.1.

These example sentences bear no discernible resemblance to the sentences that compose the text that purportedly explains them—yet the linguist's own sentences are also alleged (implicitly) to be drawn from the same English language.

—Joseph D Becker<sup>5</sup>

Strangely, one occasionally finds in the literature examples of alleged attachment

<sup>3</sup>HOWARD, Sidney. *Gone with the wind* [screenplay]. 1939.

<sup>4</sup>Taha 1983: 260.

<sup>5</sup>Becker 1975: 70.

Table 6.1. Summary of attachment ambiguities in English

*PP attachment—to noun or verb?*

Ross insisted on phoning the man with the limp.

Ross insisted on washing the dog with pet shampoo.

*PP attachment—to which noun?*

The door near the stairs with the “Members Only” sign

*Relative clause attachment—to which noun?*

The door near the stairs that had the “Members Only” sign

*PP attachment—to verb or adjectival phrase?*

He seemed nice to her.

*PP attachment—to which verb?*

Ross said that Nadia had taken the cleaning out on Tuesday.

*Adverb attachment—to verb or sentence?*

Happily, Nadia cleaned up the mess Ross had left.

*Participle attachment—to surface subject or sentence?*

Considering his situation likely to go from bad to worse, he decided to offer his resignation.

Considering the deficiencies of his education, his career has been extraordinary.

*Adverb attachment*

The friends you praise sometimes deserve it.

ambiguities that are not really ambiguous at all.<sup>6</sup> To close this section, I list a couple:

1. In his experiments intended to determine relative sensibleness ratings for ambiguous sentences, Oden (1978) included sentences such as (6-17):

(6-17) A good secretary can type quickly written reports.

It was alleged that this is an adverb placement ambiguity, and *quickly* could modify either *written* or *type*; that the latter is impossible, however, is shown by the unacceptability of (6-18):

(6-18) \*A good secretary can type quickly reports.

When asked to compare the correct and impossible interpretations of such sentences, subjects found them about equally acceptable, a fact that says more about the demand characteristics of the experiment than it does about the experimental hypothesis. Taha (1983: 260) and Holmes (1984: 240, 249) make the same mistake. The error is that in general an adverb may not be placed between a verb and its object NP; any adverb in such a position must in fact be part of the NP, if

<sup>6</sup>Any apparent instance of such a thing in this book is either a figment of the reader's imagination or the work of enemy saboteurs.

that is at all possible, and sentences in which it is not, such as (6-19), are at best marginally well formed:

(6-19) \*?Nadia closed rapidly the stopcock.

2. Ford, Bresnan, and Kaplan (1982) give examples where two clauses surround an item that may, they claim, be attached to either:

(6-20) Though Martha claimed that she will be the first woman president yesterday she announced that she'd rather be an astronaut.

The claim is that *yesterday* could be attached to *claimed* or *announced*. I don't think such examples are ambiguous, as correct punctuation requires a comma between the subordinate and main clauses, thereby unambiguously delimiting each. In speech, intonation and a pause in the appropriate place would have the same effect.<sup>7</sup> Kurtzman (1984: 165–166) also had problems because of the absence of necessary commas.

### 6.2.2 Gap finding and filling

Gap-finding ambiguities occur when a moved constituent has to be returned to its pre-transformational starting point, and there is more than one place that it might go. For example (Ford, Bresnan, and Kaplan 1982):

(6-21) Those are the boys that the police debated about fighting.

In this sentence, there are two possible gaps in the relative clause (which we denote by “ $\diamond$ ”) that the relative pronoun (whose referent is underlined) might fill:

(6-22) Those are the boys that the police debated  $\diamond$  about fighting  $\diamond$ .

Taking the first gap gives the meaning that **the police debated with the boys on the topic of fighting**;<sup>8</sup> the second gives **the police debated (among themselves) about fighting the boys**. The corresponding parses are shown in figure 6.3. The constituent that is moved into a gap is a *wh*-—either a relative pronoun, as in (6-22), or a question *wh*-, as in this example:

(6-23) Which boys did the police debate  $\diamond$  about fighting  $\diamond$ ?

<sup>7</sup>Wales and Toner (1979) have shown that intonation is not always a reliable cue for disambiguation; it seems to have an effect only in certain cases of attachment ambiguity, and is often overridden by other biases; Berkovits (1982) reports further qualifications. (For a review of research on the effects of intonation upon sentence comprehension, see Cutler 1982.) In well-formed written language, however, punctuation can be an important indicator of structure.

<sup>8</sup>This reading assumes the North American dialect of English in which the opponent in the debate may be expressed as the direct object of the verb—*Lincoln debated Douglas*; for some British speakers, *debate* is obligatorily intransitive—*Lincoln debated with Douglas*—and the first gap would not be posited in such dialects.

The gap to which the filler belongs may be a case slot at the same level as the *wh-*, as in the examples of the previous paragraph, or it may be a case slot of a subsentence from which it has been raised, as in (6-24) (based on an example from Frazier, Clifton, and Randall 1983):

(6-24) Mary is the student whom the teacher wanted  $\diamond$  to talk to the principal.

This can lead to complications when two items—the *wh-* and another constituent—have been raised from the subsentence, and each must be matched with the corresponding gap. Thus in (6-25), which is the same as (6-24) but for the addition of an extra case at the end, the gap after *wanted* takes *the teacher* instead of the *wh-*, and the *wh-* now fills the new case slot:

(6-25) Mary is the student whom the teacher wanted  $\diamond$  to talk to the principal about  $\diamond$ .

See Frazier, Clifton, and Randall 1983 for further analysis.

### 6.2.3 Analytical ambiguities

The attachment ambiguities that we saw above occur when it is clear what the nature of a constituent is but not where to put it. On the other hand, analytical ambiguities occur when the nature of the constituent is itself in doubt, that is, when there is more than one possible analysis of it.<sup>9</sup> Obviously, the two uncertainties may occur together, though often resolving one will resolve the other. For example, consider these sentences (from Ford, Bresnan, and Kaplan 1982):

(6-26) The tourists objected to the guide that they couldn't hear.

(6-27) The tourists signaled to the guide that they couldn't hear.

In (6-26), the preference is that the clause *that they couldn't hear* is a relative clause modifying *the guide*; in (6-27), the preference is that it is a sentential complement and modifies *signal*.

English offers many opportunities for analytical ambiguity. Here are examples of some others.

**1. Particle detection**—is a preposition functioning as a verb particle or as part of a prepositional phrase?

(6-28) A good pharmacist dispenses with accuracy.  
(i.e., *The way a good pharmacist dispenses is with accuracy*, or *What a good pharmacist dispenses with is accuracy*.)

(6-29) Ross looked up the number.  
(i.e., *What Ross looked up was the number*.)  
Ross looked up the elevator shaft.  
(i.e., *Where Ross looked was up the elevator shaft*.)

<sup>9</sup>We include here local ambiguities.

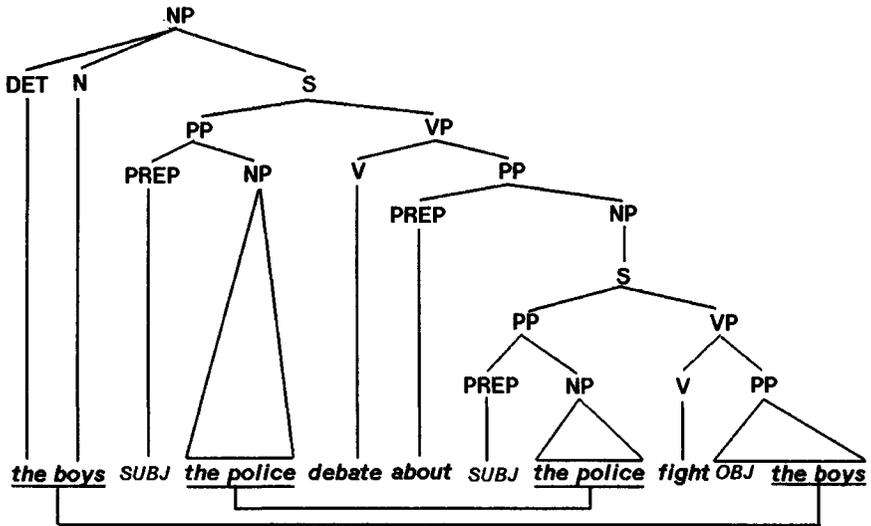
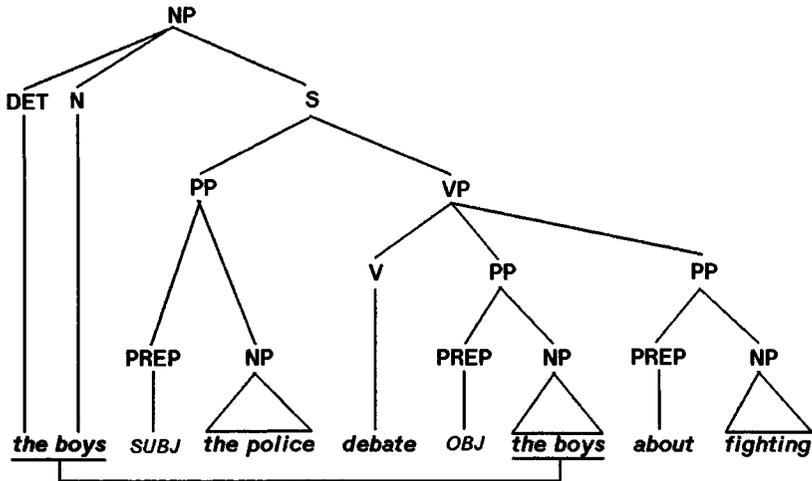


Figure 6.3. Alternative parses for *the boys that the police debated about fighting*.

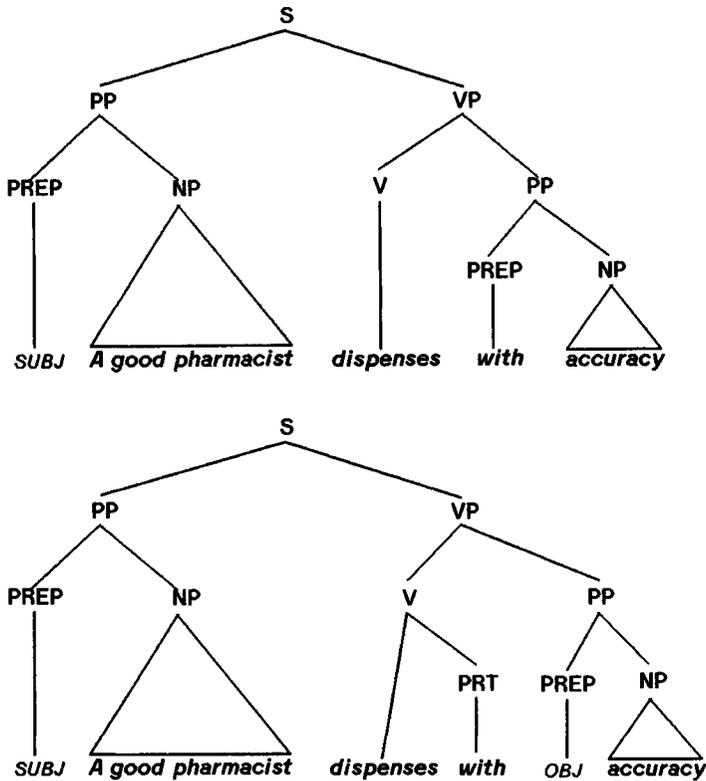


Figure 6.4. Alternative parses for *A good pharmacist dispenses with accuracy*:

See figures 6.4 and 6.5 for the parses.

2. Distinguishing a simple prepositional phrase from one that is actually an adjective phrase left after raising and *to-be*-deletion have been applied to a verb complement:

(6-30) "You can have the music box that's in the closet or the one that's on the table," said Ross. "I want the music box on the table," said Nadia.  
(*i.e.*, *I want the music box that is on the table*)

(6-31) "I put the music box on the mantelpiece. Is that okay?" asked Ross. "No," said Nadia, "I want the music box on the table."  
(*i.e.*, *I want the music box to be on the table*)

Figure 6.6 shows the alternative parses.

3. Distinguishing a present participle from an adjective:<sup>10</sup>

<sup>10</sup>Note that there isn't always a clear distinction between the two; see Quirk, Greenbaum, Leech, and

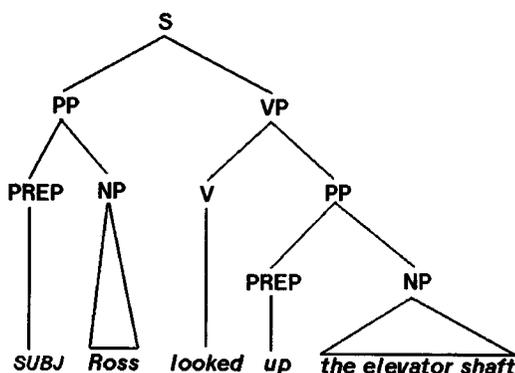
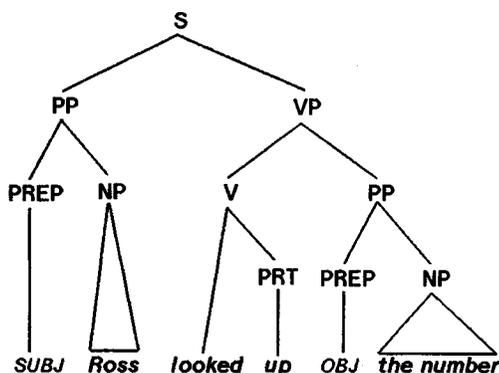


Figure 6.5. Contrasting parses of *Ross looked up the number* and *Ross looked up the elevator shaft*.

(6-32) Ross and Nadia are singing madrigals.

(6-33) Pens and pencils are writing implements.

The contrasting parses are shown in figure 6.7.

4. Distinguishing between a present participle and a noun. This example is from Ford, Bresnan, and Kaplan 1982:

(6-34) We discussed running.

(i.e., *We discussed the sport of running*, or *We discussed the possibility of our running*.)

The parses are shown in figure 6.8. In the first, *running* is a DEVERBAL NOUN (Quirk, Greenbaum, Leech, and Svartvik 1972: 133–134); that is, it has noun prop-

Svartvik 1972: 244.

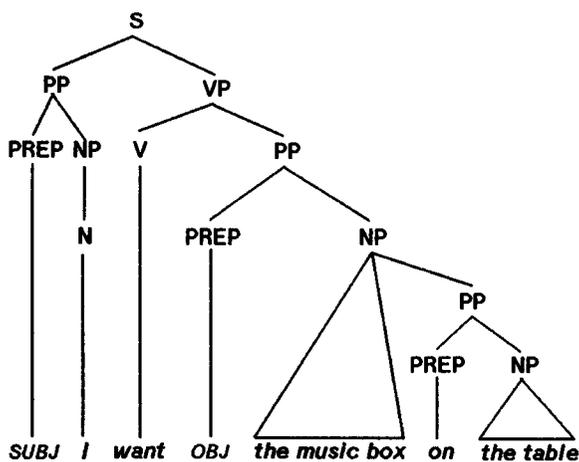
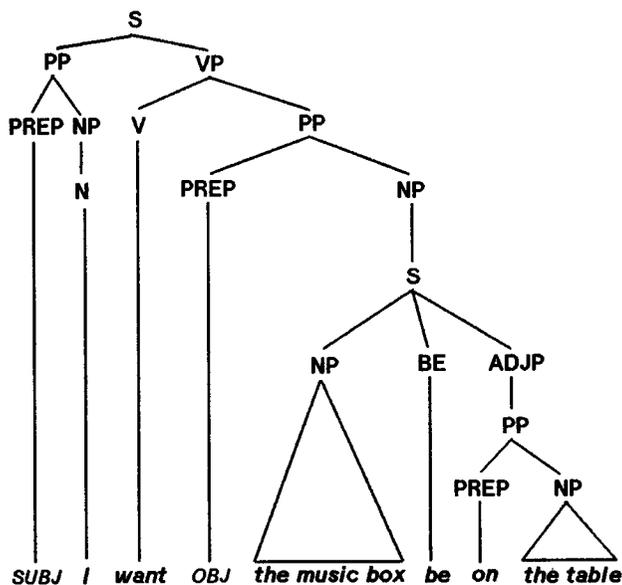


Figure 6.6. Alternative parses of *I want the music box on the table*.

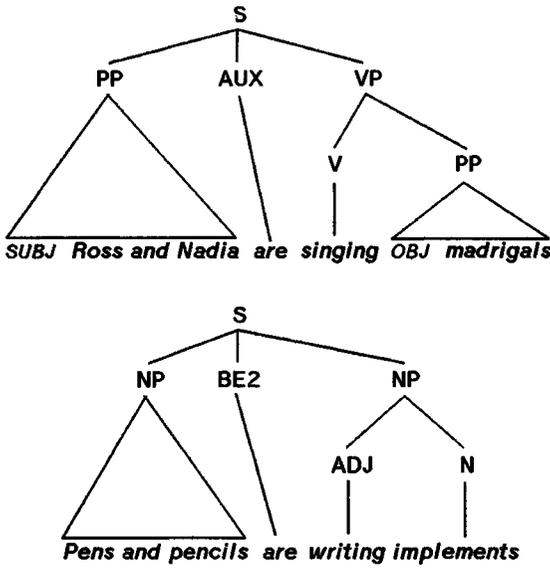


Figure 6.7. Contrasting parses of *Ross and Nadia are singing madrigals* and *Pens and pencils are writing implements*.

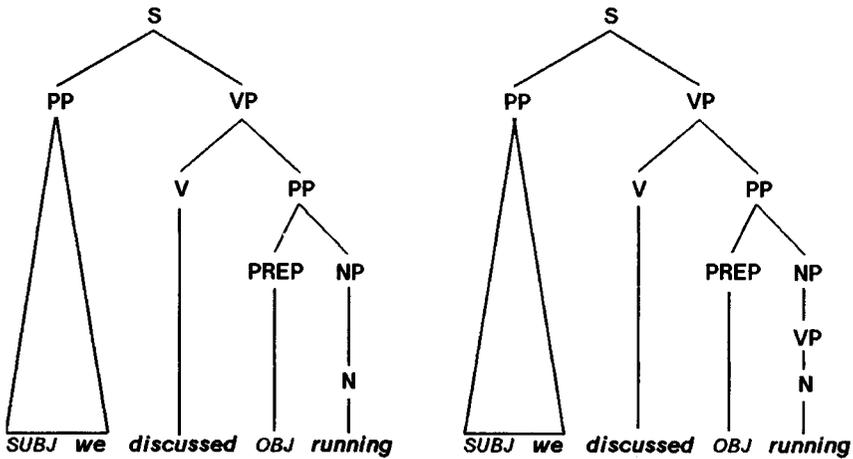


Figure 6.8. Alternative parses of *We discussed running*.

erties: it can take determiners, adjectives, and PP complements, but not *not* or NP complements (Ford, Bresnan, and Kaplan 1982):

(6-35) We discussed the excessive running of races.

(6-36) \*We discussed not excessive running.

(6-37) \*We discussed the excessive running races.

In the second parse, it is a present participle or VERBAL NOUN, with verb properties: it can take adverbs, *not*, and direct NP objects:

(6-38) We discussed not running races excessively.

**5. Detecting the end of a noun group.** Two contiguous noun phrases can appear to be a single one. Compare:

(6-39) Ross gave the dog some water, and Nadia gave the cat food.<sup>11</sup>

(6-40) Ross gave the shampoo, and Nadia gave the cat food.

The alternative parses for the second of the conjoined clauses are shown in figure 6.9. In (6-41):

(6-41) To handle particles, we must first, obviously, add to the grammar rules that will recognize the possibility that a preposition is functioning as a particle and will ask the SED for an opinion if necessary.<sup>12</sup>

the string *the grammar rules that will recognize the possibility that a preposition is functioning as a particle* is actually two separate NPs, with the separation after the word *grammar*, but this is not apparent until the second occurrence of *will*, by which time recovery is very difficult. (It is also possible to read *the grammar rules that will recognize the possibility that a preposition is functioning as a particle and will ask the SED for an opinion if necessary* as a single, stylistically bad, NP.)

One particular instance of this kind of ambiguity occurs when the first of two consecutive nouns can be analyzed as an adjective. The result is often a garden path:

(6-42) The cotton clothing is made from comes from Mississippi.<sup>13</sup>  
(*i.e.*, *The cotton from which clothing is made comes from Mississippi.*)

**6. A reduced relative clause can appear to be the VP of the matrix sentence.** This leads to the “classic” garden path sentence (6-43):

(6-43) The horse raced past the barn fell.<sup>14</sup>  
(*i.e.*, *The horse that was raced past the barn fell.*)

<sup>11</sup>Based on an example from Marcus 1980: 251.

<sup>12</sup>From section 7.4.1 below.

<sup>13</sup>I believe this example is due to Mitch Marcus.

<sup>14</sup>From Bever 1970: 316.

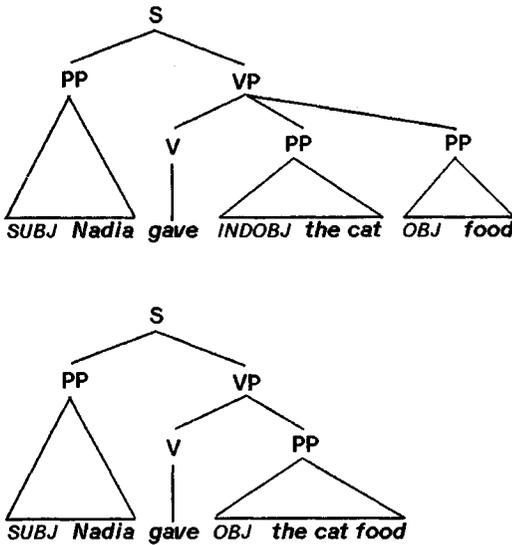


Figure 6.9. Alternative parses of *Nadia gave the cat food*.

7. Determining the structure of a complex noun group, including modifier scope. It is well known that noun groups can have a complex internal structure. An example:

(6-44) AIRPORT LONG TERM CAR PARK COURTESY VEHICLE PICKUP POINT<sup>15</sup>

This has the structure shown in (6-45), with a very complicated semantic relationship holding between the elements:

(6-45) [[[airport [[long term] [car park]]] [courtesy vehicle]] [pickup point]]

The relationships possible between the elements of a complex noun group are many and wonderful (Downing 1977, Levi 1978, B Warren 1978), and generally rely heavily on pragmatics and world knowledge (Bauer 1979) (*cf. section 3.8.2*). Levi (1978) points out that the problem is compounded by adjectives in a noun group that can be functioning as nouns instead of adjectives; thus *atomic bomb*, for example, is better analyzed as if it were the also-permissible *atom bomb*, a **bomb employing the power of atoms**. It is tempting to regard noun group analysis as a problem solely for the semantic interpreter, the parser's job being to do no more than identify and delimit the group. However, we shall see below when

<sup>15</sup>Sien at Gatwick Airport; see *Verbatim*, 8(3), Winter 1982, p. 12.

we look at disambiguation in Marcus's Parsifal parser (1980) that the parser can, with the aid of a semantic process, discover some of the structure.

He thought he saw a Banker's Clerk  
 Descending from the bus;  
 He looked again, and found it was  
 A Hippopotamus.  
 —Lewis Carroll<sup>16</sup>

8. Participles and adjectivals can be particularly troublesome when they occur at the end of a clause. It is not even clear exactly when they engender an ambiguity, and there seem to be wide idiolectic differences. Consider the following examples, where small caps indicate stress, from Quirk, Greenbaum, Leech, and Svartvik (hereafter *QGLS*) (1972: 762):

(6-46) The manager **APPROACHED** me, **SMILING**.

(6-47) The manager **approached** me **SMILING**.

In both sentences, it is the manager, not the speaker, who is smiling. These seem best treated as a supplementive clause (*QGLS* 1972: 760–764), and parsed as being derived from (6-48), a conjunction of two main clauses:

(6-48) The manager<sub>i</sub> **approached** me, and he<sub>i</sub> **was smiling**.

The same analysis seems correct for clause-final adjectivals, which *QGLS* regard as verbless supplementive clauses:

(6-49) The manager **approached** us full of apologies.

(6-50) He **drove** the damaged car home undismayed.

Two types of ambiguity can arise from this. The first occurs when the subject and the object of the matrix sentence both could be the subject of the supplementive; informants found (6-51) and (6-52) (*QGLS* 1972: 724, 763) ambiguous as to who was leaving the room and who was going home:

(6-51) We met him **leaving** the room.

(6-52) I saw him **going** home.

Compare also:

(6-53) He **drove** the car home undismayed.  
 (i.e., *The driver was undismayed*.)

(6-54) He **brought** the car back undamaged.  
 (i.e., *The car was undamaged*.)

<sup>16</sup>*Sylvie and Bruno*. 1889. Chapter 7.

The second type of ambiguity arises when the participle, instead of being a supplementive, could be attached to the object NP either as a reduced restrictive relative clause or as a verb complement:

- (6-55) The manager approached the boy smoking a cigar.  
(i.e., *The manager, smoking a cigar, approached the boy, or The boy smoking a cigar was approached by the manager.*)
- (6-56) The manager caught the boy smoking a cigar.  
(i.e., *The manager caught the boy in the act of smoking a cigar, or The manager caught the boy who was smoking a cigar (but the boy smoking a pipe escaped).*)

Note the difference between (6-55) and (6-56): in (6-55), *smoking a cigar* can be supplementive—the manager was smoking—but not a verb complement; in (6-56), the verb complement reading is available (since *catch*, unlike *approach*, can take a complement), but the supplementive reading is not. (QGLS (1972: 763) claim a three-way ambiguity for (6-56), including the supplementive, but this is not possible in my idiolect; even a comma after *boy* doesn't seem to help. Informants I asked about these sentences mostly just became confused.)

This leads us into the murk surrounding clause-final participles. The problem can be seen in the sentences with alleged participle attachment problems that were used in Oden's experiments on ambiguous sentences (1978) (*see section 6.2.1*):

- (6-57) A boy saw a pilot driving to the airport.

Supposedly, the boy or the pilot could have been driving to the airport. However, the former interpretation requires a comma after *pilot*, and even then is a highly deprecated usage; hence we find the well-known example (6-58) funny and semantically nonsensical:

- (6-58) #I saw the Grand Canyon flying to New York.

But, as we have seen, clause-final participles CAN be supplementive, with the subject of the sentence as their elided subject, even without a guiding comma. It is unclear to me why this reading should be blocked in (6-57) and (6-58).<sup>17</sup>

9. Apparent cleft sentences may also admit a non-cleft subject–verb–object analysis. Thus, (6-59):

<sup>17</sup>It is my intuition that clause-final participles of this form can qualify only the surface subject, in sentences such as (6-51) and (6-52), when the subject is the speaker and the participle describes the speaker's movement at the time. Moreover, this seems to be a convention of informal speech rather than a "real" rule of the language—a convention that lets one abbreviate a sentence like (i):

- (i) I saw him while I was driving home.

Obviously this is a tenuous and dangerous argument. For one thing, what is the difference between a convention of informality and a "real" rule? I'm not sure, but I think the former is exemplified by the fact that people will say (ii) to mean (iii), despite the apparent anomaly, a fact that I don't think I want to include in a competence grammar:

- (ii) Nadia just left, because I saw her leaving.  
(iii) Nadia just left; I know this because I saw her leaving.

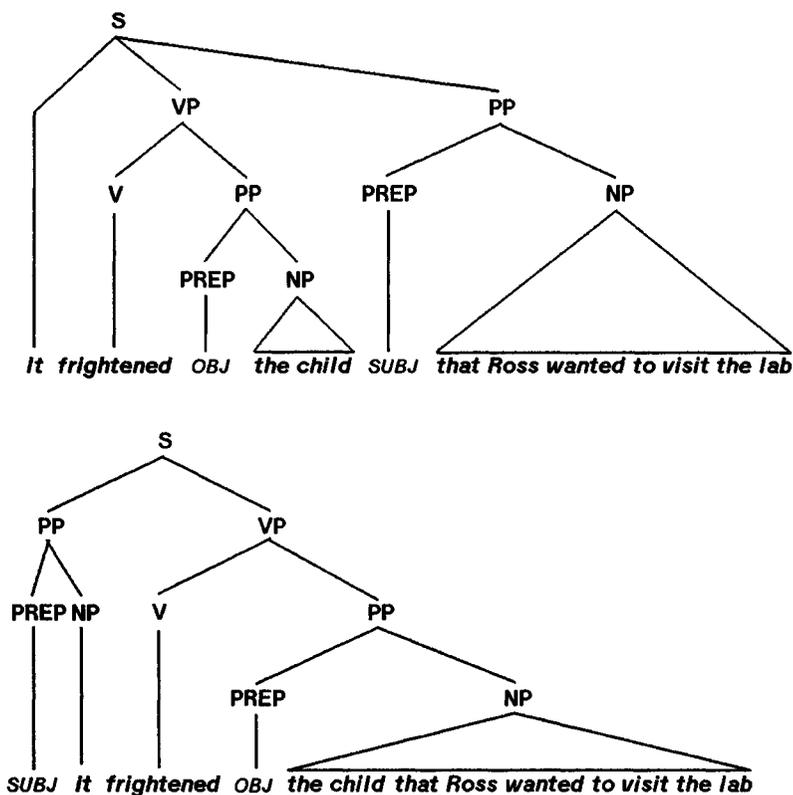


Figure 6.10. Alternative parses of *It frightened the child that Ross wanted to visit the lab*.

(6-59) It frightened the child that Ross wanted to visit the lab.<sup>18</sup>

has the two parses shown in figure 6.10. The corresponding meanings are **that Ross wanted to visit the lab frightened the child** (the cleft analysis), and **the child, whom Ross wanted to visit the lab, was frightened by X**, where X is some entity in the discourse focus (the subject–verb–object analysis).<sup>19</sup>

**10.** In a few cases, a past participle can look like a gapped VP, rendering a question indistinguishable, but for punctuation or intonation, from a command:

(6-60) Have the crystals dissolved?

<sup>18</sup>From Crain and Steedman 1985.

<sup>19</sup>There is also another cleft reading, in which the complement is instead parsed as a relative clause followed by an infinitive. The resulting sense is **to visit the lab frightened the child that Ross wanted**. There seems to be a strong bias against this reading. [I am grateful to Jim Hender for pointing this out to me.]



Table 6.2. Summary of analytic ambiguities in English

*Relative clause or complement?*

The tourists objected to the guide that they couldn't hear.

The tourists signaled to the guide that they couldn't hear.

*Particle detection*

A good pharmacist dispenses with accuracy.

*Prepositional phrase or adjectival phrase?*

I want the music box on the table.

*Present participle or adjective?*

Ross and Nadia are singing madrigals.

Pens and pencils are writing implements.

*Present participle or noun?*

We discussed running.

*Where does an NP end?*

Nadia gave the cat food.

*Reduced relative clause or VP?*

The horse raced past the barn fell.

*Determining noun group structure*

airport long term car park courtesy vehicle pickup point

*What is the subject of the supplementive?*

He drove the car home undismayed.

He brought the car back undamaged.

*Supplementive, restrictive relative, or verb complement?*

The manager approached the boy smoking a cigar.

The manager caught the boy smoking a cigar.

*Cleft or not?*

It frightened the child that Ross wanted to visit the lab.

*Question or command?*

Have the crystals dissolved?

Have the crystals dissolved.

*How is the predicate formed?*

Ross is eager to please.

Ross is ideal to please.

Ross is easy to please.

Ross is certain to please.

(6-66) The chicken is ready to eat.  
(i.e., *The chicken is ready to eat something, or The chicken is ready to be eaten.*)

This completes our long, yet not exhaustive, list of structural ambiguities in English. A summary of the list appears in table 6.2.

### 6.2.4 The interaction between categorial and structural ambiguity

If a word is categorially ambiguous, a sentence containing it can be structurally

ambiguous, and the possibilities will correspond to those for the word. For example:

(6-67) The Japanese push bottles up the Chinese.<sup>20</sup>

(6-68) Charles Wallace sat there tucking away turkey and dressing as though it were the most delicious thing he had ever tasted.<sup>21</sup>

In (6-67), the words *push* and *bottle* could be verb and noun respectively, or noun and verb; the writer intended the latter (the context of the sentence is a report on a World War II battle), though there is a strong preference for the former. In (6-68), *dressing* is a noun, but could have been a verb:

(6-69) Charles Wallace sat there tucking away turkey and dressing himself at the same time.

Clearly, not all categorial ambiguities result in structural ambiguities, since the syntactic context will often admit only one of the alternatives; and, as we saw in the previous section, some create only local ambiguity, with a possible garden path.

### 6.2.5 Structural ambiguity as a closure problem

Another way to look at many structural ambiguities is to view them as CLOSURE PROBLEMS (Ford, Bresnan, and Kaplan 1982). In parsing, a constituent of the parse tree is said to be OPEN if it has not been declared complete, and so other constituents may still be attached to it. When a constituent is complete, it is CLOSED, and that subtree may no longer be changed. In English (and most other natural languages; *but see exercise 5.3 in section 9.5*) it is almost always true that if several constituents are open, then the attachment of another constituent to one of them causes the closure of all open constituents at a lower level of the tree.

For example, suppose (6-70) has been parsed up to the point marked by the vertical bar, with the partial parse shown in (6-71):

(6-70) Nadia told the man with the limp | about Ross's indiscretion.

(6-71) [*S*[*NP*Nadia] [*VP*[*V*told] [*NP*[*DET*the] [*N*man] [*PP*[*PREP*with] [*NP*[*DET*the] [*N*limp] | about Ross's indiscretion.

At this point, the open constituents are the *S*, *VP*, *NP*, *PP*, and second *NP* that are as yet missing their right brackets; the closed constituents are the *NP* *Nadia*, the *V*, and both *DETs*. Now let us suppose that the parse proceeds, and a *PP* is built from the words *about Ross's indiscretion*. This *PP* has to be attached somewhere, and the candidates are exactly those constituents that are still open. Clearly, the "correct" choice is the *VP*, and performing this attachment has the side-effect of

<sup>20</sup>Quoted by Wilks (1982b) as a well-known example.

<sup>21</sup>L'ENGLE, Madeleine. *A wrinkle in time*. New York: Farrar, Straus and Giroux, Inc. 1962.

closing all those constituents that are dominated by this VP, namely the two NPs and the PP. The VP itself, and the S that dominates it, are not closed. To show that the NPs and PP are closed, we need only show the inadmissibility of sentences that attempt a subsequent attachment to them:

- (6-72) \*Nadia told the man with the limp about Ross's indiscretion due to gout.  
(i.e., the limp that was due to gout)
- (6-73) \*Nadia told the man with the limp about Ross's indiscretion that she met at the laundromat.  
(i.e., the man with the limp that she met at the laundromat)

There are a couple of minor counterexamples to the above generalizations. The first is that under certain circumstances a noun phrase that contains an NP-like quantifier phrase can be split in two (Akmajian and Lehrer 1976); thus all the following are generally considered acceptable:

- (6-74) A number of stories about Watergate soon appeared.
- (6-75) A number of stories soon appeared about Watergate.
- (6-76) A sizable herd of large African elephants was discovered last year.
- (6-77) A sizable herd was discovered last year of large African elephants.

In parsing, such splits require the initial noun phrase to be reopened when its second part is discovered. The second, more tenuous, counterexample is the possibility in some idiolects of breaking a modifier off a subject NP and placing it further down the sentence:

- (6-78) Are you good men and true?<sup>22</sup>
- (6-79) ?Many students failed that were expected not to.

Such sentences are, strictly, ill-formed. They seem to be least bad in cases such as the ones just given, where none of the open constituents permit the attachment of the new one, so a closed one has to be reopened. Compare:

- (6-80) \*Are you good men with no serious criminal record and true?
- (6-81) \*Many students failed the comprehensive exams that were expected not to.

Awkward counterexamples aside, it can be seen that attachment disambiguation is equivalent to deciding which open constituents should be closed. That is, instead of saying that we close all constituents below the chosen point of attachment, we can say that we attach at the lowest level that we have chosen not to close. This view also accounts for many analytical ambiguities, insofar as determining the attachment point will often eliminate all but one analysis—this is the case with

<sup>22</sup>SHAKESPEARE, William. *Much ado about nothing*. 1598. III, iii, 1.

the examples (6-26) and (6-27) above<sup>23</sup> even before the ambiguous constituent has been analyzed. One of the disambiguation methods we will look at in the next section, that of Ford, Bresnan, and Kaplan (1982), works by trying to decide which constituents should be closed. Clearly, gap-finding ambiguities cannot in general be resolved by closure decisions, nor could analytical ambiguities such as present participles that look like adjectives, or vice versa. Nevertheless, it happens that the closure decision mechanism of Ford, Bresnan, and Kaplan that we will look at in section 6.3.3 is also helpful in gap finding.

### 6.3 Current theories of structural disambiguation

In this section we look at present approaches to the resolution of structural ambiguities by a parser.<sup>24</sup>

#### 6.3.1 Structural disambiguation in ATN parsers

It is possible for a parser to perform structural disambiguation without the ambiguity ever being explicitly apparent to it. This is the case, for example, when an ATN parser (*see section 1.3.2*) has to make a choice between two alternative paths but has no way of knowing the validity of either; it chooses one at random, and if that path succeeds it will never come back to try the other. If the unchosen path would also have led to a valid parse, then the sentence was ambiguous, and the random choice amounted to blind disambiguation. The unseen path, however, might have produced a preferable parse. It has therefore been suggested (Wanner 1980) that the ATN's random choice be replaced by trying the arcs in a particular fixed order, thus modeling the syntactic bias of English that leads to a preference for one particular parse (*see section 1.1.3*); that is, the arc that would lead to the preferred parse would always be tried first, and only if this fails would others be tried.

In addition, one could eliminate semantically anomalous parses by the addition of a semantic checker at the end of the parse. The checker's finding the parse to be semantically ill-formed could be treated exactly like a syntactic failure: the parser would back up and try another path. This method was used in the LUNAR system (Woods, Kaplan and Nash-Webber 1972); the checker relied mostly on selectional restrictions.

<sup>23</sup>(6-26) The tourists objected to the guide that they couldn't hear.  
(6-27) The tourists signaled to the guide that they couldn't hear.

<sup>24</sup>Since we will not be making any claims of psychological reality for the disambiguation mechanism that we discuss in chapter 7, we will not discuss here much psycholinguistic research on structural disambiguation. It is worth noting, however, that, as in research in lexical ambiguity (*see section 4.3*), there are single-reading, multiple-reading, and ordered search hypotheses, and our computational mechanism will be closest to the multiple-reading hypothesis. For a detailed review of the literature, the interested reader may consult Kess and Hoppe 1981.

Unfortunately, these disambiguation strategies are both inadequate. Ford, Brennan, and Kaplan (1982) show that arc-choice ordering is not adequate because it does not take into account the effects of lexical bias seen, for example, in the differing analyses of sentences (6-26) and (6-27) in section 6.2.3. Marcus (1980: 224) points out that the semantic checker is not good enough because it cannot make COMPARATIVE judgments; it will accept the first result that is minimally acceptable, never knowing whether something better might appear were it to reject the parse under consideration. Moreover, even if the checker can say exactly why it doesn't like a particular parse, the ATN parser is unable to use this information, and may present the checker with other parses that turn out to have exactly the same problem.

Boguraev's (1979) ATN-based disambiguation system (*see also section 4.2.3*) countered these objections by having both ACTIVE and PASSIVE structural disambiguation strategies, which were invoked as part of the semantic interpretation procedures at the completion of each noun phrase and each clause (on the ATN's POP arcs). Passive tests were similar to those of the LUNAR system: checks that a completed structure is (or isn't) SEMANTICALLY COHERENT with respect to case frames, selectional restrictions, and so on. Active disambiguation procedures took a partial sentence structure and some additional items and attempted to identify the permissible structures that could be built. Some of the blind non-determinism of ATN parsers was thus avoided. The system always tried to eliminate possibilities as soon as possible, in order to minimize backing up and to avoid making the same mistake twice. The system could distinguish relative clauses from verb complements and make decisions about PP attachments.

### 6.3.2 Structural disambiguation in Marcus parsers

Unlike an ATN parser, a Marcus parser (*see section 1.3.2*) cannot back up, and must therefore detect structural ambiguity whenever it arises and decide immediately and irrevocably which alternative is the better. As Marcus (1980) points out, this has the advantage that the judgment can be comparative—unlike an ATN parser, a Marcus parser can take the better alternative instead of being happy with the first minimally acceptable one it finds.

In Marcus's Parsifal parser, there are three different ways in which semantics is used to guide the parse. The first is absolute selectional restrictions, used for deciding upon prepositional phrase attachments. A case-frame interpreter runs in parallel with the parser, and the parser rules may ask whether a particular PP fits any of the empty slots left in a particular case frame, or whether it fits as a modifier on a sentence or noun phrase. As in the case of an ATN parser, the order in which possible attachments are tried can account for syntactic bias in the disambiguation, though, as we saw above, this is not fully adequate.<sup>25</sup>

<sup>25</sup>The order of attempted attachments is VP, S, NP; Marcus is quite aware (1980: 305) that this is not correct in general.

Table 6.3. Example of Marcus's noun-noun algorithm operating on water meter cover adjustment screw

The Buffer	$[N_2 N_3] > [N_1 N_2]?$
1) water   meter   cover	no
2) [water meter]   cover   adjustment	no
3) [[water meter] cover]   adjustment  screw	yes
4) [[water meter] cover]   [adjustment screw]	(Rule for 2 nouns applies)
5) [[[water meter] cover][adjustment screw]]	(Finished)

(From Marcus, Mitchell P. *A theory of syntactic recognition for natural language*. The MIT Press, 1980, p.253. Copyright © 1980 by The Massachusetts Institute of Technology.)

The second use of semantics is in gap finding. In this case, comparative semantic judgments are made. They are used in a gap-finding algorithm developed by Marcus (1980:233–234) that is sensitive to both syntactic and semantic bias and uses rules of the form of (6-82) (Marcus 1980:288):

- (6-82) If semantics prefers X filling slot A {much better | somewhat better | no better} than Y filling slot A, then ..., else ...

The semantic preference takes into account the sentence verb and the nature of the gap-filler. Marcus gives this example (1980:235), with two possible gaps:

- (6-83) Which dragon did the knight give  $\diamond$  the boy  $\diamond$ ?

The semantic process considers the possibilities, one for each gap:

- (6-84) X give **higher animate entity** to **animate entity**.  
X give **animate entity** to **higher animate entity**.

and finds the second preferable to the first; the second possible gap is therefore chosen. Parsifal did not contain a complete semantic process for this kind of judgment, but faked it with selectional restrictions (Marcus 1980:320–322).

The third use of semantics in Parsifal is in finding the structure in noun-noun compounds, that is, in complex noun groups with no adjectives. Again this relies on comparative semantic judgments. Marcus's algorithm uses a buffer three items long. If only the first two items in the buffer are nouns, they are simply combined. If all three items are, then the semantic process is asked to report its preference for combining  $N_1$  with  $N_2$  or  $N_2$  with  $N_3$  (where  $N_1$ ,  $N_2$ , and  $N_3$  are the three buffer items). The preferred grouping is chosen, and the two items are combined into a single one. Table 6.3 (from Marcus 1980:253) shows the algorithm operating on the noun group *water meter cover adjustment screw*.

Marcus does not really justify this algorithm, and indeed Finin (1980) points out that there are many exceptions to it; for example, the following, where brackets indicate the desired structure, require more than three buffer elements:

(6-85) [solid state] [RCA [color television]]]

(6-86) [plastic [toy [fire truck]]]

Also, it is hard to see how a semantic process could make the required decisions at such a local level. Why, for example, is *adjustment screw* better than *water meter cover adjustment* in table 6.3? The latter is what one uses the former for, so both are equally semantically unimpeachable. Even if the buffer were longer, what would prevent the premature grouping of *plastic toy*, a very nice group, in (6-86)? Note also that the algorithm only brackets the structure, and does not actually find the relationships between the elements; this is left to the semantic interpreter. But since the semantic component will have been forced to hypothesize these relations anyway in order to provide the required semantic preference, there seems to be little use in the parser bothering about any of this.

### 6.3.3 Ford, Bresnan, and Kaplan's theory of closure

Ford, Bresnan, and Kaplan (hereafter *FBK*) (1982) propose that, at least in neutral contexts, preferences for when constituents should be closed are given by case preferences or expectations on the verb; that is, each verb in the lexicon has marked on it the cases for which fillers are normally provided (based, presumably, on frequency).<sup>26</sup> For example, *discuss* would be marked with (6-87):

(6-87) [AGENT discuss PATIENT]

while *keep* would be marked with (6-88):

(6-88) [AGENT keep PATIENT STATE]

This would explain why the preferred analysis of (6-89) is with *on the beach* attached to *the dogs* as part of the PATIENT, while that of (6-90) has it attached to *kept* as the STATE case:<sup>27</sup>

(6-89) The women discussed the dogs on the beach.

(6-90) The women kept the dogs on the beach.

<sup>26</sup>I have modified FBK's terminology and notation to make it similar to that used in this book. I hope that I haven't thereby introduced any misrepresentation of their claims.

<sup>27</sup>The data on attachment preferences come from experiments that FBK performed, in which subjects were asked for their first impression of the meaning of structurally ambiguous sentences.

That is, the preferred analysis of each sentence is the one that gives it exactly the cases expected.

FBK thus propose a closure theory based on LEXICAL PREFERENCE. An important principle of the theory is that of the FINAL EXPECTED ARGUMENT: in the parsing of the structure that is to become the last of the expected cases, closure is delayed as long as possible, so that as much of the rest of the sentence as possible is swallowed up into that case; if the structure being parsed is not the last one expected, then closure is early. (After the final expected argument is closed, attachment to the VP continues to have low priority.) Thus, in (6-89), *the dogs* is the final expected case, so closure of the NP is delayed, and the PP that follows gets sucked into it. In (6-90), *the dogs* is not the last expected case, so it is closed immediately. Note that this theory accounts not only for attachment ambiguity, but also some analytic ambiguity. Consider again these examples:

(6-91) The tourists objected to the guide that they couldn't hear.

(6-92) The tourists signaled to the guide that they couldn't hear.

The preferred form for the verb *object* is (6-93):

(6-93) [AGENT object to PATIENT]

while for *signal* it is (6-94):

(6-94) [AGENT signal PATIENT MESSAGE]

Therefore, in (6-91) *the guide* is the final argument, and so *that they couldn't hear* gets attached to it as a relative clause. In (6-92), *the guide* is not final and is closed early, forcing *that they couldn't hear* to be analyzed as a sentential complement.<sup>28</sup> If the preferred structure is simply not possible:

(6-95) The tourists signaled to the guide that they didn't like.

the parser backs up, and takes the other path. SYNTACTIC PREFERENCE—trying alternative parsing rules in a particular order—is invoked only when lexical preference does not give a choice between alternative parses. Thus there is a preference for deverbal nouns over verbal nouns, and (6-34)<sup>29</sup> is analyzed accordingly.

FBK point out that lexical preference can also be used in gap finding.<sup>30</sup> Consider again these examples of theirs, where “ $\diamond$ ” marks the preferred location of the gap:

(6-96) Those are the boys that the police warned  $\diamond$  about fighting.

<sup>28</sup>This also explains why (i) is not analyzed as a raised form of (ii), which would require early closure of the final argument:

(i) The woman wanted the dress on that rack.

(ii) The woman wanted the dress to be on that rack.

<sup>29</sup>(6-34) We discussed running.

<sup>30</sup>The role of lexical expectations in gap finding was first suggested by JD Fodor (1978).

(6-97) Those are the boys that the police debated about fighting  $\diamond$ .

If *warn* is marked as preferring (6-98) to (6-99):

(6-98) [AGENT warn PATIENT about OBJECT]

(6-99) [AGENT warn about OBJECT]

while *debate* has the reverse preference, with (6-100) preferred to (6-101):

(6-100) [AGENT debate about OBJECT]

(6-101) [AGENT debate PATIENT about OBJECT]

then the preferred gap can be located.

This theory of closure assumes that the verb of the sentence has been identified. It cannot, therefore, be applied in cases where categorial or lexical ambiguity makes it a problem just to determine where the verb is (*see section 6.2.4*) or what its case structure is.

Ford, Bresnan, and Kaplan have implemented their theory in a parser by Kaplan. In addition, Shieber (1983) has shown that lexical and syntactic preferences can be incorporated in a simple LALR(1) context-free parser for English that, given an ambiguous grammar, gives the preferred structural disambiguations.

It should be noted that FBK's theory is presented as a theory of competence for out-of-context sentences. It does not attempt to explain how lexical preferences interact with context and discourse pragmatics, or under what circumstances one may override the other. The theory assumes that a verb will have a set of preferred cases, and does not take into account the possibility that some verbs—perhaps many or most—will have no strong preference. For example, FBK's own data (*see footnote 27*) show that the preferred reading for (6-91) won by a vote of only 11 to 9—hardly an overwhelming victory.<sup>31</sup> Moreover, there seem to be counterexamples to their theory. For example, the preference in (6-89) can be changed simply by making the object NP indefinite:

(6-102) The women discussed dogs on the beach.

It may be argued that this is one of the cases where discourse pragmatics overrides the lexical preference, but unless some indication can be given of when this happens, the lexical preference theory comes dangerously close to being unfalsifiable: "Lexical preferences determine the attachment, except in cases where they don't".

<sup>31</sup>FBK offer no statistical analysis of their data. However, for each sentence 14 out of their 20 subjects would have to be in agreement to have  $p < .05$  for the hypothesis that there is any preference at all for one structure over another (Walpole 1974: 218–219; Nadia Talent, personal computation). Twelve of the 51 test sentences upon which they support their theory, including (6-91) and (6-97), did not meet this criterion. Also necessary is an analysis to see whether there is a significant difference in the results for pairs of verbs for which different preferences are alleged.

### 6.3.4 Structural disambiguation as presupposition minimization

A very different theory of structural disambiguation from that of Ford, Bresnan, and Kaplan has been proposed by Crain and Steedman (1985; Steedman 1982). FBK's theory, as we saw, assumes a null context and does not incorporate any considerations of discourse. Crain and Steedman, on the other hand, claim that discourse context and, in particular, PRESUPPOSITION, are paramount in structural disambiguation.

The presuppositions of a sentence are the facts that a sentence assumes to be true and the entities that it assumes to exist (see the papers in Oh and Dinneen 1979, in particular Karttunen and Peters 1979). For example:

(6-103) There were two reasons I didn't want to marry Mark.<sup>32</sup>

This sentence presupposes that the reader knows who the writer is, who Mark is, and that either they are married or the possibility of their marrying has been mooted. If a sentence presupposes information that the reader does not have, she has to detect and invoke these UNSATISFIED presuppositions. People have no trouble doing this,<sup>33</sup> though there is evidence that it increases comprehension time (Haviland and Clark 1974), and it is a common literary device that the opening sentences of a story (such as (6-103)) contain many unsatisfied presuppositions, thereby drawing the reader straight into the story.

Now, there is a simple trick, first used by Winograd (1970, 1972), for determining many PP attachments: try each possibility and see if it describes something that is known to exist. For example, (6-104):

(6-104) Put the block in the box on the table.

could be asking that **the block** be placed in **the box on the table**, or that **the block in the box** be placed on **the table**. The first reading can be rejected if *the block* does not in context uniquely identify a particular block, or if there is no box on the table, or if *the box on the table* does not uniquely identify a particular box. Similar considerations may be applied to the second reading. (If neither reading is rejected, or if both are, the sentence is ambiguous, and Winograd's program would seek clarification from the user.) Similarly, we can disambiguate an earlier example if we happen to know the layout of the club involved:

(6-105) The door near the stairs with the "Members Only" sign had tempted Nadia from the moment she first entered the club.

Crain and Steedman have called this technique "THE PRINCIPLE OF REFERENTIAL SUCCESS: If there is a reading which succeeds in referring to an entity already

<sup>32</sup>EPHRON, Nora. "Once burned." *Vanity Fair*, 46(1), March 1983, 80–81. Opening sentence.

<sup>33</sup>Weischedel (1979) has shown how the presuppositions of a sentence may be computed as the sentence is parsed.

established in the hearer's mental model of the domain of the discourse, then it is favored over one that does not".

The Principle of Referential Success deals with a very limited range of structural ambiguities. But Crain and Steedman hypothesize that it can be generalized, noting that success in finding a referent is just one kind of PRESUPPOSITION SATISFACTION. The generalization, then, is that the reading that satisfies the most presuppositions (or, more precisely, leaves the fewest unsatisfied)<sup>34</sup> is the one to be favored: "THE PRINCIPLE OF PARSIMONY: If there is a reading which carries fewer unsatisfied but consistent presuppositions or entailments than any other, then, other criteria of plausibility being equal, that reading will be adopted as the most plausible by the hearer, and the presuppositions in question will be incorporated in his or her model".

This principle can explain garden-path sentences such as (6-106):

(6-106) The horse raced past the barn fell.

The correct parse presupposes the existence of a particular horse and that this horse is known to have raced past a barn, presuppositions unsatisfied in the null context. The incorrect parse, the one that garden-paths, only presupposes the first of these; the other is taken as the new information that the sentence is conveying. The Principle of Parsimony claims that the garden-path parse is chosen just because it makes fewer unsatisfied presuppositions.

If this is indeed the case, then it should be possible to attenuate the garden-path effect by reducing the unsatisfied presuppositions without changing the sentence structure. This prediction was confirmed in experiments by Crain and Steedman, who found that (6-107) was judged ungrammatical in rapid presentation significantly more often than (6-108) (55% and 29% respectively), even though both have the same structure as (6-106):

(6-107) The teachers taught by the Berlitz method passed the test.

(6-108) Teachers taught by the Berlitz method pass the test.

Because it is generic, (6-108) does not presuppose the existence of any particular set of teachers the way (6-107) does. Similarly, there were fewer garden paths on sentences such as (6-109):

(6-109) The students taught by the Berlitz method passed the test.

where, presumably, *students* is more plausibly the object of *taught* than *teachers* was in (6-107). In another experiment, Crain and Steedman were able to induce garden-pathing in a sentence structure that is not normally a garden path. For example, (6-110) can be made into a garden path:

(6-110) It frightened the child that John wanted him to visit the lab.

<sup>34</sup>But cf. section 7.2.1.

by providing a context with a plausible referent for *it* and no unique referent for *the child*:

(6-111) Several children heard the explosion. It frightened the child that John wanted him to visit the lab.

Similarly, Milne (1982b) has shown that semantic plausibility affects categorial disambiguation of word pairs that could be either ADJ + N or N + V. For example, people tend to parse *the granite rocks* as a noun phrase, DET + ADJ + NP, and can get garden-pathed by sentences in which it requires the analysis DET + N + V:

(6-112) The granite rocks during the earthquake.

The converse preference is shown, for example, by *the chestnut blocks*, people having no trouble with (6-113), but tripping on (6-114):

(6-113) The chestnut blocks the sink.

(6-114) The chestnut blocks are red.

(Some pairs, such as *building blocks*, showed no bias.)<sup>35</sup>

The Principle of Parsimony is a particular case of Crain and Steedman's PRINCIPLE OF A PRIORI PLAUSIBILITY: "If a reading is more plausible in terms of either general knowledge about the world, or of specific knowledge about the universe of discourse, then, other things being equal, it will be favored over one that is not". This principle is implicit in the results of Milne mentioned above. It is, of course, an extremely vague principle, generalizing techniques such as checking selectional restrictions that have already been used in both ATN and Marcus parsers (*see sections 6.3.1 and 6.3.2*). Nevertheless, we will be able to make some computational use of it in chapter 7.

If we accept that presupposition and plausibility have strong effects in structural disambiguation, the question then arises whether structural or lexical preferences in fact play a role at all. Since the null context is in no way neutral with respect to presuppositions, studies such as that of Ford, Bresnan, and Kaplan (1982) (*see section 6.3.3*) that used it to look for such context-independent preferences may have just found artifacts of this non-neutrality. To test this, Crain and Steedman took sentences with local ambiguities of relative clause versus complement. They constructed contexts for the sentences so that both of their readings had, in the context, the same number of unsatisfied presuppositions; thus the Principle of Parsimony could not be used to choose a reading, and any preference for one reading over the other must come from structural disambiguation strategies. However, they found

<sup>35</sup>These results could be interpreted as showing a form of lexical preference similar to the verb preferences of Ford, Bresnan, and Kaplan (1982) (*see previous section*). Milne's data do not rule out the possibility that the N + V or ADJ + N reading is chosen solely on the basis of a categorial preference of the first word, even if this reading is less plausible or contains more unsatisfied presuppositions. (The choice could not be a function solely of the second word, as *granite rocks* showed an ADJ + N preference, but *jeep rocks* showed N + V.)

subjects preferred neither structure over the other, and concluded that, at least for this type of ambiguity, structural preferences are not used.

This result should be regarded as only suggestive, however; it is very difficult to construct materials so that presuppositions and plausibility are matched in different readings,<sup>36</sup> and Crain and Steedman used only five sets of stimuli.<sup>37</sup> Moreover, we saw in section 1.1.3 that some sentences seem to have a structural bias toward their less plausible reading. In addition, some of the data of Ford, Bresnan, and Kaplan (1982) do seem to require an explanation in terms of lexical preference rather than presupposition or plausibility. For example, the preferred structure for (6-115), favored by 90% of their subjects:

(6-115) The women discussed the dogs on the beach.

was (6-116):

(6-116) [AGENT discuss PATIENT]

instead of (6-117):

(6-117) [AGENT discuss PATIENT LOCATION]

It is hard to explain this difference as one of presupposition or plausibility. The choice is between the equally plausible and equally unsatisfied presuppositions that either the dogs or the women are on the beach, yet subjects showed a very strong bias. Similarly, sentence (6-118) is amusing exactly because the lexical expectation of participants rather than a place leads to an implausible reading:

(6-118) One witness told the commissioners that she had seen sexual intercourse taking place between two parked cars in front of her house.<sup>38</sup>

In addition, there is some evidence that structural or lexical preferences do affect the order in which the possible readings of a sentence are considered.<sup>39</sup> Rayner, Carlson, and Frazier (*RCF*) (1983) studied the eye movements of people as they read garden-path sentences of varying plausibility, similar to those such as (6-107) and (6-109) that Crain and Steedman used. They found that plausibility did not affect the tendency to initially choose the wrong structure for such sentences, and concluded that pragmatics does not affect the initial, preferred choice for the structure, though it can veto the structure afterwards. In a second experiment on eye

<sup>36</sup>It is also difficult to evaluate the materials one has constructed. Crain and Steedman mention that they did not notice a third possible reading for some of their stimuli until it was pointed out to them—nor did I (see footnote 19).

<sup>37</sup>See also Ferreira 1985 for a discussion of problems with Crain and Steedman's experiments.

<sup>38</sup>*The Press* (Atlantic City, New Jersey), 14 June 1979. Quoted in COOPER, Gloria (compiler). *Squad helps dog bite victim, and other flubs from the nation's press*. Garden City, New York: Dolphin Books, 1980.

<sup>39</sup>Crain and Steedman do not claim that pragmatics determines the order, but rather that there is no particular preferred order (Stephen Crain, personal communication).

movements, they found that reading times were shorter for sentences in which the more plausible reading was the one that permitted use of the MINIMAL ATTACHMENT disambiguation strategy, which they believe to be the basis for many structural disambiguation preferences.<sup>40</sup> Unfortunately, RCF's results must, like Crain and Steedman's contrary result, be taken as suggestive only, because of serious flaws in their experimental materials.<sup>41</sup> Much more work will be needed before the question of exactly what, if any, structural preferences there are can be satisfactorily resolved.

## 6.4 Conclusion

There are many different kinds of structural ambiguity, and there is at present no agreement on any general principles that can be used for disambiguation. It seems clear, however, that knowledge from several different sources is used. In the next chapter we will present a system that works with Paragram, Absity, and Polaroid

<sup>40</sup>The minimal attachment strategy is to resolve an attachment ambiguity in the manner that creates the fewest non-terminal nodes in the parse tree, whenever semantics allows it; thus, for example, PPs are wherever possible attached to the dominating VP instead of an NP below it. Example (6-115) above is a counterexample to the generality of the principle (Ford, Bresnan, and Kaplan 1982).

<sup>41</sup>RCF used rather subtle differences in plausibility in their sentences. For example, *the performer* is said to be more plausibly the indirect object than the subject of *sent the flowers*; but I find it hard to believe that there could be a significant difference. Similarly, they rate (i) plausible but (ii) implausible:

- (i) The tourist [that was] wired the money managed not to misplace it this time.
- (ii) The bank [that was] wired the money managed not to misplace it this time.

Presumably RCF's experience with wiring money is from banks to people. However, as it happens, my only experience with wiring money was when a friend wired money TO a bank, and the bank misplaced it! Similar difficulties arise for many of their other test sentences. If plausibility varies in this way from one individual to another, then RCF's results would be explained by their failure to control this variation.

Moreover, two-thirds of their test sentences were ill-formed in common dialects that prohibit reduced relative clauses whose *wh*- has undergone dative movement, to the apparent confusion of 20% of their subjects. (Such dialects find (i) and (ii) above ill-formed, and not merely garden-path-prone, when the *that was* is deleted; cf. Langendoen, Kalish-Landon, and Dore 1973.) One of their sentences even included dative movement with the verb *deliver*, which is not allowed in many (most?) dialects.

See also Kurtzman 1984: 209–214 for discussion of problems with RCF's experiments.

Similarly, Holmes (1984) also claims to have shown that context has no effect on processing strategies and structure preferences. Her subjects were asked to say rapidly whether a structurally ambiguous sentence was or wasn't consistent with a preceding three-sentence "short story" that was biased toward either the preferred or non-preferred reading of the target sentence. She found that, in general, subjects' responses indicated that they computed the preferred reading of the target even when the short story was consistent with the non-preferred reading. However, it is unclear that subjects were motivated to actually process the target sentence IN THE CONTEXT OF the short story (of which it was not itself a part); rather, they may have adopted the strategy of processing it in the null context, thereby producing the preferred reading, and then checking it for consistency with the story. Indeed, since consistency was not assured, a neutral, "open-minded" strategy like this seems a very reasonable one for a subject to adopt.

Words to resolve several kinds of structural ambiguity. It includes among the methods that it uses some that we have seen in preceding sections.