Reflexives and Tree Unification Grammar

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PhD
University of Edinburgh
1988
Declaration

I declare that this thesis has been composed by myself and that the research reported therein has been conducted by myself unless otherwise indicated.

Fred Popowich

Edinburgh, 26th August 1988
Acknowledgements

I would like to thank Ewan Klein, my supervisor, for his suggestions concerning a research topic which eventually lead to the research described in this thesis. His comments, suggestions, criticisms and questions played a major role in determining the final form and content of this thesis.

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To my mother and father, “duže djakuju.”

My deepest thanks go to my wife Jane, for the support, love and encouragement she has provided.
Abstract

Although there has been a great deal of research into identifying the constraints responsible for the distribution of reflexive pronouns (like himself, herself, themselves), accounts of reflexivisation are often based entirely on syntactic factors. Furthermore, it is usually assumed that a reflexive and its antecedent (i.e. the noun phrase to which a reflexive pronoun 'refers') must be from the same sentence, and the anaphoric relationship between a reflexive and its antecedent is often established based on a complete structural analysis of the sentence containing them.

In this thesis, we propose a treatment of reflexives in which an anaphoric relationship between pronoun and antecedent can be established based on information contained in partial structures associated with linguistic expressions. There is no need to obtain a complete structural analysis before performing anaphora resolution, and information obtained from anaphora resolution can be used to constrain possible analyses. In presenting an account for the distribution of locally bound reflexives in English and of long distance reflexives in Icelandic, we will see that the same general treatment will be applicable to local as well as non-local reflexive anaphoric phenomena.

Our first goal is to establish the constraints that are relevant for the distribution of reflexive pronouns. Then a declarative unification-based linguistic framework will be introduced in which these constraints can be stated. Within a declarative framework, constraints can be stated independent from any processing strategy. The basic grammar structures of this framework will be partial specifications of trees, and the framework will require only a single grammar rule to combine these partial specifications. Finally, we will illustrate how various phenomena associated with reflexive pronouns can be accounted for in this framework. We will provide an account for the distribution of reflexives appearing in complement clauses, picture-noun constructions, possessives, unbounded dependency constructions, prepositional phrases, and constructions where reflexives can have either 'sloppy' or 'strict' readings.
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Unless specified otherwise, the various Norwegian sentences in this thesis are from Hellan (forthcoming), the Icelandic sentences were obtained from Hoskaldur Thrainsson, the Dutch sentences were supplied by Marc Moens, and the Swedish sentences were provided by Elisabet Engdahl.
Chapter 1
Introduction

1.1. General

One problem that has plagued linguists and computational linguists for many years is that of determining the conditions under which anaphora is possible. Anaphora can be thought of as a linguistic process by which a semantically underspecified linguistic item (the anaphor) is used in lieu of a more fully specified event, state or entity (the antecedent). It is a very frequently used mechanism in both spoken and written language. Pronouns are a common form of anaphor. Consider the following example.

(1.1) John bought himself a red apple, and he bought Mary a green one.

This sentence contains: one instance of reflexive anaphora, where the pronoun himself is anaphorically related to John; one case of pronominal anaphora, where this time the pronoun he is used to refer to John; and a single instance of so-called 'one-anaphora' in which the word one is used in lieu of apple.

Anaphora resolution involves determining the antecedents of anaphors. Many linguistic and computational linguistic treatments of anaphora require anaphora resolution to be performed on complete parse trees. Thus, the ungrammaticality of sentences like the one shown below would be determined only after the syntactic (structural) analysis of the entire sentence has been completed.

(1.2) *John's portrait of herself was found in the attic.

If anaphora resolution is performed during the syntactic analysis of a sentence, then information obtained during anaphora resolution can be actively used to constrain possible analyses.

Often, accounts of anaphora have only been concerned with pronouns which appear in the same sentence as their antecedents. In an attempt to provide a more general account of anaphora, there have been proposals like Discourse Representation Theory (DRT) (Kamp 1981) which provide the same treatment for pronouns regardless of the location of their antecedents. Although DRT provides a very elegant treatment of many forms of discourse anaphora, there is the question of whether the inter-sentential anaphora mechanisms of DRT are adequate to account for intra-sentential anaphora. In particular, how do the grammatical constraints on sentence internal anaphora fit into DRT?
The particular kind of sentence internal anaphora that is of interest to us concerns the use of reflexive pronouns. Reflexivisation seems to be a very restricted form of anaphora; there are strict constraints on the distribution of reflexives in any given language. So, can the same mechanisms that are used in DRT be applied to reflexives, or do reflexives require a distinct mechanism?

Part of the study of anaphora has been to determine the conditions under which a pronoun and a potential antecedent can be related, or *anaphorically linked*. In the past, many constraints on reflexives (and intra-sentential pronominal anaphora) have been formulated in terms of syntactic restrictions (Chomsky 1981, Higginbotham 1980, Reinhart 1981). Reflexivisation has often been treated as essentially a syntactic phenomenon. Although this approach may appear to have some short-term merits, there are constructions, like those involving so-called *logophoric* antecedents (Sigurdsson 1986), that make a syntactic treatment look unfavourable in the long term.

In this thesis, we will introduce an approach to anaphora resolution in which both syntactic and semantic information play a role in determining the possible antecedents for reflexive pronouns. A linguistic framework will be introduced which allows interactions between the syntax and semantics. We will not be proposing an autonomous approach where all syntactic analysis is done before semantic analysis is attempted. Since the human sentence processing mechanism is known to use semantic information well before the end of a phrase (Swinney 1979, Marslen, Wilson and Tyler 1980, Altmann 1986), it seems natural that such interactions should be expressible in a linguistic framework.

The linguistic framework introduced will be declarative and unification-based. With a declarative framework, linguistic phenomena can be examined and described independent of any procedural considerations. A commitment to a single processing strategy will not be required. A unification-based approach is ideal for allowing the interaction of different types of information. Over the past several years, such frameworks have become very popular for characterising natural language grammars (Kay 1979, Shieber et al. 1983, Uszkoreit 1986, Zeevat, Klein and Calder 1987). Unification grammars tend to manipulate complex feature structures in which information at the phonological, syntactic and semantic 'level' is all encoded. In these structures, information can be shared between the three different levels. The primitive operation of unification is applied over all these types of information in order to build up more fully specified structures, and to form relationships between various constituents. Unlike frameworks like Montague grammar (Dowty, Wall and Peters 1981), Lexical Functional Grammar (LFG) (Kaplan and Bresnan 1982), or Generalised Phrase Structure Grammar (GPSG) (Gazdar et al. 1985), where the
semantics is constructed passively as a side effect or after syntactic derivation, unification frameworks can allow the semantics to play an active role in sentential analysis. In particular, information obtained during anaphora resolution can be actively used to constrain possible derivations.

Our discussion will for the most part be restricted to the analysis of English sentences containing third person singular reflexive pronouns. Reflexives used for stress or emphasis will not be considered in this study. However, we will present an account for long distance reflexives which are observed in many Germanic languages. Reflexivisation will be treated as a type of anaphora and not as a purely syntactic phenomenon. Questions that will be addressed include: how to determine if a linguistic expression containing a reflexive pronoun is grammatical, and if it is grammatical, what are the possible antecedents. The question of how one chooses amongst possible antecedents will not be discussed. Before we start to address these questions, we must first determine what it means for a pronoun to be reflexive.

1.2. Reflexives

The term reflexive is used to describe a relatively large and varied class of words in natural languages. This class includes reflexive pronouns, and the class of words that can be formed by the addition of a reflexive morpheme, like self, to a personal or reflexive pronoun. English possesses but a single reflexive pronoun while other Germanic languages have a rich selection of reflexive forms each with its own distributional restrictions. Instead of grouping reflexives according to their form, one can group them into different reflexivisation classes (or classes of reflexives) according to the different grammatical properties governing their distribution. In an attempt to understand what it means for a pronoun to be reflexive we will look at different forms and the different classes of reflexives, examining the relationship between these two aspects. Since English has only a single form of the reflexive, our analysis will include other Germanic languages in order to uncover relationships between form and class that may be hidden in English but obvious in these other Germanic languages. We will look at reflexivisation in Norwegian (Hellan forthcoming), Dutch (Koster 1985), Icelandic (Maling 1984a, Maling 1984b) and English.

1.2.1. Reflexive Forms

Different reflexive forms are defined based on the morphological structure of the reflexive pronoun. For a reflexive pronoun of a particular form, morphological variations of this reflexive according to number, case and gender are still considered to be of the
same form. So words like *himself, herself* and *themselves* are all considered to be instances of the same reflexive form. Most Germanic languages are not as limited as English with respect to the number of reflexive forms — they generally possess four distinct reflexive forms. First, they have a separate *simple reflexive* pronoun. Dutch for instance possesses the simple reflexive pronoun *zich*. In addition, there is a reflexive morpheme (resembling the English word *self*) which can be added to the simple reflexive to obtain the *compound reflexive* form. This morpheme can be added to a personal pronoun to obtain what we call the *compound pronoun* form of the reflexive. Finally, this reflexive morpheme can also act as a reflexive pronoun on its own (thus constituting the *self-reflexive* form). The different reflexive forms for Norwegian, Icelandic and Dutch are introduced in (1.3).

(1.3)  

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<td>hann</td>
<td>hem</td>
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<td>sjálfan</td>
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</tbody>
</table>

In cases where the reflexive pronoun varies for person, number, gender and/or case, the third person-singular-masculine-accusative form of the pronoun is used. English possesses only a *compound pronoun* reflexive form (ie. *himself*). We are not considering the English word *self* to be an instance of a *self-reflexive* since it has a much different distribution than the self-reflexives of other languages. For each of the languages in (1.3) the masculine singular personal pronoun has been included to illustrate that the compound pronoun is formed from the personal pronoun and the self-reflexive. We will not be treating the personal pronoun as a reflexive pronoun, although there are some arguments in favour of treating it as one in certain cases (Kuno 1987).

1.2.2. Classes of Reflexives

There are numerous restrictions (both linguistic and non-linguistic) responsible for determining the distribution of reflexive pronouns and thus the set of possible antecedents for a reflexive pronoun. These restrictions, which will form the basis for different reflexivisation classes, will include factors like the syntactic properties of the antecedent and the relative position of the anaphor and antecedent in the sentence. For example, we may want to group reflexives into different classes depending on whether or not the antecedent and the reflexive are in the same clause. Once we have introduced a classification for reflexives, we can take a closer look at the relationship between the
different classes and the different forms of the reflexive. Although it will often be possible to associate a particular form with a class of reflexivisation, many languages (like English) associate a single form with several classes. Furthermore, in some languages there are no forms associated with a particular class of reflexives; some languages do not allow a particular sort of reflexivisation.

A proposed hierarchy of classes, which will be justified in the following sections, is introduced in Figure 1.1. For the classes corresponding to the terminal nodes in the hierarchy, we have tentatively associated corresponding reflexive forms, the names of which are shown in italic below the class names. The top level distinction in this hierarchy is based on whether a reflexive acts as an anaphor, or as an intensifier for emphasising noun phrases (Verheijen 1986). This distinction is the basis for separating reflexives into the classes of anaphoric and emphatic reflexives. Anaphoric reflexives can be subdivided according to whether or not they are bound by a locally available antecedent. Locality, which is usually defined in terms of clause boundaries, will discussed in detail in chapter two. The class of non-locally bound reflexive anaphora can be divided into two subclasses depending on whether it involves what we call a long distance reflexive, or a stress reflexive. Locally bound reflexives correspond to reflexive anaphors in the terminology used in Government and Binding (GB) theory (Chomsky 1981). They can be separated into two classes with respect to whether they take subject or non-subject antecedents. There are also two subclasses of subject antecedent reflexives which we will call inherent reflexives (borrowing the term used by Hellan (forthcoming)) and independent reflexives.

Let us now consider the criteria for establishing the different reflexivisation classes as we look at some examples. At the same time, the different forms of the reflexive that are used by different languages for a particular class of reflexivisation will be examined.

1.2.2.1. Subject Antecedent Reflexives

Not surprisingly, for the class of subject antecedent reflexives it is the subject of the clause containing the reflexive that acts as the antecedent for the reflexive. Locally bound reflexivisation is obligatory; a personal pronoun cannot be used in lieu of a locally bound reflexive to obtain the same reading.

The subclasses of inherent and independent reflexivisation differ in several ways. Inherent and independent reflexivisation can be distinguished in terms of the semantics of the reflexive. Inherent reflexives are often viewed as detransitivising clitics or noun phrases (Geach 1962, Grimshaw 1982, Sells, Zaenen and Zec 1987); they reduce the arity of the semantic predicate associated with the verb. This is illustrated by the reduction of
Figure 1.1. A Classification for Reflexives
the wash predicate in (1.4).

(1.4) \( \lambda x \lambda y \text{wash}(x,y) + \text{REFL} \Rightarrow \lambda x \text{self-wash}(x) \)

The presence of a reflexive \text{REFL} causes the semantic predicate associated with the verb to be altered. A reflexivised version of the predicate associated with the verb which describes self-washing results. With this type of reflexivisation, the reflexive is required to be either a clitic or a syntactic argument of the verb. Inherent reflexives are also allowed to appear in prepositional phrases which act as case-marked noun phrase arguments of the verb. Prepositional phrases will be discussed in detail in § 5.4. Let us now look at some examples of inherent reflexivisation.

With respect to form, many languages associate the simple reflexive with this reflexivisation class. Consider the following examples from Norwegian, Dutch and Icelandic.

(1.5) Jon skammer seg.
Jon shames REFL
'Jon is ashamed.'

(1.6) Jan herinnerde zich dat ...
Jan remembered REFL that ...
'Jan remembered that ...'

(1.7) Jón missteig sig.
Jon misstepped REFL
'Jon tripped.'

The anaphor and intended antecedent are displayed in bold face in our examples, and the simple reflexive is translated as \text{REFL}. Note that unless it is stated to the contrary, whenever a sequence of three examples is introduced in this chapter they will be from Norwegian, Dutch and Icelandic respectively. Observe that in English, we can use an intransitive verb to obtain the translations of the sentences introduced in (1.5-1.7). In these sentences, the use of a compound reflexive form is either ungrammatical or results in the sentence having a different meaning.

Verbs which do not have 'inherently reflexive' meanings do not allow this type of reflexivisation. Examples of this are illustrated in (1.8-1.10).

(1.8) *Jon foraktet seg.
Jon despised REFL
'Jon despised himself.'
For instance, if there is no semantic predicate for 'self-hate' (i.e. self-hate(x)) then inherent reflexivisation is not allowed (1.9).

Verbs that do not allow inherent reflexivisation generally allow independent reflexivisation. Associated with this class of reflexivisation is the compound reflexive form. This is illustrated in the following examples which are the independent reflexivised counterparts to (1.8-1.10).

(1.11) Jon foraktet seg selv.
Jan despised REFL-self
'Jon despised himself.'

(1.12) Jan haat zichzelf.
Jan hates REFL-self
'Jan hates himself.'

(1.13) Jón elskar sjálfan sig.
Jon loves self-REFL
'Jon loves himself.'

Independent reflexives do not have an intransitivising effect on the verbs in which they appear as arguments. In fact, they are not required to be arguments of a verb. Instead, they can appear in constructions like prepositional phrases and in other modifiers.

(1.14) Jon fortalte meg om seg selv / *seg.
Jon told me about REFL-self / *REFL
'Jon told me about himself.'

(1.15) Jan heeft me over zichzelf / *zich verteld.
Jan has me about REFL-self / *REFL told

(1.16) Jón sagði mér frá sjálfrum sér / *sér.
Jon told me about self-REFL / *REFL

Observe that the simple reflexive is not allowed in these constructions. While the reflexive in inherently reflexive constructions acts much like a clitic, the independent reflexive behaves more like an independent noun phrase. Semantically, the reflexive does not reduce the predicate associated with the verb. The distribution of inherent and independent reflexives is by no way complementary. Some verbs allow both types of reflexivisation.
Jon washed REFL / REFL-self
Jan washed REFL / REFL-self
Jon shaved REFL / self-REFL

These verbs have inherently reflexive meanings as well as transitive interpretations.

As can be seen from the above examples, certain verbs are associated with one particular kind of locally bound subject antecedent reflexivisation while others can be associated with both. Independent reflexivisation is involved in constructions where the reflexive is not a direct argument of the verb (ie. when the reflexive is contained in a prepositional phrase or a complex noun). Shortly, we shall see that reflexives contained in certain locative prepositional phrases are not in the class of independent reflexives.

Inherent reflexivisation is linked to semantic arity reduction of the predicate associated with the verb. In general, it appears that Germanic languages associate the compound reflexive with independent reflexivisation and a simple reflexive with inherent reflexivisation.

1.2.2.2. Non-Subject Antecedent Reflexives

As suggested by the name of this class of reflexives, non-subject antecedent reflexivisation is distinguished from subject-antecedent reflexivisation according to the type of antecedent taken by the reflexive. Many languages allow reflexive pronouns to take only subjects as their antecedents and thus locally bound reflexivisation is comprised entirely of subject antecedent reflexivisation — they do not have a reflexive form associated with non-subject antecedent reflexivisation. In languages where the reflexive can take an object as its antecedent, there is often a different form of the reflexive used. In English, Norwegian and Dutch, it is the compound pronoun form of the reflexive that is used as a non-subject antecedent reflexive.

She told John about himself / *him.
She told Jon about *him / him-self.
She has Jan about *him / himself told
Dutch do not allow the personal pronoun to be used to refer to the antecedent. Koster (1985) suggests that the Dutch compound reflexive might also take non-subject antecedents as illustrated in his example (6) which is shown here as (1.23).

(1.23) John raadde Peter zichzelf an.
   John recommended Peter, REFL-self, prt
   'John recommended Peter to himself.'

However, such constructions are not widely accepted.

One dialect of Icelandic behaves much more like English, allowing the same reflexive form to act as either a subject or non-subject antecedent reflexive. Unlike English, in Icelandic it is the simple reflexive form that is used (Thrainsson 1979, p291).

(1.24) Jón sýndi Haraldi fót á sig / hann.
   Jon showed Harold, clothes for REFL / him

In other dialects, the simple reflexive cannot be used. Observe that a personal pronoun can be used when the intended antecedent is not the subject. Furthermore, the compound reflexive and the compound pronoun can also be used grammatically in such constructions, although this results in interpretations that are somewhat more emphatic (Thrainsson pers.com.).

(1.25) Jón sýndi Haraldi fót á sjálfan sig / hann sjálfan.
   Jon showed Harold, clothes for self-REFL / him-self

Unlike the cases of inherent and independent reflexivisation, we are unable to associate one and only one reflexive form with non-subject antecedent reflexivisation. The forms used vary from language to language, but the compound pronoun seems to be allowed in all of the languages that we have been examining.

1.2.2.3. Long Distance Reflexivisation

In many Germanic languages, there are instances where a reflexive can be bound by an antecedent which is not locally available (ie. within the same clause as the reflexive). The circumstances that permit long distance reflexivisation are very language dependent. However, it seems that long distance reflexivisation is optional — a personal pronoun with the same antecedent can be used in lieu of a long distance reflexive. The study of long distance reflexives has centred on Icelandic (Thrainsson 1976, Maling 1984b), but it appears that these reflexives are also present in Norwegian (Hellan forthcoming) as we shall shortly see.
The long distance reflexive in Icelandic is found in sentences containing tensed subjunctive clause complements. If the subordinate clauses are in the indicative tense, then the distribution of the reflexive is the same as that in English — the reflexive is prohibited and the personal pronoun is required.

(1.26) Jón veit að María elskar ham / *sig.
Jón knows that María loves(I) him / *REFL

Elskar is the indicative form of loves as indicated by (I) in the translation. If the main clause introduces a subjunctive complement, then the reflexive can take the subject of the main clause as its antecedent, as well as the subject of any intermediate clause. Consider the following examples from Thrainsson (1976).

(1.27) Jón segir að María elski ham / sig.
Jón says(I) that Mary loves(S) him / REFL

(1.28) Jón segir að María telji að Haraldur vilji að Billi heimsækj sig.
Jón says(I) that María believes(S) that Harold wants(S) that Billy visits(S) REFL

Even though the reflexive is contained in the most deeply embedded clause in (1.28), the subject of the main clause can act as its antecedent. All of the verbs in the subordinate clauses are in the subjunctive mood, as indicated by (S) in the translations. The sentence given in (1.28) is ambiguous, since sig can also take the subject of any intermediate clause as its antecedent. In constructions involving long distance reflexivisation, it is always the simple reflexive form of the pronoun that is used. The use of the compound reflexive results in an ungrammatical sentence.

(1.29) *Jón segir að María elski sjálfan sig.
Jón says(I) that Mary loves(S) self-REFL

In Norwegian, infinitival complements seem to behave much like the Icelandic subjunctive complements with respect to long distance reflexivisation; a simple reflexive contained in such a complement can have the subject of the main clause as its antecedent (Hellan forthcoming:§2.3).

(1.30) Jon bad oss snakke om ham / seg / *seg selv.
Jon asked us talk about him / REFL / *REFL self
‘Jon asked us to talk about him.’

Jon and the reflexive are not in the same clause, yet there is an anaphoric relationship between them. The personal pronoun ham can also be used in place of the reflexive. Unlike seg, seg selv cannot act as a long distance reflexive; it must be bound locally.
Sigurdsson (1986) and Kuno (1987) give arguments for viewing long distance reflexives as a type of logophoric pronoun. Logophoric pronouns are used to refer to "the individual (other than the speaker) whose speech, thoughts, feelings, or general state of consciousness are reported or reflected in the linguistic context in which the pronoun occurs" (Clements 1975, p.141). We shall defer our discussion of logophoricity until chapter seven when we will examine the constraints on long distance reflexives and the relationship between logophoricity and long distance reflexives.

Long distance reflexivisation is also present in non-Germanic languages like Italian, French and Japanese.

(1.31) La signora ha lasciato che io restassi ancora presso di sé.  
(1.32) On regrette toujours que les gens disent du mal de soi.  
(1.33) Bill wa John ni [Mary ga zibun o nikundeiru] koto o hanasita.

While the presence of long distance reflexivisation is related to the presence of a subjunctive mood in French and Italian, this is not the case for Japanese. It should be noted that many native Italian speakers do not find constructions like (1.31) grammatical. Furthermore, long distance reflexives in French seem to be restricted to cases where the impersonal pronoun is used. We will not be examining non-Germanic languages in our study.

Although most languages do not freely allow long distance reflexivisation, there is a group of constructions in which the appearance of the reflexive could be classified as belonging to the long distance variety. The postulation of this class of reflexives would resolve a lot of confusion associated with reflexives and certain locative prepositional phrases. Prepositional phrases will be examined in detail in § 5.4, but here we will consider a locative prepositional phrase in which either a simple reflexive or a personal pronoun can take the subject as antecedent.

(1.34) Jon sparket ballen bort fra ?ham / seg.
(1.35) Hún ýtti mér frá *henni / sér.

'She pushed me away from her.'
In Norwegian, the use of the simple reflexive is "slightly preferred" and seems to be tied to the action being associated with the antecedent's "own experience or intention," (Hellan forthcoming, p.3.28). Unlike this logophoric use of the reflexive, the personal pronoun is used in non-logophoric contexts. This behaviour is characteristic of long distance reflexives. Note that in (1.35), the personal pronoun is not allowed, perhaps due to the unavailability of a non-logophoric reading in Icelandic. So in certain contexts, reflexives in prepositional phrases might act as long distance reflexives; the prepositional phrase would block locally bound reflexivisation just as clauses normally do. In § 5.4, we shall see that in English the choice of verb appearing with a locative prepositional phrase is responsible for determining whether a locally bound reflexive is allowed within the prepositional phrase. Verbs that appear with either type of prepositional phrase have different meanings depending on the type of prepositional phrase.

It appears that long distance reflexives are not entirely in free variation with personal pronouns as illustrated by the Icelandic sentence shown below.

(1.36) Haraldur skipaði mér að raka *hann / sig.
Haraldur ordered me to shave *him / REFL
'Harold ordered me to shave him.'

This structure seems to possess the same anaphoric properties as a single clause, prohibiting the appearance of anything but a reflexive pronoun. Perhaps infinitival boundaries do not prevent locally bound reflexivisation in Icelandic. If this were the case then sig would be a locally bound reflexive in (1.36). In cases of locally bound reflexivisation, we have proposed that the reflexive cannot be replaced by a personal pronoun with the same intended antecedent; hann is disallowed. However, this would predict that hann should also be disallowed in sentences containing multiple infinitival complements. This prediction is not valid as illustrated in (1.37) (Thrairinsson, pers.com.).

(1.37) Jón skipaði mér að skipa Mariú að raka hann / sig.
Jón ordered me to order Mariú to shave him / REFL
'Jon ordered me to order Mary to shave him.'

An alternative explanation would involve sig acting as a long distance reflexive in both (1.36) and (1.37) but with hann being disallowed in (1.36) owing to the unavailability of a non-logophoric reading.

In sum, long distance reflexivisation in Norwegian and Icelandic is to some degree optional, and only subjects are allowed as antecedents for long distance reflexives. It appears to be closely tied to the notion of logophoricity. For Germanic languages that do allow long distance reflexivisation, it is the simple reflexive form that is always associated
with this class of reflexivisation.

1.2.2.4. Stress Reflexives

For many of the sentences introduced in this chapter, the use of the compound pronoun is generally ungrammatical except in certain contexts where the reflexive receives contrastive stress. The cases where the stressed reflexive is grammatical are called stress reflexivisation. Like long distance reflexives, the antecedents for stress reflexives do not have to be locally available and the stress reflexive can usually be replaced with a personal pronoun having the same antecedent. It is the compound pronoun form of the reflexive that is associated with stress reflexivisation. When used as a stress reflexive, the compound pronoun must receive contrastive stress in speech (as indicated by the stress marker ' in (1.38)).

(1.38) John didn't want me to talk about his brother, he wanted me to talk about himself.

If this reflexive is unemphasised in speech, then its use is usually ungrammatical. In normal contexts, the personal pronoun is used. The following sentence (1.39) from Hellan (1986:2a) illustrates a stress reflexive in Norwegian.

(1.39) Jon ville at jeg skulle snakke om ham selv.
Jon wanted that I should speak about him-self
‘Jon wanted that I should speak about him himself.’

In order for this sentence to be grammatical when spoken, selv must be stressed more than it would normally be. Although we will not be analysing stress reflexives in this thesis, Kuno (1987) uses the notion of logophoricity to account for their distribution. So like long distance reflexivisation, logophoricity influences this type of reflexivisation.

1.2.2.5. Emphatic Reflexives

Finally, there is a type of reflexivisation which is reserved for emphasising noun phrases and resolving ambiguity. Unlike anaphoric reflexives which are arguments of verbs and prepositional phrases, emphatic reflexives act as modifiers or intensifiers. The self-reflexive form is generally used to obtain this type of reflexivisation.

(1.40) Jon selv hadde blitt syk. (Hellan 1986:2c)
Jon self had become ill
‘Jon himself had become ill.’

(1.41) Jan zelf is ziek geworden.
Jan self is sick become
In English, the compound pronoun is used instead.

(1.43) John **himself** had become ill.

These reflexives have the property that when they are omitted from a sentence, the resulting sentence is still grammatical. Furthermore, they can appear in various locations in the sentence, not just next to the noun phrase that they are related to. This is illustrated in the following Icelandic examples.

(1.44) Jón **hafði sjálfur orðið veikur.**
Jon had self become ill
‘Jon had himself become ill.’

(1.45) Jón hafði orðið veikur sjálfur.
Jon had become ill self
‘Jon had become ill himself.’

Some restrictions on English emphatic reflexivisation are examined by Edmondson and Plank (1978) and Verheijen (1986). As with stress reflexives, an account of the distribution of emphatic reflexives is beyond the scope of this thesis.

1.2.3. Analysis

Now that we have seen various forms of reflexives and classes of reflexivisation, let us return to the question about what we mean by the term reflexive. Broadly speaking, reflexivisation is a term for describing specific emphatic phenomena, short range anaphoric phenomena, and long range logophoric-anaphoric phenomena. Specific forms of reflexive pronouns are associated with the various classes and subclasses of reflexivisation.

The different aspects of reflexivisation are summarised in Figure 1.2 which includes the criteria by which a given instance of a reflexive pronoun can be classified. If the reflexive is an intensifier which can be deleted to leave a grammatical sentence then it is an emphatic reflexive, otherwise it must be a noun phrase involved in anaphoric reflexivisation (reflexive anaphora). If the antecedent of the reflexive is locally available and if reflexivisation is obligatory (ie. if one cannot use a personal pronoun with the same antecedent in lieu of the reflexive) then we have locally bound reflexive anaphora. A reflexive pronoun which may have a non-local antecedent corresponding to some logophoric entity is a non-locally bound reflexive. Generally, a non-locally bound reflexive can be replaced with a non-reflexive pronoun without affecting the grammaticality of the sentence — long distance reflexivisation is optional. If the non-locally bound reflexive
Figure 1.2. Criteria for a Classification for Reflexives
takes a subject antecedent and is not stressed, then it is realised with a simple reflexive form and we have long distance reflexivisation. Otherwise, the reflexive must be a stressed compound pronoun form of the reflexive. English does not have a reflexive form which is associated with long distance reflexivisation, but it does have a stressed compound pronoun. Locally bound reflexivisation is composed of two classes which differ according to whether or not the subject is used as the antecedent. Non-subject antecedent reflexivisation has the compound pronoun form associated with it. Some languages may use other forms in addition to the compound pronoun. Subject antecedent reflexivisation is subdivided on semantic criteria. Inherent reflexivisation is associated with an 'inherently reflexive' predicate and is realised with the simple reflexive form of the pronoun. In addition, the simple reflexive must be a syntactic argument of the verb (or a clitic). The reflexive involved in independent reflexivisation possesses a compound reflexive form and acts like an independent noun phrase; it is not required to be an argument of the verb.

Our classification highlights the different aspects of reflexivisation that are present in different languages. We have been interested in the question of how reflexives are the same from language to language, not how they are different from language to language. Unlike other classifications, we are not proposing a classification of various reflexive strategies (Faltz 1985) which state how reflexives are realised in a language. For instance, one reflexive strategy could require a locally bound reflexive to take the form of a suffix placed onto the verb, while another could require it to be a separate word.

Sells, Zaenen and Zec (1987) also propose a classification for reflexivisation but they restrict their discussion to cases of subject-antecedent reflexivisation where only the simple reflexive is used. They provide a detailed analysis of the simple reflexive form of various languages (not just Germanic). Since English does not have a simple reflexive form of the pronoun they use the English compound pronoun *himself* in their analyses. So their comparison is actually between a selected form of subject antecedent reflexive from a range of languages. They propose that languages can be characterised in terms of three parameters corresponding to the lexical, syntactic and semantic ‘transitivity’ of their subject antecedent reflexive. In brief, semantically *closed* reflexivisation acts as a predicate reduction operation while *open* reflexivisation does not. This is the same criteria on which our distinction between inherent and independent reflexives is based. Syntactically *analytic* reflexivisation has an independent noun phrase associated with a reflexive while *synthetic* does not (ie. non-clitic vs. clitic reflexive). Lexically *transitive* reflexivisation requires that the same form of verb be used in both reflexive and non-reflexive constructions, while *intransitive* reflexivisation does not. They choose a particular reflexive pronoun from a language and classify it in terms of these parameters. Languages are then classified on the
basis of the reflexive pronouns.

Similarly, Faltz (1985) investigates the different reflexive strategies used by languages and proposes three main groups: pronominal, compound and verbal. In our terminology, he is concerned with how a particular class of reflexivisation is realised in different languages. It is interesting to note that these groups can be defined in terms of the values of the syntactic and semantic transitivity parameters proposed by Sells, Zaenen and Zec as shown in (1.46).

(1.46) Faltz           Sells et.al.           sample language
                      pronominal       analytic, closed  Dutch, German
                      compound        analytic, open  English
                      verbal          synthetic, closed French
                      ?               synthetic, open   ?

Faltz does not propose a strategy that corresponds to a synthetic-open language. This is in accordance with a prediction by Sells, Zaenen and Zec which states that there should be no languages of this type.

Although our analysis of reflexive forms and classes provides us with a better understanding of what it means for a pronoun to be reflexive, as with any classification there are apparent exceptions. Unanswered questions include why the simple reflexive form is used for both inherent and long distance reflexivisation and why a compound pronoun is used for both non-subject antecedent and stress reflexivisation. We have also not looked at how the meaning of reflexive differs from class to class and from language to language. Having established this classification, we can now explicitly describe the types of reflexive phenomena that will be of interest to us in this thesis. We will primarily be interested in locally bound English reflexives and long distance Icelandic reflexives. The actual language specific restrictions associated with locally bound reflexives and long distance reflexives, in addition to the general restrictions outlined in this section, will be discussed in chapters two and seven respectively. There will also be occasions when we will find ourselves looking at this classification and at the reflexive forms of other languages in conjunction with issues arising concerning the distribution of English reflexive pronouns.

1.3. Unification

As we have already mentioned, we will be introducing a unification-based framework for describing reflexive anaphora. The notion of information is fundamental to an understanding of unification. Unification is an operation for combining information.
Given two information structures, applying the unification operation to the two structures will result in a single structure containing all the information present in both of the initial structures. Unification could be viewed as the union of information except for one important difference — the unification of two information structures containing incompatible information will fail. Let us now look at unification in more detail, elaborating on what we mean by information structures, incompatible information and unification failure.

When discussing unification, it is the attribute-value structure that is commonly used as an information structure (Johnson 1987). Such a structure consists of a set of attributes or features each of which has an associated value. The value for a particular feature may be atomic, it may be another attribute-value structure, or it may be unspecified. A common notation for representing attribute-value structures is the feature matrix (Kay 1979, Pollard and Sag 1987). Consider the feature matrix introduced in (1.47).

(1.47) RELATION: believe
BELIEVER: X
BELIEF:
RELATION: love
LOVER: X
LOVEE: Mary

The top level RELATION feature (attribute) possesses an atomic value believe, while the BELIEVER feature possesses an unspecified value which is represented by the presence of a variable, X. In general, we will use capital letters to represent variables. The BELIEF feature possesses a feature matrix as its value. This feature matrix possesses three features, two of which have atomic values and one which possesses an unspecified value X. Observe that X is the same variable which appears in the top level feature matrix. The BELIEVER and LOVER features share a common value (which is as of yet unspecified). With the use of variables, we are thus able to access information without knowing its actual content (ie. we can say that the same information is the value of two features without knowing what the information actually is). It is not only unspecified values that can be shared — atomic and feature matrix values can be shared as well.

Unification is an operation that is defined over two information structures (or over descriptions of information structures (Johnson 1987)). It combines the information in the two component structures to yield a more informative structure. It is probably best illustrated through an example. Consider the following simple feature matrix.
The unification of (1.48) with (1.47) will result in the following matrix.

(1.49) LOCATION: London
RELATION: believe
BELIEVER: John
BELIEF: RELATION: love
          LOVER: John
          LOVEE: Mary

This feature matrix is composed of the information contained in (1.47) plus the information contributed by (1.48), which is displayed in bold; the order of the features in the matrix is not relevant. The feature matrix from (1.48) contributed information about the LOCATION which was not present in (1.47). Moreover, it specified the value of BELIEVER to be John. Since BELIEVER and LOVER are required to share a common value, as specified in (1.47), John is also required to be the value of the LOVER relation in (1.49), as shown in italic.

An attempt to unify two matrices containing incompatible information will lead to unification failure. Consider the following two matrices.

(1.50) SYNTAX: verb
       NUMBER: singular
(1.51) SYNTAX: noun
       GENDER: masculine

Unification of (1.50) and (1.51) would fail since a SYNTAX value of noun is incompatible with the value verb. In general, any two distinct atomic values are incompatible. A value which is atomic is incompatible with a value which is a feature structure. A variable is compatible with anything. Two structures will unify if and only if none of their values are incompatible. A more detailed discussion of unification is presented in (Shieber 1986).

Attribute-value structures can also be described in terms of directed graphs and unification can be defined in terms of graph operations (Shieber 1986, Uszkoreit 1986). A graph consists of a set of nodes which are connected with edges. For each graph there is a specified starting node. In a directed graph the edges are directional; if an edge joins a node A to a node B, then that same edge does not join B to A. The edges of a directed graph can correspond to the attributes of an attribute-value structure with the nodes corresponding to values. For example, the graphs $\alpha$ and $\beta$ introduced in Figure 1.3 describe the same structures as the feature matrices introduced in (1.47) and (1.48)
Figure 1.3. Directed Acyclic Graphs

Figure 1.4. Graph Unification
respectively. The result of the graph unification of these two graphs, which is equivalent to the feature matrix from (1.49) is shown in Figure 1.4. Observe that shared values in a feature matrix correspond to shared nodes in a graph. Unspecified values correspond to nodes that do not have a value.

There is yet another popular type of notation for representing information and yet another way of viewing unification. Terms, consisting of a predicate symbol followed by a list of zero or more terms called arguments, can also be used to describe information structures (Colmerauer 1978, Clocksin and Mellish 1981). A variable is also defined to be a term. Term structures can be thought of as graph structures where each node in the graph has a fixed number of edges leading from it and where each feature has a fixed argument position associated with it. For instance, the two structures introduced in Figure 1.3 could be represented by the following two terms.

\begin{equation}
\text{(1.52)} \quad \text{matrix} \left( \text{believe}, \text{X}, \text{matrix} \left( \text{love}, \text{X}, \text{mary}, \text{Y} \right) \right)
\end{equation}

\begin{equation}
\text{(1.53)} \quad \text{matrix} \left( \text{A}, \text{john}, \text{B}, \text{london} \right)
\end{equation}

The four argument positions of the matrix term correspond to RELATION, BELIEVER, BELIEF and LOCATION. Information that was implicitly unspecified in the graphs and feature matrices must be explicitly unspecified in these terms by the introduction of variables like A and B in (1.53) and Y in (1.52). The result of the term unification of these two terms is shown in (1.54).

\begin{equation}
\text{(1.54)} \quad \text{matrix} \left( \text{believe}, \text{john}, \text{matrix} \left( \text{love}, \text{john}, \text{mary}, \text{london} \right) \right)
\end{equation}

One disadvantage of term unification is that you lose the information associated with the different edges of the graph (ie. the feature name). It is implicit in the argument position in the term and would require some sort of meta-specification which states what the different argument positions correspond to. One of the principle arguments in favour of term unification concerns the efficiency with which it can be processed by computer; the Prolog programming language is based on term unification (Clocksin and Mellish 1981).

Regardless of the type of information structures and the version of unification adopted, the fundamental principles remain the same. Unification provides a way of combining compatible information. Furthermore, unification is declarative since the order in which the information structures are combined does not affect the contents of the final information structure. For our needs, the relative merits of feature matrix unification vs. graph unification vs. term unification are not relevant.
1.4. Structure of the Thesis

In chapter two, various treatments of reflexivisation will be surveyed to determine the constraints that can account for the distribution of locally bound reflexive pronouns in English. Numerous constructions containing reflexives which have proved to be troublesome for different approaches will be outlined.

Chapter three will introduce a unification-based framework in which our constraints on reflexivisation can be incorporated. This framework, called Tree Unification Grammar (TUG), will possess partial specifications of trees as lexical entries and will require only a single grammar rule for combining these specifications. Each node in these trees will contain the phonology, syntactic, semantic and antecedent information associated with some linguistic expression.

The fourth chapter will contain a detailed description of TUG, looking at the information contained in the TUG lexical entries and examining how this information is manipulated by the single grammar rule. It will also illustrate how linguistic generalisations are captured in the lexicon of a tree unification grammar and how TUG differs from other unification-based frameworks.

In the fifth chapter, we will show how the distribution of reflexive pronouns in a wide range of troublesome constructions can be accounted for in terms of our general principles for reflexivisation and in terms of the structures associated with the different linguistic expressions. At the same time, proposals for unbounded dependencies and lexical control will be introduced.

Chapter six will consist of a comparison of our treatment of reflexives with that of other frameworks which share some of the features possessed by TUG.

In chapter seven, we will extend our approach to reflexive anaphora to include the long distance reflexive phenomena observed in Icelandic. As with the study of locally bound reflexives in chapter two, we shall look at proposed constraints concerning the distribution of long distance reflexivisation while examining various constructions in which it occurs. Then we will show how the various phenomena can be accounted for in TUG.

Finally, the eighth chapter will contain a summary of the contents of the thesis and will introduce areas that might lend themselves to further investigation. We will briefly look at quantifier scoping problems and at how our proposals could be extended to handle more general cases of pronominal anaphora.
Chapter 2
Locally Bound Reflexives

The approach to reflexives taken in this thesis considers English reflexive pronouns to be anaphoric in nature. Reflexivisation is not viewed as a lexical operation on verbs or as an explicit arity reducing operation, although such treatments might be appropriate for other languages, nor is it considered to be a purely syntactic relationship between categories. Like other pronouns, the meaning of a reflexive will be assumed to be dependent on the context or environment in which it appears.

As we have seen in the previous chapter, reflexive anaphora can be divided into several classes. It is an account of locally bound reflexive anaphora that will be of interest to us here. Later we will be looking at long distance reflexives in some detail (chapter 7). Before we can propose a grammar which describes the distribution of locally bound reflexive pronouns in English we must first identify the precise restrictions that are associated with these pronouns, and also determine the nature of the anaphoric relationship that holds between a reflexive and its antecedent. In this chapter, various proposed restrictions on reflexivisation will be examined and data will be introduced in order to determine the accuracy of these proposals. Different views of the anaphoric relationship will also be examined, again being considered in light of various linguistic data.

2.1. Restrictions

As suggested by the term *locally bound reflexives*, it is the notion of locality that distinguishes this class of reflexives from other reflexives and from other pronouns. There have been various proposals in numerous linguistic frameworks describing what it means for a reflexive to be locally bound. We shall examine some of these proposals, considering linguistic data that was involved in their motivation as well as looking at data that appears to be troublesome.

2.1.1. Locality Constraints

The first thorough account of reflexivisation in a generative grammar was provided by Lees and Klima (1963). Within a transformational grammar framework, they viewed reflexivisation as a transformation which would replace the second of two identical nominals with the appropriate reflexive pronoun as long as a locality condition associated with the transformation was satisfied. This condition required the two nominals to be from the same simplex sentence. So reflexives, which were not present in the deep structure, were introduced by a transformation of the form shown in (2.1).
(2.1) \[ X \cdot nom_1 \cdot Y \cdot nom_2 \cdot Z \Rightarrow X \cdot nom_1 \cdot Y \cdot nom_2 + \text{self} \cdot Z \]

conditions: 
- \( nom_1 \) and \( nom_2 \) are identical 
- \( nom_1 \) and \( nom_2 \) are from the same simplex sentence

In later formulations of this transformation (Postal 1966), the vague term nominal was replaced with the more specific description noun phrase, and the transformation resulted in a reflexive feature being placed on the second noun phrase. As might be expected, there was disagreement on what constituted a simplex sentence, as well as on what it meant for two nominals or noun phrases to be identical. There was also no clear consensus on whether reflexivisation should be optional or compulsory. Similar to the reflexive transformation was pronominalisation, which could replace the second of two identical noun phrases with a pronoun.

As an example, consider the transformational history of the sentence *Mary loves herself*. The simplex sentence corresponding to the deep structure of this sentence is *Mary-loves-Mary*. Application of the reflexive transformation (2.1) under an analysis where \( X \) and \( Z \) are empty, \( nom_1 = \text{Mary} \), \( Y = \text{loves} \) and \( nom_2 = \text{Mary} \) is successful since \( nom_1 \) and \( nom_2 \) are identical nominals from the same simplex sentence. The result of this transformation is shown in (2.2).

(2.2) Mary - loves - Mary -self

What were known as morphophonemic rules were said to be responsible for converting this sequence into the final sentence.

A sentence like *Mary persuaded John to kiss himself* was viewed as being composed of two simplex sentences. The subordinate simplex sentence is shown in brackets in (2.3).

(2.3) Mary - persuaded - John - ( for - John - to - kiss - John )

Reflexivisation would apply to the subordinate simplex sentence from which the expression *for-John* would later be deleted. In this way, the reflexive and its antecedent were from the same simplex sentence. A similar explanation accounted for the ungrammaticality of sentences like *John said that Mary loved himself*.

The distribution of reflexives in possessive constructions was accounted for by treating the possessive determiner as a post-nominal modifier. Thus, the deep structure for the sentence *Mary's father loves her* would consist of the two simplex sentences *Mary has a father* and *The father loves Mary*. Since the two *Mary's* in this example are from different simplex sentences, reflexivisation cannot apply but pronominalisation can. After
application of the pronominalisation transformation, another morphophonemic rule would be responsible for obtaining the final sentence.

Unfortunately, this treatment of post-nominal modifiers caused problems for reflexives contained in so-called ‘picture-noun’ constructions, as illustrated by the sentence John found a picture of himself. This sentence was generally viewed as being composed of the simplex sentence John found a picture, along with the simplex sentence corresponding to the post-nominal modifier, The picture is of John. Since the two John’s are in different simplex sentences, reflexivisation should not be allowed — but it is! If nominal modifiers are instead considered to be part of the same simplex sentence as the nominal which they modify, then we get the correct behaviour for reflexives in picture-nouns. Unfortunately, this will also allow reflexives in possessive constructions, as exemplified in the ungrammatical sentence Mary’s father loves herself.

A proposal which resulted in a consistent treatment for both possessive and picture-noun constructions was presented by Jackendoff (1972). The problem was overcome by allowing transformations to apply not only to sentences, but also to complex noun phrases (those containing complement structure). While the transformational account advocated by Lees and Klima was characterised by the lack of a reflexive in the deep structure of a sentence, the proposal by Jackendoff (1972) advocated a deep structure reflexive. In an attempt to remove some of the power from the transformation, coreference (or noncoreference) of noun phrases was not determined at the point of transformation application but rather by a selection of semantic interpretation rules. These rules required the reflexive and its antecedent to be within the same minimal sentence or complex noun phrase.

Consider the sentence Mary found John’s picture of himself. The syntactic structure of this sentence is shown in Figure 2.1. The reflexive is required to take the noun phrase acting as the determiner of the complex noun phrase, which is shown in bold, as its antecedent. If the sentence were John found Mary’s picture of himself then Mary could not be the antecedent of the reflexive, due to a gender conflict, nor could John be the antecedent, due to a locality violation. The sentence would not be grammatical.

A sentence like John found a picture of himself does not have a noun phrase in the determiner position of the object noun phrase, as illustrated in Figure 2.2. In this case, the noun phrase is not deemed to be a complex noun phrase acting as a boundary for local reflexivisation. The reflexive can take the subject of the sentence as its antecedent — reflexivisation can apply to the two coindexed noun phrases.
Figure 2.1. Syntactic Structure of Sentence Containing Possessive and Picture-Noun

Figure 2.2. Syntactic Structure of Sentence Containing Picture-Noun
Adopting the 'clause mate' locality condition proposed by Jackendoff would lead one to conclude that reflexives should appear in locative adjuncts. But in the sentence *John saw a snake near him*, the locative PP is within the same clause as the antecedent of the pronoun, yet a personal pronoun is generally preferred over a reflexive. Jackendoff concedes that his proposals were not intended to cover these cases.

2.1.2. Thematic Constraints

Aside from the locality restriction on locally bound reflexives, Jackendoff also proposed a restriction based on the thematic roles of the reflexive and its antecedent. This restriction relied on the thematic hierarchy shown in (2.4).

(2.4) Agent
Location, Source, Goal
Theme

It stated that the thematic role of the reflexive should not be higher in this hierarchy than that of its antecedent. Consider the sentence *John was killed by himself*. The reflexive takes on the role of agent, while the subject is the theme. So the unacceptability of this sentence can be explained in terms of a violation of the thematic hierarchy constraint (THC). Similarly, the sentence shown in (2.5), where the reflexive and its intended antecedent are displayed in bold, violates this constraint while the sentence provided in (2.6) does not.

(2.5) *John talked about Bill to himself.*
(2.6) John talked to Bill about himself.

In the first sentence, the reflexive is the goal while *Bill* is the theme. The second sentence has *Bill* as the goal and the reflexive as the theme. Jackendoff notes, however, that the violation of the THC need not result in an ungrammatical sentence as illustrated by (2.7).

(2.7) John sold the *slave* to himself.

In this sentence, *the slave* is the theme and the reflexive is the goal; the THC is violated yet the sentence is grammatical. It is argued that sentences which do not conform to this constraint are "not fully grammatical," (Jackendoff 1972, p.148).

Hellan (forthcoming) uses a thematic hierarchy as the basis for his role-command constraint on reflexivisation. Role-command is essentially a restatement of the THC except that it applies between the role of the antecedent and the role of *the phrase containing* the reflexive. However, it is subject to various restrictions which do not make it applicable in
all instances of reflexivisation. So although the thematic role seems to influence the
distribution of reflexives, a restriction like the THC does not appear to be universal. There
must be some other constraint in addition to (or in lieu of) the THC.

2.1.3. 'Command' Constraints

Another constraint on the distribution of reflexive pronouns can be stated in terms of
a c-command relation that holds between antecedent and anaphor in syntactic structure
(Reinhart 1981). It is proposed that a reflexive must be c-commanded by its antecedent.
For two nodes A and B of a syntactic structure, A c-commands B if and only if the first
branching node properly dominating A dominates B. This is actually a simplified version
of the c-command relation; a more complex definition is supplied in Reinhart (1983). By
definition, a node can dominate itself but it cannot properly dominate itself. Examples of
c-command can best be illustrated with the use of Figure 2.3 which is from (Reinhart
1981:26). Node b c-commands only itself, B and e, while B c-commands all of the nodes
in the tree. Each of c and C also c-commands all of the nodes of the tree. Although the
notion of c-command appears to be applicable to a wide variety of anaphoric phenomena,
there are some cases where, given the standard assumptions about constituent structure, the
locally bound reflexive is not c-commanded by its antecedent. This is illustrated in Figure
2.4. The NP associated with Mary only c-commands itself and the preposition; the
reflexive is not c-commanded by its antecedent.

While the c-command restriction is usually associated with syntactic structures, there
are semantic-based alternatives that appear to capture this ordering restriction more
adequately. Williams (1980) proposes a constraint between a reflexive and its antecedent
which is described in terms of a c-command relationship that applies to a level of
representation known as predicate structure. Hellan (forthcoming) advocates a similar level
of representation (P-structure) along with a similar relationship which he calls predication-
command. Chierchia (1988) describes an F-command relation which applies to function-
argument structure.

All of these relations have much in common with a proposal of Keenan (1974) in
which it is suggested that the reference of a function can depend on the reference of its
argument, but an argument cannot obtain its reference from its functor. With respect to
anaphora, Keenan proposes that for a functor taking a pronoun as its argument, a noun
phrase contained in the functor cannot be the antecedent of the pronoun. However, he
states that an argument noun phrase can “usually’’ be the antecedent for a pronoun
contained in a functor over the noun phrase. To illustrate these relations, let us look at the
simple sentence John loves himself. Semantically, the translation of loves himself can be
Figure 2.3. C-Command

Figure 2.4. Phrase Structure of Sentence with Non-Subject Antecedent

Figure 2.5. Predication Structure of Simple Sentence

Figure 2.6. Predication Structure of Simple Predicate
viewed as a predicate, or function, which applies to the translation of John. This predicate itself is composed of the predicate love’ applying to the translation of himself.

(2.8)  (love’ (himself’)) (John’)

In (2.8), a word followed by a prime denotes the semantic translation of that word. The predication structure of such a formula is more easily observable if it is displayed as a tree structure like the one shown in Figure 2.5. Observe that the antecedent, $A_2$, c-commands the anaphor, $A_1$; the first branching node properly dominating John’ also dominates himself’. In Keenan’s terms, $A_2$ is the antecedent for the pronoun $A_1$ which is contained inside the functor $P_2$ over $A_2$. Since we are using predication structures, we will refer to this c-command relationship as *predicate command*. Adapting the *command* relation discussed by Langacker (1969), we will also require that for a node $\alpha$ to predicate command $\beta$, neither $\alpha$ nor $\beta$ can dominate the other. Now consider the ungrammatical sentence *Himself loves John*, which could be translated as shown in (2.9).

(2.9)  (love’ (John’)) (himself’)

In the associated predication structure, the antecedent would not predicate command the reflexive; the antecedent for the reflexive is contained in a functor over the reflexive. Consequently, an anaphoric relationship between John and the reflexive pronoun is not allowed.

Williams’ (1980) predicate structure consists of a syntactic surface structure in which the nodes corresponding to a predicate and its argument are coindexed. In predicate structure, a predicate must be c-commanded by its coindexed argument. This coindexing can be used to establish an anaphoric relationship between a reflexive and its antecedent. We shall talk more about coindexing when discussing the relationship between the reflexive and its antecedent (§2.2). It is proposed that a reflexive will be assigned the same index as the predicate in which it is contained. This means that a reflexive will be coindexed with its antecedent, which will be the argument of the predicate containing the reflexive.

Hellan (forthcoming) notes that his P-structure may actually be a more explicit formulation of Williams’-view of predication. Rules are used to induce P-structures from syntactic structures. In these structures, implicit arguments (or subjects) of predicates are explicitly represented. Predication-command is only one of the *command* relations that he uses to account for the distribution of reflexive pronouns. It interacts with the syntactic *c-command* relation and the thematic *role-command* restriction.
The F-command relation introduced by Chierchia (1988) into a categorial grammar framework is essentially the same as predicate command. It is the only command relation required for describing anaphoric relationships; an antecedent is required to F-command its anaphor. F-command is a c-command relation which is defined relative to the function-argument structure obtained during a categorial grammar derivation.

These semantic-oriented 'command' relations are closely related to a restriction requiring the antecedent of the reflexive to be a less oblique semantic argument of the verb than the reflexive (Pollard 1984). Depending on the type of semantic structure used, this restriction could be equivalent to predicate-command. For example, a verb like give with three semantic arguments, whose semantic structure could be (((give' arg3) arg2) arg1), could have a predication structure as illustrated in Figure 2.6. Unfortunately, the 'less oblique argument' restriction becomes more complicated when the reflexive is not an argument of the verb, but is embedded in an argument of a verb as illustrated in the sentence John gave Mary a book about a picture of herself. For this reason, a variation of predicate command seems to be preferable.

2.1.4. A Semantic Locality Constraint

Although predicate command describes directional dependencies, it can not account for all of the restrictions governing the distribution of locally bound reflexives. Just as the syntactic c-command relation needs to be used in conjunction with a locality restriction (eg. the syntactic 'clause mate' restriction), so does predicate command. Consider the following ungrammatical sentence.

(2.10) *John believes that Mary loves himself.

A predication structure for this sentence is introduced in Figure 2.7. Observe that the reflexive is predicate commanded by John' yet the sentence is ungrammatical. Instead of proposing a syntactic locality condition based on clauses, we can use a semantic locality restriction. Such a restriction, which is proposed in Pollard and Sag (1983), also makes use of the notion of predicates. The restriction states that anaphoric 'information' cannot pass through categories of a generalised predicative type. That is, for the nodes associated with a reflexive R and its antecedent A in a predication structure, if F is the node associated with the functor over A then any generalised predicative node that dominates R must also dominate F. A generalised predicative takes an NP denotation as its argument, and returns either an NP denotation or a 'proposition.' Adopting the notation used in (Dowty, Wall and Peters 1981), the semantic type of a functor that takes expressions of semantic type \( \alpha \) as arguments to produce resulting expressions of type \( \beta \) is \( \langle \alpha, \beta \rangle \). This
Figure 2.7. Predication Structure for Sentence with Sentential Complement

Figure 2.8. Predication Structure for Sentence with Picture-Noun

Figure 2.9. Predication Structure for Sentence with Possessive
means that the semantic type of a generalised predicative is either \(<\text{NP}',\text{NP}'\rangle\) or \(<\text{NP}',\text{S}'\rangle\), where \(\text{NP}'\) and \(\text{S}'\) are the semantic types associated with noun phrases and sentences respectively. Conventional categories that are associated with generalised predicatives include verb phrases and possessed nominals.

Verb phrases are considered to be generalised predicatives, since they are functors which take noun phrase denotations to produce propositions — their semantic type is \(<\text{NP}',\text{S}'\rangle\). Let us return to the example introduced in Figure 2.7. The semantic types associated with the different predicates and arguments are displayed in italics next to their corresponding nodes; generalised predicative types are displayed in bold. The nodes \(A\) and \(C\) in this example correspond to generalised predicatives. An anaphoric relationship between \(\text{John}\) and \(\text{himself}\) is prohibited since there is a generalised predicative node \((A)\) which dominates \(\text{himself}\) but does not dominate the node \(C\) corresponding to the functor over \(\text{John}\).

Reflexivisation is allowed in picture-noun constructions since the generalised predicative restriction is not violated. Consider the predication structure for the sentence \(\text{John loves a picture of himself}\) which is introduced in Figure 2.8. We have assumed that picture-nouns act as predicates taking their modifiers as arguments. No matter how the picture-noun itself is structured (ie. whether it be \(\text{picture-of (himself')}, \text{picture' (of-himself')}\) or even \(\text{of-himself' (picture')}\), the node labelled \(A\) will not be a generalised predicative. Treating the indefinite article as a functor over common nouns, which is how it is commonly treated (Dowty, Wall and Peters 1981), means that \(B\) is not a generalised predicative either. So with \(C\) being the only generalised predicative, an anaphoric relationship between the reflexive and the subject noun phrase is allowed — \(C\) dominates \(\text{himself}\) and the node \(C\) associated with the functor over the antecedent.

Let us now consider the semantic structure of possessive constructions. The treatment of possessives presented here is inspired by a proposal by Pollard and Sag (1983) which was based on an approach described in (Keenan and Faltz 1978). Relative to semantic structure, it is suggested that possessed nominals take their possessors as arguments. In terms of traditional phrase structure, the translation of the N-bar is applied to the translation of the genitive noun phrase. For instance, the phrase \(\text{Mary's picture}\) would be translated as \(\text{picture'}(\text{Mary'})\); the possessed nominal \(\text{picture}\) would be of a generalised predicate type \(<\text{NP}',\text{NP}'\rangle\). The consequence of this approach is that reflexives contained in a noun phrase with a possessive determiner, as in \(\text{Mary's picture of herself}\), cannot have their antecedents outside of the noun phrase. So for example, the ungrammatical sentence \(\text{John loves Mary's picture of himself}\) would have the predication structure shown in Figure...
2.9. The translation of Mary's would be an argument of the predicate associated with the nominal picture of himself. Since node $A$ is associated with a generalised predicative, John cannot act as the antecedent for the reflexive.

2.2. Relationship between Anaphor and Antecedent

So far, we have been concentrating on the syntactic and semantic constraints that govern the distribution of locally bound reflexive pronouns. Just as important as determining when a reflexive and its antecedent are related is determining how they are related. Let us now turn to the examination of the relationship between reflexives and their antecedents.

Recall that Lees and Klima (1963) stated that reflexivisation would apply to two nominals that were identical in the deep structure of a sentence, with the latter nominal being replaced by a reflexive pronoun. Since the reflexive and its antecedent were identical in the deep structure, and since it was the deep structure of the sentence that was responsible for semantic interpretation, one might then assume that the reflexive and its antecedent had the same meaning. The trouble with such a view of reflexives is illustrated in sentence pairs like the following (Geach 1962, §80-84).

(2.11) Only Satan pities himself.
(2.12) Only Satan pities Satan.

These two sentences do not mean the same thing. The first sentence means that Satan is the only self-pitying individual, while the second means that no one pities Satan other than Satan.

A solution to this problem involved the introduction of referential indices on noun phrases (Chomsky 1965, Postal 1966). Reflexivisation was only allowed to apply to coindexed noun phrases. By associating different indices with the two occurrences of Satan in (2.12), reflexivisation was blocked. The deep structures (and meanings) of (2.11) and (2.12) were different.

Helke's (1979) approach to reflexivisation relied on some form of coreference between anaphor and antecedent but it did not require the reflexive and its antecedent to have the same meaning. Adopting the Fregean view of meaning, he proposed that the reflexive and antecedent may have a different sense, but he claimed that "it is nevertheless true that reflexives and their antecedents have the same reference,"

(1979, p.173). Since Helke did not examine universally quantified noun phrases in his analysis, he did not note that even a simple sentence like Every man loves himself would violate this claim.

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These early transformational accounts of reflexivisation were characterised by either identical or coindexed elements, corresponding to anaphor and antecedent, present in the syntactic structure. With the introduction of logical form (Chomsky 1975), an additional level of representation between syntactic structure and semantic interpretation, a much more elegant treatment of reflexivisation is available. An anaphoric relationship can be characterised by the coindexing of elements at this intermediate level. Structures used at this intermediate level, which are called logical forms (LFs), contain relationships required for the semantic interpretation of sentences. Elements coindexed in an LF can either be interpreted as coreferential, or can be interpreted so that one element acts as a variable bound by a specified quantifier. There are various restrictions on coindexing in LFs and on the mapping from syntactic structures to LFs (Higginbotham 1980). Unfortunately, a rigorous description of how semantic interpretations are determined from LF and from other levels of representation is lacking. Some issues concerning the semantic interpretation of LFs are discussed in (Higginbotham 1985).

An alternative proposal which also relies on a form of 'coindexing' within an additional level of representation appears within discourse representation theory (DRT) (Kamp 1981). Unlike the approaches that we have been looking at so far, DRT is not restricted to examining single sentences in isolation. Furthermore, it allows analyses of pronouns which do not fall into the classes of bound variable and coreferent anaphors. These E-type pronouns "have quantifier expressions as antecedents but they are not bound by those quantifiers," (Evans 1980, p.338). Examples of such pronouns can be found in so-called 'donkey sentences' which were first discussed by Geach (1962).

(2.13) If Pedro owns a donkey then he beats it.

The pronoun it in (2.13) seems to be neither coreferential with nor bound by its antecedent. In DRT, the intermediate level of representation between syntax and semantic interpretation consists of discourse representation structures (DRSs). Each structure contains discourse markers which are associated with expressions like noun phrases and nouns. These structures also contain a set of conditions on these markers and may contain subordinate DRSs which are joined by a special semantic connective. The anaphoric relationship between anaphor and antecedent can be represented by associating the same discourse marker with anaphor and antecedent (Kamp 1981) or equivalently by introducing an equality condition between discourse markers (Klein 1987b, van Eijck 1985). Since there is an explicit description of how DRSs can be embedded into models (Kamp 1981), the exact relationship between anaphora and antecedent can be determined.
To illustrate some DRSs, and to show how anaphora is expressed within them, consider the sentence *A man loves himself* and its associated DRS in Figure 2.10.

Indefinite noun phrases result in the introduction of a discourse marker into the current DRS plus they introduce a condition on that marker. So the noun phrase *a man* results in the introduction of the discourse marker $x$ in Figure 2.10 and the introduction of a condition $\text{man}(x)$ on that marker. The reflexive pronoun introduces a marker $y$ along with a condition requiring it to be the same as the antecedent $y=x$. The antecedent of a reflexive must correspond to some pre-existing discourse marker to which the reflexive has access. Departing from traditional approaches, we also have the pronoun introducing a condition requiring $y$ to be a masculine entity $\text{masc}(y)$ — we express the agreement exhibited between a pronoun and its antecedent explicitly in the DRS. Verbs introduce conditions relating the markers associated with their different arguments. In our example, the verb *love* introduces a condition between markers $x$ and $y$, namely $\text{love}(x,y)$. The meaning of the sentence is determined by embedding the DRS into a model, the details of which are described in (Kamp 1981). The DRS shown in Figure 2.10 would be interpreted so that both the $x$ and $y$ would denote the same individual in the model. If the sentence were instead *A woman loves himself*, then there would be no embedding for the DRS unless there were some model possessing an entity which satisfied both the conditions of being masculine and being a woman.

Let us now look at a more complicated example which contains a universal quantifier. For the sentence *Every man loves himself*, the presence of the universal quantifier results in the introduction of two subordinate DRSs connected by the semantic connective for implication as shown in Figure 2.11. The markers and conditions associated with the noun are placed into the first subordinate DRS, with those of the verb phrase being placed into the second. Such a DRS is interpreted by requiring all embeddings of the first DRS to be extendible to form an embedding for the second DRS. For the DRS shown in Figure 2.11, this means that for all entities $x$ in a model that satisfy the condition $\text{man}(x)$, there must be some entity $y$ in that model which is masculine, which $x$ loves, and which is the same as $x$. In first order logic, we can express this as the formula shown in (2.14) which can be simplified to yield (2.15).

$$
\forall x \ [ \text{man}(x) \rightarrow \exists y \ [ \text{love}(x,y) \land \text{masc}(y) \land x=y ] ]
$$

$$
\forall x \ [ \text{man}(x) \rightarrow \text{love}(x,x) ]
$$

In this way, we get the correct interpretation for universal quantification, and it results in the discourse marker for the reflexive being interpreted as a bound variable.
Figure 2.10. DRS for Simple Sentence

Figure 2.11. DRS for Sentence containing a Universal Quantifier

Figure 2.12. DRS using Cospecification for Sloppy/Strict Distinction

Figure 2.13. Predicate-DRSs for Sloppy/Strict Distinction
Although the treatment of pronouns in DRT handles bound pronouns, coreferential pronouns and E-type pronouns as discussed in (Kamp 1981), it is not capable of distinguishing between the sloppy and strict readings of the pronouns. Sloppy identity (Ross 1967, Keenan 1971, Dahl 1973, Reinhart 1983) with respect to reflexive pronouns is illustrated in (2.11) which is repeated as (2.16).

(2.16) Only Satan pities himself.

The sloppy reading entails that Satan is the only self-pitier, while the strict reading entails that no one else pities Satan. Viewed in another way, the sloppy reading corresponds to a bound variable interpretation of the reflexive while the strict reading appears to be coreferential. The distinction between sloppy and strict readings is often captured in predicate logic by associating two different formulae with the different interpretations for expressions like Satan pities himself as illustrated in (2.17) and (2.18).

(2.17) \( \lambda x \text{pity}'(x,x) (s) \)
(2.18) \( \lambda x \text{pity}'(x,s) (s) \)

The first formula captures the sloppy reading (i.e. self-pitying) by equating the two arguments of the pity' predicate. The second formula illustrates a strict reading where the second argument of the pity' predicate, which corresponds to the reflexive, is specified to be the constant s associated with Satan.

In order to incorporate the sloppy/strict distinction into DRT, Sells, Zaenen and Zec (1987) propose amending DRT with the inclusion of a cospecification condition which can apply between discourse markers. A sloppy reflexive pronoun and its antecedent have the same discourse marker associated with them, just like in traditional DRT (Kamp 1981). However, a strict reflexive pronoun introduces its own discourse marker and introduces a cospecification condition \( \beta \rightarrow \alpha \) between its own discourse marker \( \beta \) and that of its antecedent \( \alpha \). This condition is informally defined so that "relative to a true assignment for \( \alpha, \beta \) and \( \alpha \) pick out the same sets," (Sells, Zaenen and Zec 1987:202). In many respects, cospecification is similar to the equality condition described earlier. The subtle differences between equality and cospecification need not concern us here. The two DRSs that would correspond to (2.17) and (2.18) are shown in Figure 2.12.

An alternative suggested in Klein (1987b) incorporates the lambda calculus treatment of the sloppy/strict distinction illustrated in (2.17) and (2.18) into DRT. This requires the introduction of predicate DRSs and parameter markers. Roughly speaking, a predicate DRS contains a distinguished discourse marker called its parameter. Associated with the
predicate DRS is a predicate marker which can be thought of as the name of the predicate DRS. Predicate DRS formation can be viewed as lambda abstraction of a discourse marker out of a DRS, with predicate application equivalent to lambda conversion. Let us once again consider the sentence *Satan pities himself*. Two corresponding DRS containing predicate DRSs corresponding to sloppy and strict readings are introduced in Figure 2.13. The predicate DRS $P$ corresponds to the verb phrase, and $y$ is the parameter marker of $P$. Application of $P$ to $x$, $P(x)$, can be interpreted as replacing all instances of the parameter $y$ in $P$ with its argument $x$. A detailed semantics for the interpretation of predicate DRSs is supplied in (Klein 1987b). The first structure in Figure 2.13 shows the parameter $y$ being chosen as the antecedent of the reflexive, while the second DRS instead has the argument $x$ included in an identity condition with the marker of the reflexive. This allows a distinction to be made in the semantic structure corresponding to sloppy and strict readings without requiring the introduction of a cospecification relation. Sloppy reflexives and strict reflexives are treated in essentially the same way, unlike the approach taken by Sells, Zaenen and Zec. Both kinds of reflexives introduce equality conditions, they just differ in their choice of antecedents. However, this uniform treatment is at the cost of introducing a more complicated DRS.

2.3. Reflexives and Unification

As we have seen in § 2.1, semantic-based restrictions on locally bound reflexivisation can account for a wide range of data concerning the distribution of reflexives. When taken together with the generalised predicative restriction, the predicate command constraint can account for the distribution of reflexives without relying on syntactic properties like c-command and clause boundaries. It is these semantic-oriented restrictions that will form the basis for our treatment of reflexives in a unification-based framework.

The use of an intermediate level of representation, like DRT augmented with predicate DRSs, can be used to account for the various relations exhibited between anaphor and antecedent and does not require the inclusion of an additional relation in order to express the sloppy/strict distinction. In DRT, the anaphoric relationship between a pronoun and its antecedent is represented through an equality condition between their associated discourse markers. The most intuitive way to translate this relation into a unification-based framework is to express anaphora through the unification of the appropriate discourse markers. The discourse markers will be represented by *sorted* variables in the semantic notation. In chapter four, these sorted variables will be described in more detail. For now, it is worth noting that incompatibility between antecedent and anaphor can be represented by having variables of different sorts associated with them. Since unification of two
variables with incompatible sorts will fail, failure of anaphora resolution can be used as a constraint on the derivation of complex structures. For instance, if a feminine discourse marker were associated with the reflexive pronoun *herself*, and if the only possible antecedent for the anaphor had a masculine sorted variable associated with it, then unification (anaphora resolution) would fail and a complex structure would not be constructed. Agreement between reflexive and antecedent would be mediated through the sort of the variable, and not through the use of syntactic features.

We are now ready to introduce a unification-based grammar formalism into which these different constraints on reflexivisation can be incorporated. The basic grammar structures of our formalism will have much in common with the predication structures that we have been discussing in this chapter. Only a single grammar structure will be necessary in our formalism. After we have introduced the formalism and seen how our constraints on reflexivisation can be incorporated into it, we will be able to see how the constraints apply to a wider range of linguistic constructions.
Chapter 3
A Framework for Anaphora

There is a trend in unification-based grammar formalisms to use a single grammar structure to contain the phonological, syntactic and semantic information associated with a linguistic expression. Adopting the terminology used by Pollard (1985), which is based on a term introduced by de Saussure (1916), this grammar structure will be called a sign. Grammar rules, guided by the syntactic information contained in signs, are used to derive signs associated with complex expressions from those of the component expressions. The relationship between the component signs and the complex signs derived from grammar rule application can be expressed in derivational structures. These structures both explicitly illustrate relations that are implicit in the syntax of the signs and express relations that are present in the grammar rules.

Tree unification grammar (TUG) is a formalism which uses function-argument specifications (FA specifications) as its primary grammar structures. These specifications resemble partially specified derivational structures of sign-based formalisms like head-driven phrase structure grammar (HPSG) (Pollard and Sag 1987) and unification categorial grammar (UCG) (Zeevat, Klein and Calder 1987). TUG uses FA specifications as lexical entries and possesses a single grammar rule which combines these specifications to obtain a specification for the complex expression being analysed. The use of FA specifications allows generalisations that are often captured in grammar rules to be captured in the lexicon through the use of lexical rules and templates. The constraints on reflexivisation outlined in the previous chapter can be stated perspicuously in the lexicon without causing unnecessarily complicated lexical entries and without requiring the introduction of additional grammar rules.

In this chapter, a framework in which our constraints on reflexivisation can be incorporated will be introduced. After outlining the motivation for the development of this framework, we will provide an overview of how the TUG formalism is structured and of how reflexives are treated.

3.1. Motivation

It was mentioned earlier that we wanted to develop a lexical unification-based framework which was declarative, discourse oriented, and concerned with the semantics of an expression, not just the syntax. One pre-existing framework which appears to satisfy these criteria is UCG.
As described in (Zeevat, Klein and Calder 1987), UCG is a grammar formalism which combines some of the notions of categorial grammars with those of unification-based formalisms, like HPSG and PATR-II (Shieber et al. 1983). This framework will serve as a starting point for examining the grammar structures that will be needed in our framework. The phonological, syntactic and semantic information associated with complex expressions are built up by the unification of signs corresponding to the component expressions.

3.1.1. The Sign

Like HPSG, the fundamental construction used in UCG is the sign. A sign, which is associated with every linguistic expression, has attributes for phonology, category, semantics, and order. Signs are specified as shown in (3.1) and are often abbreviated as illustrated in (3.2).

\[
\begin{align*}
\text{(3.1) } & \text{phonology} \\
& \text{category} \\
& \text{semantics} \\
& \text{order}
\end{align*}
\]

\[
\text{(3.2) } \text{phonology: category: semantics: order}
\]

Signs may be underspecified. Through unification they may become increasingly specified by the merging of information. Incompatibility of information leads to unification failure. We shall see how this works after we have looked at the structure of the sign in greater detail.

The phonology attribute should represent a phonological specification of the linguistic expression associated with the sign. However, for our needs we will use a simple sequence of words (or morphemes) separated by hyphens. So the phonology of the sentence John loves Mary will be represented as John-loves-Mary.

The category structure of a sign is very similar to that used by categorial grammar. There are three primitive categories, namely sent, np, and noun. Complex categories are of the form A / B, where B is a sign and A is a category (either primitive or complex). For complex categories, B is often referred to as the active part of the category. A primitive category can possess a syntactic feature specification which is placed in square brackets after the category name. This is illustrated in the following category for a verb phrase.

\[
\text{(3.3) } \text{sent[fin]} / (W: \text{np[nom]}: X: \text{post})
\]

Intuitively, this category description means that the item is looking for a nominative noun
phrase in order to form a finite sentence. Capital letters are used to denote variables that are associated with unspecified values which will be instantiated during a derivation, as described in § 1.3.

The semantic representation uses a language called InL, which incorporates many of the features of DRT (Zeevat, Klein and Calder 1987, p.202). For now, it will suffice to note the following features of this language. First, InL variables are assigned sorts. A sort can be thought of as a collection of features based on factors like gender and number. Unification of variables of incompatible sorts will fail, thus providing a mechanism by which semantic information can restrict possible derivations. There are different sorts for events, states and objects. Variables of the object sort may be further specified with respect to gender (masculine, feminine, or neuter), and number (singular or plural). Since we are only interested in singular pronouns, the number sort can be ignored. Unsorted variables will be denoted by the letter $a$, events by $e$, states by $s$, and genderless objects by $x, y, z$. The letter $m$ will be used to represent variables corresponding to a masculine object, $f$ for feminine, and $n$ for neuter. Unique identifiers which will be used to distinguish variables will appear as numbers following the variable names (ie. $n1, m1, s2$). Unification of variables may lead to the further specification of the sort of the variable. For example, the unification of an 'object' variable with a 'feminine' variable will yield a variable of the feminine sort. An attempt to unify an 'object' variable with an 'event' variable will fail.

An InL formula is of the form $(a)\text{Condition}$ where Condition consists of a predicate name followed by its argument list. Each element of the argument list is either a variable (ie. discourse marker) or an InL formula. The variable $a$ preceding Condition is the index of the formula. An index corresponds to a discourse marker of conventional DRT. Semantic translations of linguistic expressions describing, or modifying, objects will possess an index of the appropriate sort for that object. For instance, the formula corresponding to the translation of the noun man will possess an index of the masculine singular sort. There is a similar relationship for states and events. There are two binary connectives, and and implies, which correspond to conjunction, and DRT implication respectively. Formulae containing these connectives are often displayed in infix notation, with and and implies being replaced by a comma and an arrow respectively. Implies will be abbreviated as impl. As an abbreviatory convention, the index preceding predicates which contain the index as their first argument will be omitted. Pairs of InL formulae and their abbreviations are shown in (3.4).
The interpretation of these semantic formulae will be discussed in §4.1.3. Further details about the InL language can be found in (Zeevat, Klein and Calder 1987).

The order attribute of a sign contains information which is used to determine the ordering of the phonology of components during rule application. If an argument possesses pre as its order, then the phonology of the functor must precede that of the argument in that of the result. The value post describes the opposite situation.

The various components of the sign are illustrated in the following two signs.

(3.5) Mary: np: mary(fl): _
(3.6) walks
    sent[fin] / (_:np[nom]:[x]S:post)
    [e1] [(x)S, walk(e1,x)]

The first sign specifies the expression with phonology Mary to be a noun phrase. The semantics of (3.5) is an abbreviation for [fl]mary(fl). It possesses a feminine variable fl as its index and has a condition requiring this variable to satisfy the predicate mary. There is no restriction on the order of (3.5) as indicated by the appearance of the 'don't care' variable _ in the order attribute. In (3.6), the syntax of the expression walks requires it to 'look for' a nominative noun phrase with order post. The semantics of (3.6) includes the as yet uninstantiated semantics, [x]S, of the nominative noun phrase argument. The index of this noun phrase appears as an argument of the walk predicate. The event variable el appears as the index of the semantics since walks denotes an event. This event is subject to the condition that it is the entity denoted by x who is walking.

3.1.2. Grammar Rules

Only two grammar rules are proposed in (Zeevat, Klein and Calder 1987). They are forward and backward functional application, the two rules in basic categorial grammar. Forward application creates a new sign called the result from a sign corresponding to the functor and one corresponding to the argument. The phonology of the result is obtained by concatenating the phonology of the functor to the left of that of the argument. For a functor of category A/B, recall that B is known as the active part of the category. During rule application, the active part of the functor is unified with an argument, which will have
order *pre*. The category of the result is $A$, and its semantics is that of the functor. Backward application works in the same manner, but the argument will have order *post* and the phonology of the result will be that of the argument followed by that of the functor. These rules can be represented in the following manner.

(3.7) $W_1 W_2: C: S: \_ \rightarrow W_1: C/(W_2: C_2; S_2; \text{pre}): S: \_ \quad W_2: C_2; S_2; \text{pre}

(3.8) $W_2 W_1: C: S: \_ \rightarrow W_2: C_2; S_2; \text{post}, \quad W_1: C/(W_2: C_2; S_2; \text{post}): S: \_

It should be noted that in unpublished work (Klein 1988) there is an alternative formulation of UCG in which only a single grammar rule is required; the sign does not contain an order attribute and the phonological information of the functor is the same as that of the result. We will be discussing the formulation of UCG which contains the two grammar rules shown above.

Now, consider the result of applying rule (3.8) to the two signs associated with *Mary* (3.5) and *walks* (3.6). Rule application can be broken up into two parts. First, the argument is unified with the active part of the functor, resulting in the following instantiation of the variables of the functor.

(3.9) walks

\begin{align*}
\text{sent[fin]} & \rightarrow (\text{Mary: np[nom]: [f1]mary(f1): post}) \\
[\text{e1}] [\text{[f1]mary(f1), [e1]walk(e1,f1)]}
\end{align*}

The variable $x$ in (3.6) is unified with $f1$ from (3.5) and $S$ is unified with *mary(f1)*. The result of rule application is the sign shown in (3.10).

(3.10) Mary-walks

\begin{align*}
\text{sent[fin]} & \\
[\text{e1}] [\text{[f1]mary(f1), [e1]walk(e1,f1)]}
\end{align*}

The semantic formulae in these signs have been left in their unabbreviated form in order to illustrate the unification process more clearly.

Notice that the grammar rules do not modify the structure of semantic attribute of a sign; the same variable $S$ corresponds to the semantics of the functor and that of the result in (3.7) and (3.8). Rule application builds up the semantics of an expression by instantiating unspecified components, like $S$ in the lexical entry for *walks* (3.6), that have been placed into the semantic structure.
3.1.3. Derivation Trees

Associated with every linguistic expression is a derivation tree which describes how the sign corresponding to the complete expression is derived from grammar rules operating over signs associated with lexical entries. The leaves of this binary tree are labelled with signs for individual words, the root is labelled by the sign for the complete expression, while the other non-terminal nodes are associated with intermediate expressions. Each nonterminal node is labelled with the result obtained by applying a grammar rule to the signs which are referred to by its two daughter nodes. The edges to the daughters of a nonterminal node are designated functor and argument depending on the role that the sign at the daughter node plays during grammar rule application. Nonterminal nodes are also labelled with the name of the grammar rule which relates its sign to those of its daughters.

As an example, the derivation tree provided in Figure 3.1 illustrates how backward functional application (BFA) (3.8) relates the signs for Mary (3.5) and walks (3.6) to the sign associated with Mary-walks (3.10). The functor edge of a nonterminal node is represented by a line darker than that of the argument edge. In this derivation tree, variables that are uninstantiated in the original functor and argument are instantiated as a result of rule application. For instance, although the order of the argument sign is unspecified in (3.5) it is instantiated as post in Figure 3.1 (since the lexical entry for the verb requires its argument to have order post). An alternative derivation tree structure, which is shown in Figure 3.2, could be obtained if the effects of unification are not propagated throughout the tree. By propagating the effects of unification throughout the tree, it can be easier to find information associated with a sub-expression. For instance, in Figure 3.1 the order attribute of the noun phrase can be determined by examining the order information of the sign associated with Mary. In Figure 3.2 the order information embedded in the category attribute of the functor would have to be examined.

Derivation trees provide a history of how grammar rules are applied to signs in order to obtain complex signs. These trees contain all of the information that is contained in the constituent signs plus they state how these signs are related to each other. The sign of the root of the derivation tree contains the phonological, the syntactic, and most importantly the semantic information of the entire linguistic expression. Since derivation trees contain all this information, why not work with these trees in the first place? Partial specifications of a complete derivation tree could be combined to yield an increasingly further specified derivation tree. In a way this is what normal rule application does. Rule application combines signs, which can be viewed as depth zero trees, and builds derivation trees as a side effect. A more general form of this operation would be to combine trees to yield trees
**Figure 3.1. Derivation Tree**

**Figure 3.2. Alternative Derivation Tree**

**Figure 3.3. Dependencies between Constituents**
directly.

The principle advantage of using partially specified derivation trees as lexical entries lies in the ease with which certain dependencies between different constituents can be described. Consider the general case in UCG where a functor is applied to an argument to produce a result. Each of these three constituents possesses its own set of features which describes the phonological, syntactic and semantic information associated with it (Bouma 1988). The relationship between these constituents is outlined in Figure 3.3. The information $F$ associated with the functor can be dependent on the information $G$ associated with the argument; the dependency relation is shown by the arc labelled $\psi$ in Figure 3.3. Such a dependency can be captured in the lexical entry for the functor since the functor contains the information associated with the argument in its own category name (as highlighted in italic in Figure 3.3). We have already seen an example of such a dependency in Figure 3.1 — the semantic information of the functor is dependent on that of the argument. While the dependency marked by $\psi$ can be captured in the lexicon in UCG, the dependency marked by $\rho$ must be captured by the grammar rule; the grammar rule must state how the information $F'$ associated with the result is obtained from that of the functor and that of the argument. If we adopt the premise that $F=F'$, then $\rho$ becomes an identity relation and there is no need for introducing additional-grammar rules to capture a more complicated relation $\rho$. Unfortunately, there are cases where the condition $F=F'$ does not apply. For instance, Bouma (1988) argues for the need of a $\text{lex}$ feature which would distinguish lexical elements from phrases; a lexical functor and its result would have different values for this feature ($+\text{lex}$ and $-\text{lex}$ respectively). Similarly, if one wanted to encode bar level information (Jackendoff 1977) into the different constituents then there would be numerous cases where the bar level of a functor and that of its argument would not be the same. Most importantly though, we will be able to provide a straightforward account of reflexivisation if we are not subject to the requirement that $F=F'$.

By using a derivation tree as a lexical entry, the dependencies corresponding to $\rho$ in Figure 3.3 are captured in the lexicon instead of in the grammar rules. For instance, the BFA grammar rule states that the phonology of the resulting constituent consists of the phonology of the argument followed by that of the functor. The lexical entry for walks (3.6) implicitly describes such a relationship through the presence of the $\text{post}$ feature. This feature is interpreted by the grammar rule, with the relation being explicitly represented in the result. If the derivation tree is used as a lexical entry, this relation is explicitly represented and the presence of a $\text{post}$ feature is actually not necessary. Furthermore, local relationships other than those corresponding to $\phi$ and $\rho$ can be captured explicitly in the lexical entry. For instance, the features associated with an argument can be dependent on
those of its functor and information associated with the result can be directly related to that
of the argument. One could even have a more long distance dependency, say between an
argument and a subconstituent of its functor, stated directly in the lexical entry.

Certain constructions requiring complex features and various grammar rules can be
described much more easily if the relations between constituents are represented explicitly
in the lexical entry. In UCG, for example, two rules are used to account for the different
relationships between the phonology of the functor, argument and result. What if,
independent from phonological properties, there were cases where the semantics of the
result needed to be different from that of the functor? So in some cases the grammar rules
would perform this new semantic operation while in other cases the usual unification of
result semantics with functor semantics would be performed. Suppose that, in certain
instances, the category of the result needed to be different than the non-active part of the
functor's category. Again, these possibilities would have to be reflected in modifications to
the grammar rules. If these two phonological, two semantic, and two categorial relations
were mutually independent, this would require a grammar with $2 \times 2 \times 2 = 8$ different
grammar rules. As we shall shortly see, our treatment of reflexivisation will require
information associated with the functor and result to be different, and we will see cases
where it would be beneficial for certain syntactic features associated with the functor to be
different than those associated with the result. In addition, we shall see cases where the
phonology of the functor can not only precede or follow that of the argument, but can be
wrapped around it. Incorporating all of these possibilities directly into the lexicon will
allow the presentation of a grammar that does not suffer from a proliferation of grammar
rules.

3.2. Alternative Grammatical Structures

We are now ready to introduce a grammar formalism in which trees, not signs, will
be subject to manipulation by grammar rules. Like derivation trees, these trees will have
their nodes labelled by signs. Unification will still be the basic operation of this
formalism, which will be called Tree Unification Grammar (TUG). In this section, we will
be providing a brief overview of TUG.

Although the grammar rules operate over trees in TUG, signs still have a role to play
in the organisation of information. The signs of TUG differ from those of UCG in several
respects. First, order information is not an explicit part of the TUG sign. The
subcategorisation information that is contained in the UCG sign is not present in the TUG
sign; it is represented in the tree structures of the framework instead. Finally, on a point
of terminology, the second attribute of the TUG sign is referred to as the syntax instead of
the category, since it contains more than just categorial information.

The grammar structure associated with every linguistic expression is a binary tree called a *function-argument specification* (FA specification). These specifications resemble derivation trees in many ways. Each node of this binary tree is labelled with a sign. Unlike derivation trees, the nonterminal nodes of an FA specification are not labelled with rule names. The root node possesses a sign corresponding to the complete expression, while the leaves are labelled with signs for the component words or morphemes. Each nonterminal node dominates a functor node and an argument node. The terms *functor-sign* and *argument-sign* will be used to refer to the signs associated with the functor and argument nodes respectively. Again, the functor and argument edges are distinguished in the various figures by the use of a darker line for edges leading to functor-signs. The left-to-right ordering of functor and argument edges is not relevant. As a convention, we will usually have the functor appear to the right of the argument. To refer to the sign of the root node of a tree, the term *root-sign* will be used. The trees rooted at non terminal nodes of an FA specification will be called *subtrees*.

TUG has only a single grammar rule. It describes how the FA specification for a complex linguistic expression is obtained from unification of the FA specifications associated with component expressions. Unification of two FA specifications involves unifying one FA specification, called the *auxiliary tree*, with a specified subtree of the other. This second FA specification is called the *primary tree*. The resulting specification is a more instantiated version of both component FA specifications. Subsequent rule applications result in a more instantiated FA specification which will eventually describe the *FA structure* associated with a linguistic expression.

An FA structure is essentially the tree described by a fully instantiated FA specification. While FA specifications may contain variables and partially instantiated attributes, FA structures do not. Thus we distinguish between *information structures* and the *descriptions* of those structures in a manner similar to the approach proposed by Kaplan and Bresnan (1982) and discussed in detail by Johnson (1987). An FA specification can be interpreted as describing a set of FA structures. For instance, the FA specification given in Figure 3.4 describes a set of FA structures which includes those provided in Figure 3.5. Grammar rule application then corresponds to the intersection of the sets associated with the component FA specifications. The resulting set is associated with a new FA specification. If the resulting set contains no FA structures, then there is no FA specification associated with the resulting set — grammar rule application fails! An ungrammatical sentence (ie. one without an FA structure) will not be assigned an FA
Figure 3.4. FA Specification

Figure 3.5. FA Structures described by an FA Specification
specification. The result of the grammatical analysis of a sentence is the set of FA structures described by the final FA specification. Grammatical sentences can have one or more FA specifications, each of which will describe at least one FA structure.

We are requiring a wellformed FA specification to describe at least one FA structure. In this respect, FA specifications differ from the description languages introduced in (Kasper and Rounds 1986) and in (Johnson 1987). These languages allow descriptions for which there may not be associated structures. FA specifications are actually higher order descriptions which may be defined in terms of these description languages. They are intended to (transparently) describe structures associated with linguistic expressions; they are not intended to be a powerful language for describing feature structures in general. Instead of using FA specifications to describe FA structures, we could use one of these lower level description languages in conjunction with a restriction requiring a wellformed description to describe at least one structure. In the next chapter, we will provide more details concerning how FA specifications can be defined in terms of a lower level description language.

To illustrate some FA specifications, and to outline how they are unified, we will trace the construction of the FA specification associated with the sentence Every man walks. Lexical entries for the different words of this sentence are included in Figure 3.6.

The lexical entry for every is a primary tree which requires an auxiliary tree to be unified at the location marked by α. For the moment, let us examine the subtree associated with the argument of the lexical entry. This subtree describes a functor-argument relation between two linguistic expressions. One is a functor 'noun phrase' of unspecified case C with phonology every, while the argument is a 'noun' possessing an index compatible with the 'entity' sort, as designated by the presence of x. Observe that we have not proposed separate syntactic categories for constituents like determiners. In general, we will propose that for any subtree in an FA structure, the functor-sign and the root-sign will possess the same syntactic category information. For this reason, every is specified to be a noun phrase. Such relationships will be discussed in more detail when we introduce lexical templates in § 4.4.1. The syntax attribute of the functor-sign and root-sign of this subtree are the same, and the phonology of the root-sign is that of the argument-sign preceded by that of the functor-sign. The functor-sign introduces a semantic index of the 'state' sort which will also be the index of the InL formula of any constituent which possesses a universally quantified noun phrase as its argument. This means that sentences like Every man walks will describe a state, even though the word walks describes an event. This functor sign also introduces the semantic connective impl which is
Figure 3.6. Lexical Entries

Figure 3.7. Intermediate FA Specification

Figure 3.8. Final FA Specification
associated with the universal quantifier. The behaviour of indices and the meaning of the semantic notation will be described in detail in § 4.1.3.

The lexical entry for *man* shown in Figure 3.6 describes a noun with phonology *man* whose semantics introduces a discourse marker *ml* and a condition on this marker, *man*(ml). Recall that *man*(ml) is an abbreviation for *[ml]man*(ml).

When the FA specification for *man* is treated as a (depth zero) auxiliary tree which is unified with α from the lexical entry for *every*, we get a more instantiated FA specification which is associated with *every man*. This specification, which is introduced in Figure 3.7, is similar to the lexical entry for *every* except that x has been instantiated to *ml*, S to *man*(ml), and W to *man*. It also differs from the lexical entry for *every* in that it is not a primary tree; it does not possess any labelled subtrees with which an auxiliary tree could be unified.

The FA specification for *every man* can act as an auxiliary tree to be unified with β from the lexical entry for *walks* shown in Figure 3.6. Any potential auxiliary tree must have an argument-sign whose syntax is compatible with nominative noun phrase specification. No restrictions are placed on the indices of the root and argument signs; these indices will be specified by the auxiliary tree. The lexical entry for *walks* states how the semantics of the root-sign is formed from that of its functor and argument signs. When the FA specification for *every man* is combined with this primary tree, P of the primary tree is unified with *impl* of the auxiliary tree, x is instantiated to *ml*, and S is unified with *man*(ml). C of the auxiliary tree is instantiated to *nom*. The resulting FA specification is shown in Figure 3.8. Note how the semantic connective which was originally supplied by the universal quantifier determines the main semantic connective that appears in the semantics of the root-sign. To account for this role of the quantifier on the semantics of a sentence, UCG required the use of type-raised noun phrases. This is illustrated in the following type-raised UCG lexical entry for *every man*.

\[(3.11) \begin{array}{c}
W \\
C / (W: C/(every-man:np:m1:O): [a]S: O) \\
[a][man(ml) \Rightarrow [a]S]
\end{array}\]

Not only does the type-raising make (3.11) difficult to read, but it also results in unnecessary complications of the syntax (like allowing variables over complex categories). The same effect can be achieved in TUG without resorting to type-raising; the noun phrase is an argument, not a functor, in the FA specification. We will be discussing the semantics of noun phrases in more detail in § 4.1.3. The FA specification for the complete sentence
describes exactly one FA structure. In fact, the same tree corresponds to both the FA structure and the FA specification.

The phonological and semantic information of the FA structure of the entire sentence is compositional. That is, for any subtree the phonology of the root-sign is composed of that of its functor-sign and argument-sign. Similarly, the semantics of the root-sign of any subtree is composed of that of its components. Shortly, we will be looking at these and other relationships between the different types of information in an FA structure in greater detail.

In TUG, many local dependencies between grammatical constituents and some other bounded relationships can be stipulated explicitly in lexical entries. This is because FA specifications for one lexical entry can directly access information contained in the sign associated with a different linguistic expression. For instance, we have already seen how the lexical entry for a quantifier can directly specify semantic information (the index) for a sentence in which it is contained. Similarly, we shall see in §5.1 how some control relationships can be described explicitly in the lexical entry without the need for any special mechanisms for control. Thus, the use of FA specifications as lexical entries allows many relationships that are ordinarily described via grammar rules or other principles to be expressed explicitly in the lexicon.

Now that the basic structures and operations behind this grammar formalism have been outlined, we can consider how reflexives should be treated within the framework. Then we can outline how the constraints on reflexivisation can be incorporated into a TUG grammar.

33. Reflexive Antecedent Information

The TUG treatment of reflexives will be based on the concept of reflexive antecedent information, henceforth R-antecedent information. R-antecedent information, which will be distinct from the semantic information contained in a sign, will be responsible for determining the antecedents of reflexive pronouns. The constraints on reflexivisation will determine how the R-antecedent information of one sign is related to the information contained in other signs of an FA structure.

33.1. The Reflexive Attribute

Since many local relationships can be stated explicitly in the lexical entries of TUG, one may ask why locally bound reflexivisation cannot be captured explicitly in an FA specification? Conceivably, reflexivisation could be treated as a 'lexical rule' of some sort which would create a lexical entry for a reflexivised verb from one for a non-reflexivised
verb. Since the lexical entries for verbs contain the signs associated with all their arguments, then a rule could generate an FA specification for a reflexivised verb by unifying the indices of two of its arguments. However, we know that not all reflexives find their antecedents locally (e.g. long distance reflexives). Even locally bound reflexives can be widely separated from their antecedents. This is illustrated by reflexives contained in (multiple) picture-nouns, an example of which is shown in (3.12).

(3.12) John loves a book about a picture of himself.

We want the same general treatment to be applicable to all types of reflexives. In constructions like (3.12) it is impossible for the lexical entry for a verb to contain both the sign associated with a reflexive and the one associated with its antecedent (unless one were to introduce special lexical entries for expressions like loves a book about a picture of). Since the signs corresponding to the reflexive and its antecedent need not both be present in the FA specification for a verb, we will introduce a reflexive attribute into the TUG sign. This additional attribute which will contain the R-antecedent information needed for establishing an anaphoric relationship between the reflexive and its antecedent. So instead of adopting the UCG format for signs, which was illustrated in (3.1), we will adopt the format shown in (3.13) for signs used in FA specifications.

(3.13) phonology
syntax
semantics
R-antecedents

Since we have already seen the type of information contained in the first three attributes of the sign, let us consider the information contained in the fourth attribute.

R-antecedent information is just one type of antecedent information. Antecedent information is responsible for determining the antecedent and thus the meaning of pronouns. It is distinct from semantic information. Semantic information is used to determine how the meaning of a complex expression is composed from that of its components. The semantic information of a sign can also be dependent on other information, like R-antecedent information, contained in the sign. For any node in an FA structure, the semantic information of the sign labelling that node will be composed of information contained in that sign and information associated with the signs of descendent nodes. Information from signs labelling ancestor or sister nodes will not play a direct role in determining the semantic information. According to these criteria, semantic information will be said to be compositional. The source of compositional information for an attribute of a sign $\alpha$ contained in an FA structure is outlined in Figure 3.9. Antecedent information
Figure 3.9. Source of Compositional Information for α

Figure 3.10. Source of Environmental Information for α
is not compositional. The meaning of a pronoun depends on the context or environment in which it occurs; its antecedent comes from its context, not from its components. So for any node in an FA structure, if the antecedent information of sign labelling that node is to describe the environment, then it will be composed of information associated with the signs of sister and ancestor nodes. Information from other attributes of the same sign and information contained in the signs of descendent nodes will not provide a direct source of antecedent information. Intuitively, the environment is what one finds surrounding oneself; it is not what one finds within oneself. Antecedent information will be said to be environmental. The source of environmental information for a sign $\alpha$ of an FA structure is outlined in Figure 3.10.

The notion of compositionality has been the subject of a great deal of discussion with respect to natural language semantics, and numerous definitions of this term have been proposed (Partee 1984). The ‘strong’ compositionality of frameworks like Montague grammar (Dowty, Wall and Peters 1981) can been weakened in order to allow a treatment of phenomena, like anaphora, which are dependent on the context of a linguistic expression (Bach and Partee 1980, Cooper 1983). The dependence of anaphora resolution on contextual information is evident from the constructions studied in chapter two. For instance, if a reflexive appears within a noun phrase having a possessive determiner, like John's picture of himself, it cannot take the subject of the clause containing the noun phrase as its antecedent. If a reflexive appears within a picture-noun phrase which lacks a possessive, it can take the subject as its antecedent. Montague’s compositional approaches to anaphora allowed only ‘bound variable’ uses of pronouns. Pronouns were introduced by a quantification rule (schema) which was dependent on the presence of coindexed variables. A separate operation was required for each possible variable index. So compositional anaphora was achieved at the expense of a greatly extended set of grammar rules. By separating out antecedent (context-dependent) information from the semantics, it is possible to obtain an elegant treatment of anaphora that does not rely on complicated grammar rules and still have FA structures in which the semantic information is compositional. But what does antecedent information look like, and what exactly constitutes the environment of a linguistic expression?

The antecedent information is responsible for determining the discourse marker that can be the antecedent of the pronoun. Based on a proposal for the treatment of personal pronouns described in (Johnson and Klein 1986), we will propose that the R-antecedent information explicitly describes the set of potential discourse markers available as antecedents for reflexives. This is the information that will be contained in the reflexive attribute of a sign. These markers will originate from the semantic information of the
environment. It will be assumed that this semantic information will be the source of all the antecedents. The effect of phonological and syntactic information in determining the environment is more subtle. These two forms of information are responsible for determining how specifications are combined, and thus they indirectly determine the semantics of the various signs which supply the discourse markers for the reflexive attributes. The reflexive attribute of a sign will behave like a store of possible antecedents which will be available for a reflexive associated with the sign. The lexical entry for the reflexive will only need to state that its antecedent marker is an element from this store. Unlike the Cooper storage mechanism described in (Cooper 1983) which has been adopted in various proposals for anaphora (Bach and Partee 1980, Gazdar et al. 1985), our reflexive attribute contains a set of antecedents, not a set of anaphors. We shall look at this in detail when we analyse various storage-based approaches to reflexivisation in chapter six.

The R-antecedent information will be represented as an ordered list of discourse markers (sorted variables) corresponding to potential antecedents. Lists will be displayed in square brackets with the different elements separated by commas as illustrated in (3.14).

\[(a,b,c,d)\]

The notation \(\ldots x!\ldots\) will be used to designate \(x\) as an arbitrary element from a list. The sign associated with a reflexive pronoun will resemble the one shown in (3.15).

\[(3.15)\]

\[ \text{himself} \]

\[
\begin{align*}
[ & \text{np, obj} ] \\
& \text{true(m)} \\
& [\ldots m!\ldots ]
\end{align*}
\]

The discourse marker appearing in the semantic formula associated with the reflexive pronoun is an arbitrary element (of the masculine sort) of the reflexive attribute of the pronoun. The condition true introduced in the semantic attribute is always satisfiable for any discourse marker. We will discuss the semantics of the reflexive pronoun in more detail shortly.

The operation of selecting an arbitrary element from a list of arbitrary length is a fairly powerful operation. Nevertheless, it seems to be a sufficiently primitive operation to be included in a framework. It cannot be expressed in the PATR-II framework (Shieber et al. 1983) which is often used to implement grammars. However, in PATR-II one can select an arbitrary element from a list of fixed length. This is achieved by a disjunction of rules for selecting the \(i\)'th element of the list for each \(i\). So unlike HPSG and UCG, grammars written here cannot be translated into PATR-II specifications. If functional
uncertainty (Kaplan, Maxwell and Zaenen 1987) were included as a primitive in PATR-II, then the selection of an arbitrary element from an arbitrary list could be implemented. Functional uncertainty allows the characterisation of an infinite set of disjunctions. It can be characterised by the use of a Kleene closure operation in PATR-II-like path specifications (Johnson 1987:§5.3, Johnson pers.com.). In PATR-II, values of an attribute value structure can be referenced by a path equation. For instance, if a list $L$ is treated as an attribute value structure where the attribute $\text{first}$ has the value of the first element of the list, and $\text{rest}$ has the value for the rest of the list, then the path expression $L:\text{rest:}\text{first}$ would refer to the second element of the list. With functional uncertainty, an arbitrary element could be referenced with the path expression $L:\text{rest}^*:\text{first}$.

Instead of placing a restriction like $\{\ldots x_I\}$ on the reflexive attribute, one could alternatively incorporate a similar restriction as a condition in the semantic attribute of the reflexive. For instance, the semantics for a reflexive pronoun possessing a semantic index $x$ and a reflexive store $L$ could be described by the formula $\{x\text{in}(x,L)\}$. The semantic predicate $\text{in}$ would be satisfied if the variable $x$ were a member of the list of variables $L$. However, in cases where anaphora resolution fails we would end up constructing an FA specification for an ungrammatical sentence, unless we evaluated the InL formula associated with intermediate expressions. In the proposal that we have presented so far, we only need to evaluate the semantic formula associated with the final FA structure.

3.3.2. Distribution of R-Antecedent Information

The constraints on reflexivisation introduced in chapter two affect the distribution of R-antecedent information and its interaction with other forms of information. These constraints are incorporated directly into the TUG lexical entries. Recall that our predicate command restriction is derived from Keenan's proposal whereby the antecedent for a pronoun is an argument of the functor containing the pronoun. This can be incorporated into TUG by having the R-antecedent information of a functor consist of the R-antecedent information of its parent sign augmented with semantic index of its argument. To illustrate this 'flow' of R-antecedent information, consider the distribution of this information in an FA specification for the simple sentence *Mary loves herself*.

A series of FA specifications corresponding to different stages of an analysis for this sentence are shown in Figure 3.11. To highlight the relevant information, much of the information contained in the signs of these FA specifications has not been displayed. The first FA specification corresponds to the lexical entry for *loves*. Observe that the R-antecedent information of the functor-sign consists of the semantic index of the argument sign; the reflexive attribute of the sign associated with the object noun phrase is the same.
Figure 3.11. Distribution of R-Antecedent Information
as that of the constituent which contains it. Also note that the InL formula from the sign associated with the verb references the semantic indices of the signs for the two noun phases. The second FA specification from Figure 3.11 illustrates the effect of unifying a sign (actually a depth zero tree) corresponding to the noun phrase *Mary* with the argument-sign of the initial FA specification. Note that the semantic index, $f_l$, of *Mary* is introduced into the reflexive attribute of the functor over *Mary*. It also appears as the second argument of the semantic predicate *love* (underlined in the FA specification). Since the lexical entry for the verb also embodies the relation requiring the reflexive attribute of an argument-sign to contain the same information as its parent sign, $f_l$ is also introduced into the sign associated with the object noun phrase. This 'flow' of R-antecedent information is highlighted by the dark arrows in Figure 3.11. In the final FA specification from this figure, a sign corresponding to the reflexive pronoun is unified with the sign of the object noun phrase in the FA specification. The reflexive pronoun obtains its semantic index from the information contained in its reflexive attribute as highlighted by the small arrow. This semantic index is used as the final argument in the InL formula associated with the verb (which is underlined in the FA specification).

Let us now look at the distribution of R-antecedent information in FA specifications in general. Instead of proposing that the semantic index of an argument noun phrase be introduced into the reflexive attribute of a functor over the noun phrase, we will propose that it is the index of the subformula appearing as the first argument of its semantic connective which is introduced. That is, for a noun phrase argument-sign with semantics $[a]P([x]S)$, where $P$ is a semantic connective like *and* or *impl*, it is $x$ (not $a$) that is contributed to the reflexive attribute of the functor-sign. This variable $x$ will be called the *anaphoric index* of the argument sign. The choice of $x$ instead of $a$ seems to be appropriate since it is always of a sort associated with entities, whereas $a$ can be of a sort corresponding to a state or event, as illustrated in the InL formula for *every man* which is shown in (3.16).

\[(3.16) \ [s1] \ impl( [m1]man(m1) )\]

Furthermore, it is $x$ not $a$ that is used to represent the noun phrase in the semantic condition associated with functors that take noun phrases as arguments. In the sentence *every man walks*, it is $m1$ not $s1$ that appears in the semantic formula, $[el]walk(el,m1)$, associated with the verb.

A relationship between semantic and R-antecedent information is illustrated in the FA specification shown in Figure 3.12. For every subtree of this FA specification, the reflexive attribute of the argument-sign is obtained from that of the root-sign. The
Figure 3.12. Predicate Command Restriction

Figure 3.13. Predicate Command and Locality Restrictions
reflexive attribute of the functor-sign is obtained by adding the anaphoric index of the argument-sign to the list obtained from the reflexive attribute of the root-sign as highlighted in Figure 3.12. In general, we will use the notation "\([x:A]\)" to denote a list resulting from the addition of an element \(x\) to a list \(A\). So for any node in this FA specification, the reflexive attribute of the sign labelling that node will be a list of indices from signs associated with nodes predicate commanding that node (assuming that each branch corresponds to predication). The R-antecedent information of the root-sign of the entire FA specification is in this case initialised to the empty list \([],\). This denotes an initially null context.

The presence of a generalised predicative results in the blocking of R-antecedent information. Consider a subtree of an FA specification (like \(\alpha\) in Figure 3.13), where the functor-sign is a generalised predicative. The R-antecedent information of the generalised predicative is a list consisting of only the anaphoric index of the argument-sign. The R-antecedent information of the root-sign does not contribute to that of the functor sign. The signs of an FA specification corresponding to generalised predicate functors will be marked with a syntactic feature to distinguish them from non-generalised predicatives. Functor-signs will be marked with the feature \(gprd\) if they are generalised predicatives. Non-generalised predicative functors which take noun phrases as arguments will be marked as \(+prd\), and other functors will possess the feature \(-prd\). Arguments will not be marked with any 'predicate' features. These features will be discussed in more detail in § 4.1.2. We shall later see that these features are not actually necessary for our account of the distribution of reflexive pronouns; our restrictions on reflexivisation can be defined in terms of other basic features.

The use of these features will allow the behaviour of R-antecedent information to be observed more easily, as illustrated in Figure 3.13. For predicative functors, the R-antecedent information of the functor-sign is composed of semantic information (the anaphoric index) from the argument-sign and the R-antecedent information from the root-sign. Note that the R-antecedent information of the sign labelled \(\alpha\) is not included in that of the generalised predicative, but the anaphoric index of the argument-sign of \(\alpha\) is included in that of the functor. For non-predicative functors, the R-antecedent information of the root-sign will be the same as that of the functor-sign. Thus, the R-antecedent information of the functor-sign is determined from its environment, not from its components. For the argument-sign of any subtree, the R-antecedent information is inherited from its root-sign. Again, we have environment being the source of the R-antecedent information.
3.4. Derivation

Now that we have seen how R-antecedent information can be incorporated into FA specifications, we can examine how this information interacts with other forms of information during the analysis of a complex linguistic expression. We will first examine how the various lexical entries are combined to obtain the FA structure for a very simple sentence. Then during the analysis of a more complex sentence, we shall see how R-antecedent information can play a role in constraining possible analyses.

3.4.1. A Simple Example

A simple use of the reflexive is illustrated in the sentence *Mary loves herself*. The lexical entries for the different words of this sentence are included in Figure 3.14. After discussing each of these lexical entries, we shall see how they are combined to form FA specifications for the expression *loves herself* and for the complete sentence.

In the lexical entry for *herself*, it is the argument-sign that is associated with the linguistic expression *herself*. This sign contains a restriction \([\ldots f^1\ldots]\) which specifies that the semantic index \(f\) associated with *herself* is a member of the reflexive attribute of the sign. This arbitrary element of the reflexive store is required to be a variable of the feminine sort. The syntax of this sign states that *herself* can act only as a noun phrase of the objective case. Thus it cannot appear in any positions in an FA specification which require the noun phrase to possess some other case, like *nominative*. Like other noun phrases, the argument-sign contains the semantic connective *and* which will be used in determining the semantics of the root-sign. Unlike lexical entries for proper names and quantified noun phrases, the semantics of the argument-sign does not associate any restrictive condition on the index it introduces; the condition *true* is always satisfiable for any discourse marker. This ties in with the view of pronouns being semantically underspecified linguistic items. Viewed in terms of DRT (Kamp 1981), the formula *true*(\(f\)) (which is an abbreviation for *\([f\ true(f)\]*) merely introduces a discourse marker into the universe but does not introduce any condition on that marker. Since the syntax of our semantic notation requires a formula to consist of an index-condition pair, we need to introduce a condition like *true* along with the discourse marker.

In contrast, the lexical entry for *Mary* possesses an argument-sign which introduces a variable \(f^1\) and a condition on that variable *mary*(\(f^1\)). The noun phrase is unspecified with respect to case as represented by the presence of a variable \(C\) in the syntactic attribute of the argument sign. No restrictions are placed on the R-antecedent information contained in this sign. As in the lexical entry for *herself*, the lexical entry for *Mary* requires the index of the root-sign to be the same as that of the functor-sign. We shall later see that this is
Figure 3.14. Lexical Entries with R-antecedent Information
the usual behaviour for non-quantified noun phrases.

The lexical entry for the transitive verb *loves* requires two auxiliary trees corresponding to its object and subject noun phrases to be unified with subtrees \( \alpha \) and \( \beta \) respectively. It is structured much in the same way as the lexical entry for the intransitive verb *walks* discussed earlier in this chapter. For each subtree, the phonology of the root-sign is composed of that of its functor and argument signs, as is the semantics. Note that for \( \alpha \), the functor-sign is not generalised predicative and so the R-antecedent information of the functor sign is made up of the anaphoric index \( y \) of the argument-sign and the R-antecedent information \([x]\) of the root-sign. \( \beta \) does have a generalised predicative functor-sign, so the R-antecedent information \( A \) of the root sign is not included in that of the generalised predicative, \([x]\).

The lexical entry for *herself* can act as an auxiliary tree to be unified with \( \alpha \) in the FA specification for *loves*. The resulting FA specification for *loves herself* is included in Figure 3.15. This unification instantiates the reflexive attribute of the sign for *herself* to the list containing the single element \( x \). As a consequence of this instantiation, the restriction \([...f\] from the lexical entry for *herself* will require \( f \) from the auxiliary tree to be unified with \( x \) in the primary tree; the variable \( x \) becomes further specified as a variable of the feminine sort. This occurs since \( x \) is the only member of the list in which \( f \) is an arbitrary element. Since \([f]\text{and}(\text{true}(f))\) is actually an abbreviation for \([f]\text{and}(\text{true}(f))\), the unification of this formula with \( \text{[...f]} \) from the primary tree will result in \( P' \) becoming instantiated to \( \text{and}, y \) to \( f \), and \( S' \) to \( \text{true}(f) \). Note that in this example, \( P' \) is a variable over our (finite) set of semantic connectives. So the semantics of the functor-sign of the resulting FA specification contains a condition where the variable \( f \) appears twice in the argument list of the semantic predicate love. The semantics of the functor-sign \([sl]\text{and}(\text{true}(f))(\text{love}(sl,f,f))\) is abbreviated as the equivalent formula \( \text{love}(sl,f,f) \) in the semantic attribute of the root-sign. This will often be done to improve the readability of complex semantic formulae. Finally note that the FA specification for *loves herself* requires the anaphoric index of its nominative noun phrase (shown in bold) to be of the feminine sort.

To obtain the FA specification for the complete sentence, the tree for *loves herself* acts as the primary tree and the lexical entry for *Mary* is the auxiliary tree. The auxiliary tree is unified with \( \beta \) of the primary tree. As a consequence of this unification, the variable \( f \) of the primary tree is instantiated to \( f1 \). So, as reflected in the FA specification for the complete sentence in Figure 3.16, the index (the antecedent) of the reflexive pronoun is \( f1 \). If the argument-sign of the auxiliary tree possessed an index of a sort not
Figure 3.15. Intermediate FA Specification with R-antecedent Information

Figure 3.16. Final FA Specification with R-antecedent Information
compatible with 'feminine,' then the unification of f with this sort would have failed and thus tree unification would have failed. For instance, the lexical entry for John would have introduced an index of the masculine sort. So the unification of this lexical entry with the FA specification for loves herself would have failed, and an FA specification for John loves herself would not be created. The semantics of the root-sign of the final FA specification is displayed in an abbreviated form; [s1]and(mary(f1),love(s1,f1,f1)) can be abbreviated as [s1][mary(f1),love(s1,f1,f1)]. For a sentence in a null context, the reflexive attribute of root-sign of the sentence's FA structure will be empty, [ ]. So the FA structure for the sentence Mary loves herself in a null context will be same as its FA specification shown in Figure 3.16 except that A will be instantiated to [ ].

3.4.2. R-antecedent Information and Picture-Nouns

In the preceding example, there was only one potential antecedent contained in the list from the reflexive attribute of the reflexive pronoun. Furthermore, the reflexive and its antecedent were both arguments of the same verb. In picture-noun constructions, the reflexive and its antecedent are not both arguments of the verb. If a reflexive is contained in a ditransitive verb phrase, then it can have more than one possible antecedent. Therefore, we will now look at the more complicated sentence Mary gives John a picture of herself and see how anaphora resolution is performed during the construction of the FA specification associated with the sentence.

Let us first consider the FA specification associated with the picture-noun itself. The lexical entries which must be combined to yield a specification for picture of herself are introduced in Figure 3.17. This lexical entry for of takes an object noun phrase argument to form a constituent which modifies a common noun. Additional restrictions would be required to ensure that it modifies only depictive nouns like picture and portrait. The lexical entry requires an auxiliary tree corresponding to an objective noun phrase to be unified with α and one for a noun to be unified with β. It also introduces a semantic formula $off(x,y)$ which requires the entity denoted by $x$ to be of the entity denoted by $y$. Using this formula, the phrase picture of Mary would be translated as shown in (3.17).

\[(3.17) \ [n1][[picture(n1), [n1][Mary(f1),off(n1,f1)]]]\]

The functor-sign of α has been specified as a generalised predicative — it takes a noun phrase as an argument and results in another noun phrase. According to our restrictions on R-antecedent information, the R-antecedent information A of the root-sign of α is not included in that of the generalised predicative but it is included in that of the argument-
Figure 3.17. Lexical Entries for Picture-Nouns

Figure 3.18. FA Specification for a Picture-Noun
sign. In this way, the same R-antecedent information that is associated with the root-sign of \( \alpha \) is also available to the embedded noun phrase (i.e. the argument of \( \alpha \)) as highlighted in bold in Figure 3.17. The functor-sign of the lexical entry for \textit{of} possesses the feature +prd since it take a noun phrase as an its argument. Since an argument sign always inherits its R-antecedent information from the root-sign, the same R-antecedent information is associated with both the root-sign of the lexical entry and the embedded noun phrase.

In order to obtain an FA specification for \textit{picture of herself} shown in Figure 3.18, the lexical entry for the reflexive pronoun acts as the auxiliary tree which is unified with \( \alpha \) of the lexical entry for \textit{of}, and the lexical entry for \textit{picture} is unified with \( \beta \). The FA specification for \textit{herself} introduces a restriction on the anaphora attribute of the sign associated with \textit{herself}. This restriction requires \( f \) to be a member of the reflexive attribute \( A \) which is still uninstantiated. To represent that the restriction \( [\ldots f l \ldots] \) was unified with \( A \), we will introduce \( A \) as a subscript on this restriction in the FA specifications that we are discussing. This will make it easier to examine the behaviour of R-antecedent information. Aside from placing this restriction on the R-antecedent information \( A \), the unification of the primary and auxiliary trees results in the variable \( y \) being unified with \( f \). The lexical entry for the noun \textit{picture} introduces a marker of the neuter sort, \( nl \), and includes a condition which requires this marker to be a picture \( \textit{pic(nl)} \). When this lexical entry is combined with the FA specification for \textit{of herself}, \( x \) from the primary tree gets instantiated to the variable associated with the picture \( nl \). \( A \) is still not instantiated.

The FA specification for \textit{a} is introduced in Figure 3.19. Unlike the lexical entry for the universal quantifier, this determiner specifies the index of the root-sign to be the same as that of the functor-sign. It does not introduce its own index. This behaviour is based on the observation that indefinite noun phrases modify the state or event described by functionals operating over them, while the semantics of other quantified noun phrases is combined with that of their functionals to describe a new state or event (Zeevat, Klein and Calder 1987). The FA specification for \textit{picture of herself} from Figure 3.18 is repeated in Figure 3.19 in an abbreviated form in order to remove details not relevant to our discussion. This abbreviated form displays only the root-sign and the sign associated with the reflexive pronoun. When this FA specification is unified with \( \alpha \) from the lexical entry for \textit{a}, we get the FA specification shown at the bottom of Figure 3.19. Notice that \( A \) is still uninstantiated. Adopting some notation used in (Calder, Moens and Zeevat 1986), a restricted form of re-entrancy has been utilised for displaying the FA specification associated with a \textit{picture of herself}. An attribute \( S \) from a sign can be labelled with a label \( L \) as shown in (3.18) and then referenced as shown in (3.19).

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Figure 3.19. FA Specifications for a Picture-Noun Phrase
In our FA specification, the semantic attribute of the sign associated with *picture of herself* is labelled with *I* and then referenced, *#1*, in the semantics of the sign associated with its ancestor node. Note that the R-antecedent information, *A*, of the complex noun phrase *a picture of herself* is the same as that of the embedded noun phrase associated with the reflexive pronoun. So, any antecedents available to the complex noun phrase will also be available to the embedded reflexive.

A lexical entry for *gives* is introduced in Figure 3.20. Until now, for any subtree of an FA specification, the phonology of the root-sign was created by concatenating the phonology of the functor-sign to that of the argument-sign, or by concatenating that of the argument-sign to that of the functor-sign. For subtree β of the FA specification for *gives*, the phonology of the root sign is that of the functor-sign wrapped around that of the argument sign. This phonological operation is required if we want the FA structure of a verb to have its arguments ordered according to decreasing obliqueness, which is essential for our account of reflexivisation. Since the ordering of the arguments in the FA specification does not correspond to the position of the arguments in a sentence, this wrapping operation is essential. A wrapping operation was introduced by Bach (1979) and used in the account of reflexivisation described in (Partee and Bach 1981). Head grammar (Pollard 1984) also relies on a variation of this head wrapping operation. The result of our wrapping relationship between phonologies is stated explicitly in the lexical entries, just as the results of the other two relationships between phonologies are. In general, phonological information behaves according to our description of compositional information. For any subtree of an FA structure, the phonology of the root-sign is composed of the that of the functor and argument signs. Aside from the wrapping relation exhibited in the phonological information of ditransitive verbs, their FA specifications are very much like those of ordinary transitive verbs. Observe that for each of the noun phrase arguments of the ditransitive verb, its reflexive attribute consists of the anaphoric indices of the less oblique noun phrases. For instance, the reflexive attribute of the most oblique object noun phrase (ie. the one described by the argument-sign of α) contains the indices of the first object noun phrase and the subject noun phrase (in that order). So the markers in the reflexive attribute appear in order of decreasing obliqueness (the opposite order to which they appear in the semantic attribute of the verb).

When the lexical entry for *gives* takes the FA specification for *a picture of herself* as an auxiliary tree to be unified with α, the variables *C* and *A* from the auxiliary tree become
Figure 3.20. Lexical Entry for Ditransitive Verb

Figure 3.21. FA Specification for Subject Antecedent

Figure 3.22. FA Specification for Non-Subject Antecedent
instantiated to \textit{obj} and \{y,x\} respectively. But recall that there is still an additional restriction placed on the \textit{A} which requires \textit{f} to be an arbitrary member of \textit{A}. This means that there are two possible FA specifications that can be associated with the phrase \textit{gives a picture of herself} depending on whether \textit{f} is unified with the last member (ie. \textit{x}) of this list or the first (ie. \textit{y}). One of these FA specification corresponds to the situation where the subject is chosen as the antecedent for the reflexive (as shown in bold in Figure 3.21). The unification of the entity sort variable \textit{x} with the feminine sort variable \textit{f} results in a discourse marker of the feminine sort. When \textit{y} is chosen as the antecedent, we get an FA specification corresponding to the case where the less oblique object is chosen as the antecedent (as shown in Figure 3.22). The semantic formula \textit{PIC(nlf)} in Figure 3.21 and Figure 3.22 is an abbreviation for the somewhat lengthy formula \textit{[nl][pic(nl), of(n1,f)]}. Unification of the auxiliary tree with \textit{\alpha} also results in \textit{z} being instantiated to the variable associated with the picture \textit{nl}.

Let us now consider the result of combining each of these two FA specifications for \textit{gives a picture of herself} which the lexical entry for \textit{John}. In Figure 3.23 the relevant parts of the two FA specifications have been outlined. An attempt to unify the lexical entry for \textit{John}, shown in Figure 3.24, with the subtree \textit{\beta} of the first specification will fail. The anaphoric index of the argument-sign of \textit{\beta} is stipulated to be of the feminine sort, but the anaphoric index of the argument-sign of the tree for \textit{John} possesses a masculine sort (as shown in bold). Unification of the tree for \textit{John} with \textit{\beta} of the second specification will succeed, since \textit{y} will unify with \textit{ml} from the primary tree (the sorts of these two variables are compatible). Thus there is only one FA specification for the expression \textit{gives John a picture of herself} as illustrated by the FA specification segment shown in Figure 3.25. If an FA specification for a noun phrase possessing a feminine index were used as an auxiliary tree instead of the lexical entry for \textit{John}, then there would be two FA specifications associated with the resulting expression.

Figure 3.26 illustrates the effect of unifying the FA specification for \textit{gives John a picture of herself} with the lexical entry for \textit{Mary}. The variable \textit{f} from the primary tree becomes instantiated to the discourse marker \textit{fl} associated with \textit{Mary}. A section of the resulting FA specification is included at the bottom of Figure 3.26. An attempt to unify an FA specification for a ‘masculine’ noun phrase with \textit{\delta} of the primary tree would fail since the nominative noun phrase is required to possess an anaphoric index of the feminine sort (as shown in bold). Thus, for a sentence like \textit{Harold gives John a picture of herself} there would be no FA specification and consequently no FA structure (unless there were a lexical entry for some female entity named \textit{Harold} or \textit{John}). If the analysis were for a sentence like \textit{Jane gives Mary a picture of herself}, then there would be two FA
Figure 3.23. FA Specifications for Verbs Containing Picture-Nouns

Figure 3.24. Lexical Entry for Proper Name

Figure 3.25. Failure of Anaphora Resolution
Figure 3.26. FA Specification for Complete Sentence
specifications corresponding to two different interpretations of the reflexive. The actual FA structure associated with the sentence *Mary gives John a picture of herself* would resemble the FA specification for the complete sentence but it would additionally have the initial R-antecedent information \( A \) instantiated to an empty list to represent a null context.

The FA structures described by a TUG analysis of a sentence are difficult to obtain as derivation trees in UCG. As discussed earlier, the UCG grammar rules require the semantic attributes of the root-sign and functor-sign of any subtree to be the same. Additional grammar rules would be needed by UCG to allow the different relationships between semantic information and to allow the three different relations between the R-antecedent information of a root-sign and functor-sign. The R-antecedent information of a functor-sign can either be the same as that of the root-sign (non-predicative functors), it can consist of the the anaphoric index of its argument in addition to the R-antecedent information of the root-sign (predicative functors), or it can contain only the anaphoric index of its argument (generalised predicative functors).

### 3.5. Summary

In TUG, the phonological, syntactic, semantic and antecedent information describing linguistic expressions is contained in signs which are organised into FA structures. These FA structures are binary trees which encode the functor-argument dependencies between the signs corresponding to components of a complex expression. Partial specifications of FA structures are associated with individual lexical entries and these FA specifications are combined by a single grammar rule. Dependencies between information associated with different linguistic constituents that are traditionally captured by the grammar rules are captured explicitly in the TUG lexical entries.

The R-antecedent information contained in FA specifications is treated on a level equal to the other forms of information; there is no need to invoke special mechanisms for passing this kind of information. Its distribution is governed by the predication command and generalised predicative constraints introduced in the second chapter. The reflexive attribute of the sign contains information that *might* be needed by a reflexive pronoun. So if a sign for a reflexive pronoun appears in an FA specification, the possible antecedents for the reflexive are easily accessible. During tree unification, if the sign associated with a reflexive pronoun contains no variables of the appropriate sort in its reflexive store, then the use of the pronoun is ungrammatical and tree unification fails. Since an FA specification is associated with each potential antecedent of a reflexive pronoun, failure of anaphora resolution can constrain possible analyses; if there is no possible antecedent for a reflexive, there will not be an FA specification.
Finally, the R-antecedent information contained in an FA structure is environmental, in contrast to semantic and phonological information which is compositional. The reflexive attribute of a sign is determined by information contained in its environment, while the semantics and phonology are determined by information contained in its components. The notions of compositional and environmental relations are applicable to FA structures, not to FA specifications. FA specifications possess variables which can be used in a unification framework to obtain all sorts of different 'directions' of information flow when they get instantiated; FA structures do not contain 'uninstantiated variables.'
Chapter 4
Tree Unification Grammar

In the previous chapter the basic structures and mechanisms of the Tree Unification Grammar framework were outlined and an account of reflexivisation within this framework was proposed. At this point, it would be appropriate to provide a thorough description of TUG. We shall start by describing the information contained in signs including a detailed discussion of the semantic notation. Then FA structures and FA specifications will be examined in more detail, looking at how the single TUG grammar rule is used to combine FA specifications. The focus will then shift toward the lexicon, with lexical entries, templates and lexical rules being discussed. Finally, TUG will be compared with various other linguistic frameworks. The focus of this comparison will be on what makes TUG unique and on what makes it an appropriate formalism for describing the distribution of reflexive pronouns.

4.1. Signs

The signs used in the TUG possess attributes for phonological, syntactic, semantic, and R-antecedent information. So far, we have only briefly outlined the way that information is organised in each of these attributes. In this section, we shall provide a detailed analysis of each of these attributes.

4.1.1. Phonology

The phonology of a sign is a sequence of one or more 'words' from a set $W$ where the individual words are separated by hyphens. Included in $W$ is a special word $e$ which represents a null phonology. It is associated with linguistic items which are not realised phonologically. So phonology attributes like $e$-foo, foo-$e$ and foo would all correspond to the linguistic expression foo.

This sequence of words contained in the phonology attribute possesses a flat structure. For instance, assume that the two variables $X$ and $Y$ become instantiated to every-boy and loves-Mary respectively. Then the expression $X$-$Y$ will describe the sequence every-boy-loves-Mary and not (every-boy)-(loves-Mary). Equivalently, a phonological expression could be treated as a string of words with the hyphen appearing between expressions denoting string concatenation. An introduction to strings and string operations is provided in (Hopcroft and Ullman 1979:§1.1).

In order to describe some phonological relationships between constituents, it was necessary to introduce a phonological operation known as wrapping in the previous
Following a proposal used in head grammar (Pollard 1984), we will consider a phonology to be a **headed sequence**. This means that every phonological sequence will have a distinguished element called the head, much in the same way that every semantic formula has a distinguished element called the index. A *head wrapping operation* is used to insert one sequence into a second sequence at a point following the head of the second sequence. For instance, let $X$ and $Y$ be two sequences as defined in (4.1). The element appearing in brackets at the beginning of each sequence is its head.

(4.1)  
$X = [Mary]$ Mary  
$Y = [tells]$ tells-to-go-home

Applying the above mentioned head wrapping operation to the pair of sequences $X$ and $Y$ will result in $X$ being incorporated into $Y$ at the point following the word *tells*. The resulting sequence is shown in (4.2).

(4.2)  
$\text{wrap}(X,Y) = [tells]$ tells-Mary-to-go-home

This wrapping operation corresponds to the operation $RL2$ described by Pollard (1984). There are other variations of this operation which need not concern us here. It was noted in the previous chapter that the result of this operation is stated explicitly in lexical entries; a wrapping operation is not needed by the TUG grammar rule. Since we will not be concerned with the details of head wrapping, the phonologies will usually be displayed without their heads specified.

### 4.1.2. Syntax

There are many different approaches to syntactic features that could be adopted for use within TUG. For our needs, we will adopt a variation of the feature structures used in GPSG (Gazdar et al. 1985). Some details will be glossed over, since we will not be concerned with handling certain classes of constructions.

The syntactic attribute of a sign consists of two separate lists of features which are separated by a comma as illustrated in (4.3).

(4.3)  
$[n_1, n_2, \ldots, n_m, [f_1, f_2, \ldots, f_n]]$

Each $f_i$ in (4.3) is a foot feature which is used on conjunction with unbounded dependencies (§ 5.3). In the FA specifications that have been presented so far, the foot feature list has been omitted. Each $n_i$ is a non-foot feature. Let us now look in detail at the information contained in each of these lists.
The first element of the first feature list contains information about the syntactic category of the associated linguistic expression. Categories can be defined in terms of a *nominal* feature, which must take a value from the set {+,−}, and a *verbal* feature, which also takes its value from this set (Chomsky 1970). The conventional categories for nouns, verbs, prepositions, and adjectives can be defined in terms of these features as illustrated in (4.4).

(4.4)  

<table>
<thead>
<tr>
<th>+nominal</th>
<th>-nominal</th>
</tr>
</thead>
<tbody>
<tr>
<td>adjective</td>
<td>verb</td>
</tr>
<tr>
<td>noun</td>
<td>preposition</td>
</tr>
</tbody>
</table>

In addition to these features, there is also a bar level feature which corresponds to a variation of the notion of bar level introduced with X-bar syntax (Jackendoff 1977). Possible values for this feature will be from the set {1,2}. Traditional phrasal categories will generally have a bar value of 2, while non-phrasal categories will have value 1. For our analyses, there is no need to distinguish lexical categories (bar 0). Taken in conjunction with the category descriptions introduced in (4.4), this will give us the eight different categories shown in (4.5).

(4.5)  

<table>
<thead>
<tr>
<th>adjective</th>
<th>verb</th>
<th>noun</th>
<th>preposition</th>
</tr>
</thead>
<tbody>
<tr>
<td>bar 2 adjp</td>
<td>sent</td>
<td>np</td>
<td>pp</td>
</tr>
<tr>
<td>bar 1 adj</td>
<td>v</td>
<td>n</td>
<td>prep</td>
</tr>
</tbody>
</table>

Instead of explicitly describing the category of a sign in terms of the nominal, verbal, and bar features, the different categories names introduced in (4.5) will be used as abbreviations. So, a sign with syntax [+nominal, -verbal, bar 2] will usually have its syntax abbreviated as [np]. Later, we will encounter some cases where the unabbreviated form of the syntax will be necessary.

Also included in the non-foot features of the sign is the *form* feature. As with GPSG, this feature distinguishes different forms of verbs and prepositions. It will also be used to describe the different cases of nouns, and to describe certain properties of adjectives. Valid sentence forms are drawn from the set {bse, fin, inf, pas, prp, psp}. These different features correspond to the base infinitive, the finite, the infinitive, the passive participle, the present participle and the past participle forms of the verb. For prepositions and prepositional phrases, the form feature will describe the phonology of the preposition (e.g. to, from, by). As an example, the syntactic attribute of a sign with
phonology to-his-mother would be [pp, to]. Permissible forms for noun phrases can be drawn from the set {nom, obj, gen} as well as from the set of prepositional forms. Nom, obj and gen correspond to the three cases that are morphologically distinguished in English, namely nominative, objective, and genitive. Other languages could draw from a larger set of cases. Prepositional forms are included since prepositions often act as case markers for noun phrases (§ 5.4). Although GPSG introduces additional noun forms for it and there, these special forms will not be needed in the examples that we will be examining. For adjectives, the form feature is used to distinguish adverbs from adjectives. Adverbs are treated as a special kind of adjective, and possess the form specification adv, whereas adjectives possess the form adj. Again, this follows directly from proposals made in GPSG.

We will also include a predicative feature in the syntax of the sign. The prd feature can take on the values from the set {g, +, -, undef}. These four cases will be abbreviated gprd, +prd, -prd, "prd. Every sign of an FA structure has a value for this feature. The values of the prd features of signs are based on the predicative properties of the linguistic expressions associated with the signs. Signs associated with generalised predicatives possess the feature gprd. Viewed in terms of FA structures, if a subtree possesses a noun phrase argument-sign and has a root-sign corresponding to either a sentence or a noun phrase, then the functor-sign must be marked as gprd. This corresponds to the definition of generalised predicatives provided in chapter two which states that they take noun phrase denotations as arguments and result in either sentence or noun phrase denotations — our tree structures are based on predication structures. Functors which take noun phrase arguments but which are not generalised predicatives have the prd value ‘+’. That is, all other subtrees having noun phrase argument-signs will have functor-signs with a +prd feature. All other functors take the value ‘-’, with all arguments having an undefined value. As an abbreviatory convention, we will not specify the predicative feature on argument signs. From this discussion, we can see that the introduction of the prd feature is not actually necessary. The presence of prd does not add any meaningful information to the FA structure; all of the relevant predicative information is already contained in the category names and functor/argument status of the different signs in the FA structure. The different reflexive relationships which are dependent on this feature (§ 3.3.2) could be associated with the different category values in an FA structure instead. However, the introduction of the prd feature makes it easier to highlight the different relationships.

The foot feature is used to handle unbounded dependencies in TUG, and is adapted from the foot feature SLASH used in GPSG (Gazdar et al. 1985, Chap.7). This feature is used as a store of information for establishing a relationship between a ‘moved’ constituent.
and its 'trace.' For example, consider the analysis of the sentence introduced in (4.6) in a categorial framework augmented with an unbounded dependency store.

(4.6) Mary, I love.

Let us assume that the category of each constituent is described by the pair $<C, S>$, where $C$ is a UCG-like category description and $S$ is the store. The store would be empty for lexical entries. For the sentence from (4.6), the category of the subject noun phrase $I$ would be $<\text{np}[\text{nom}], \phi>$ and that of object noun phrase $Mary$ would be $<\text{np}[\text{obj}], \phi>$. The verb would be of the category $<\text{sent}/\text{np}[\text{nom}]/\text{np}[\text{obj}], \phi>$. In the topicalised sentence, there is no object noun phrase to the right of the verb. Since the grammar rule for combining the verb with its object noun phrase would not be applicable, an alternative grammar rule would be required. It would place the category of the 'missing argument' of the verb into the store and remove it from the category description. Ignoring semantics, the sign resulting from this operation would look something like the following.

(4.7) love

\[<\text{sent}/\text{np}[\text{nom}], \text{np}[\text{obj}]>\]

Then, the verb could combine with the subject noun phrase, $I$, in the usual manner to yield the description as shown in (4.8).

(4.8) I-love

\[<\text{sent}, \text{np}[\text{obj}]>\]

A special rule would then remove the element from the store and combine it with the topicalised noun phrase to yield the final expression.

(4.9) Mary-I-love

\[<\text{sent}, \phi>\]

A treatment for unbounded dependencies in TUG could be proposed without requiring the introduction of a store. Such a proposal would rely on incorporating functional composition and type-raising into a categorial grammar (Steedman 1985). One possible rule of functional composition is shown in (4.10).

(4.10) $X/Z \rightarrow X/Y, Y/Z$

Let us start with $NP$ and $S$ as our basic categories. Again consider the expression $Mary, I love$. Assume that the verb possesses the traditional category specification $(S\!\!NP)/NP$ — it is 'looking' to the right for one $NP$ and then to the left for another $NP$ in order to yield an
S. If the subject NP is type-raised to be of category \( S/(S'NP) \) then functional composition (4.10) can be used to combine I with love, where \( X=S, Y=S\,NP \) and \( Z=NP \). The constituent for I love will be of the category \( S/np \). If the topicalised noun phrase is also type-raised to have a category of the form \( T/(S/np) \), where \( T \) is a basic category for topicalised sentences, then the topicalised noun phrase can take the constituent corresponding to the expression I love as its argument — forward functional application results in a topicalised sentence. The categories \( S \) and \( T \) are distinguished to prevent multiple topicalisations. Instead of the category of the ‘moved’ constituent being placed into a store, it is encoded in a category name until the ‘moved’ constituent is encountered.

Since we have so far avoided the use of type-raising, it would be preferable to adopt a treatment of unbounded dependencies that would not require its use. We will adopt a storage-based treatment of unbounded dependencies which will require the use of a syntactic foot feature. Bouma (1987) also adopts such a proposal for treating unbounded dependencies in a unification categorial framework. The value of the foot feature will either be nil (ie. [ ]) or a list containing a single sign that will be associated with the ‘moved’ constituent. In our simplified account of unbounded dependencies, only constituents possessing a bar feature of value 2 will be allowed to appear in the foot feature. This means that nouns, verbs (including verb phrases) adjectives, and prepositions cannot be involved in unbounded dependencies, while noun phrases, sentences, adjectival phrases (including adverbials), and prepositional phrases can be. Unfortunately, this means that VP-preposing, as illustrated in (4.11) which is based an example from (Radford 1981, p.214), could not be treated as a form of unbounded dependency unless we altered our syntactic features or our restrictions on the contents of the foot feature.

(4.11) I suspected he would be playing cricket, and playing cricket he was.

However, we will be primarily concerned with topicalised noun phrases and the distribution of reflexive pronouns in these constructions (§5.3), not with the numerous restrictions on unbounded dependencies — the emphasis of this thesis is on reflexive anaphora, not unbounded dependencies.

4.1.3. Semantics

Our semantic representation is adapted from the Indexed Language (InL) introduced in (Zeevat, Klein and Calder 1987). InL is based on Kamp’s Discourse Representation Theory (1981) along with Davidson’s treatment of verb semantics (1967). After providing an overview to InL, a formal definition of the syntax of this language will be provided. This formal definition will not only explicitly describe the structure of InL formulae, but it
will also allow us to show how InL formula can be translated into the traditional discourse representation structures described in (Kamp 1981).

4.1.3.1. Overview of InL

One of the advantages that InL has over traditional DRT is that the former allows a complex formula to be built incrementally during sentential analysis, while the latter, as formulated in (Kamp 1981), does not. Incremental construction is a desirable trait for our framework since we want to use semantic information during sentential analysis to perform anaphora resolution. If, as in traditional DRT, the semantics were constructed after syntactic analysis, then we could not use antecedent information during analysis to rule out possible derivations.

The index of an InL formula is "crucial" for the treatment of modifiers, and it turns out that it is the fundamental component of the semantics that is required for our treatment of reflexivisation. In fact, most of the rest of the semantic formula is irrelevant with respect to reflexive anaphora resolution. The index also plays an essential role during the incremental construction of the semantic formula associated with a linguistic expression. However, with respect to the interpretation of the semantics, the index is often irrelevant. Before we consider how the 'meaning' of an InL formula is determined, we shall provide a more thorough description of the InL language itself.

An mentioned earlier, an InL formula is of the form \([a]S\), where \(a\) is the index of the formula and \(S\) is the condition. In its simplest form, \(S\) consists of the necessarily false condition \(\bot\), or the necessarily true condition \(T\). Alternatively, \(S\) may be composed of a predicate name followed by an argument list. Each argument is either a sorted variable (discourse marker), or an InL formula. Some special predicates which take two InL formulae as their arguments are the semantic connectives and, impl, and no. The use of these predicates is illustrated in the InL translations of the simple sentences shown in (4.12)

\[
\begin{align*}
\text{(4.12) Every man walks.} & \quad [s1] \ [(m1]\text{man}(m1) \Rightarrow [e1]\text{walk}(e1,m1)] \\
\text{John loves Mary.} & \quad [s1] \ [(m1]\text{john}(m1), [s1][f1]\text{mary}(f1), [s1]\text{love}(s1,m1,f1))] \\
\text{No woman walks.} & \quad [s1] \ \text{no(}(f1)\text{woman}(f1), [e1]\text{walk}(e1,f1))] \\
\text{John wants to walk.} & \quad [s1] \ [(m1]\text{john}(m1), [s1]\text{want}(m1, [e1]\text{walk}(e1,m1))]
\end{align*}
\]

In these examples, the conditions involving the connectives impl and and have been displayed in infix form according to the abbreviations discussed in § 3.1.1. Notice that proper names introduce conditions that modify existing events or states. Indefinites behave in this way as well. This is contrasted with the quantifiers no and every which introduce a new marker that describes the state. The predicate want takes two arguments, one of
which is a discourse marker while the other is an InL formula. By allowing a complex InL formula to appear as an argument of a verbal predicate, opaque contexts associated with verbs like believe and say can be represented (Zeevat 1987).

Sorted variables or discourse markers used in InL are represented as complex structures. Each discourse marker possesses a sort specification along with a unique identifier. The identifiers, which take the form of integers, are used to distinguish variables of the same sort. A subsumption hierarchy of sorts which is taken from Zeevat (1987) is shown in (4.13).

(4.13)

```
undefined
  \______________\  \______________\
temporal          object
                  \______________\  \______________\
state          process          mass          countable
                \______________\  \______________\
nonculminating  event          singular    plural
                          \______________\  \______________\
                               male      female    neuter
```

For any two sorts in this hierarchy, if one sort is dominated by another then the first sort is a subsort of the second. For instance, an element of the ‘male’ sort is also an element of the ‘object’ sort. Sorts that are on different ‘branches’ of the hierarchy are incompatible. Since we are primarily concerned with reflexive anaphora, it is the different kinds of singular sorts that we will be most interested in.

4.1.3.2. Syntax of InL

We will now formally define InL as a typed language, patterning our definition from one used to describe Montague’s intensional logic language (Dowty, Wall and Peters 1981). The two primitive types $m$ and $c$ will be used which will correspond to discourse markers and to indexed formulae respectively. These two types loosely correspond to the traditional types for entities and truth values, $e$ and $t$. For simplicity sake, we will not be discussing the different sorts that could be associated with the markers. The treatment of sorts could be incorporated by having a different type associated with each sort. As it turns out, the sort of the marker will be irrelevant in our translation of InL formulae to DRSs. Our definition of types will be organised so that an expression will have a type associated with it if and only if it is an InL formula.
Types
1. \( m \) and \( c \) are nonrecursive types
2. \( c \) is a recursive type
3. if \( a \) is a nonrecursive type and \( b \) is a recursive type, then \( <a, b> \) is a recursive type

The first clause of the definition introduces the type for expressions that can act as arguments of semantic predicates, and the second clause introduces the type for indexed formulae. The final clause defines types for semantic predicates that take discourse markers and indexed formula as their arguments. According to our definition of types, \( <m, c, c> \) and \( <m, c> \) would be valid types but \( <c, m> \) and \( <<-m, c>, c> \) would not be.

The basic expressions of our language are described by the following definition.

Basic Expressions
1. for type \( m \), a countably infinite supply of constants of that type; these constants are from a countably infinite set \( D \).
2. for each recursive type, a countably infinite supply of constants of that type; these constants are of the form \([x]\alpha\), where \( x \) is from the set \( D \) and \( \alpha \) is from some countably infinite set \( P \).

We have introduced the sets \( D \) and \( P \) in order to allow a straightforward translation from InL formulae to DRSs. The set \( D \) will correspond to DRT discourse markers with the set \( P \) corresponding to DRT predicates. Included in our basic expressions will be constants of the form \([x]_\land \) and \([x]_T \) which will be of type \( c \), and constants of the form \([x]\land, [x]\impl \) and \([x]\no \) which will be of type \( <c, c, c> \).

Using our definitions of types and basic expressions we can recursively define the set of InL formulae.

InL Formulae
1. every constant \( \alpha \) of some type \( a \) is an InL formula of type \( a \); this will be denoted as \( \alpha \in \text{InL}_a \), where \( \text{InL}_a \) is the set of InL formulae of some type \( a \)
2. if \([x]\alpha \in \text{InL}_{<b, \alpha>} \) and \( \beta \in \text{InL}_b \) (for some nonrecursive type \( b \)) then \([x]\alpha(\beta) \in \text{InL}_a \)

The first clause states that all of the constants introduced as basic expressions are InL formulae. Clause 2 describes how complex formulae are constructed from predicates that take either indexed conditions or discourse markers as arguments. According to this definition, what we have usually been expressing as \([s1]\love(s1, m1, f1)\) should actually be written as \([s1]\love(f1)(m1)(s1)\). For readability, we will still use the first format as an
abbreviation for the second. Note that we are treating isolated discourse markers as valid InL formulae. This could be prevented by altering our definitions so that only expressions of recursive types would be valid InL formulae. For our needs, it does not matter whether or not single discourse markers are valid InL formulae.

4.1.3.3. Translation of InL Formulae to DRSs

If we do not concern ourselves with the details of the semantics of the verbs with respect to time, an InL formula can be interpreted by converting it into an equivalent DRS using a procedure outlined in (Zeevat 1987). The resulting DRS can then be interpreted relative to a model as discussed in (Kamp 1981). A DRS can be represented by an ordered pair $[M, C]$, where $M$ is a set of discourse markers, and $C$ is a set of conditions on markers and on other DRSs. The predicates used to form these conditions come from the set $P$, which was described earlier, with the discourse markers coming from the set $D$. We will now define the function $DRS$ which translates an InL formula of type $c$ or $m$ into an associated DRS.

Translation

1. if $\alpha \in \lnL_c$, then $\text{DRS}(\alpha) = [\text{DM}(\alpha), \text{COND}(\alpha)]$

2. if $\alpha \in \lnL_m$, then $\text{DRS}(\alpha) = \alpha$

The function $\text{DM}$ appearing in the first clause of this definition describes the set of discourse markers that are associated with an lnL formula.

$$(4.14) \quad \text{DM}(\{a\}P(t_1)\ldots(t_n)) = \{a\}$$
$$\text{DM}(\{a\}\text{and}(A)(B)) = \{a\} \cup \text{DM}(A) \cup \text{DM}(B)$$
$$\text{DM}(\{a\}\text{impl}(A)(B)) = \{a\}$$

For the first clause of the definition, $n$ can be any integer greater than or equal to zero. Thus, this clause also works for when $P$ is $\bot$ or $T$. The function $\text{COND}$ determines the set of conditions corresponding to a formula.

$$(4.15) \quad \text{COND}(\{a\}P(t_1)\ldots(t_n)) = \{P(\text{DRS}(t_1), \ldots, \text{DRS}(t_n))\}$$
$$\text{COND}(\{a\}\text{and}(A)(B)) = \text{COND}(A) \cup \text{COND}(B)$$
$$\text{COND}(\{a\}\text{impl}(A)(B)) = \{ \text{DRS}(A) \Rightarrow \text{DRS}(B) \}$$
$$\text{COND}(\{s\}\text{no}(A)(\{a\}B)) = \{ \text{DRS}(\{a\}\text{and}(A)(\{a\}B) \Rightarrow \text{DRS}(\{s\}\bot) \}$$

The semantic connective $\text{and}$ is translated so that the conditions introduced by its two arguments are all incorporated into the same DRS. $\text{Impl}$ is translated directly into DRT implication. Notice that the translation of an expression containing the semantic connective $\text{no}$ is defined in terms of $\text{and}$, $\text{impl}$ and the necessarily false formula $\bot$. So, a formula like
(4.16) has the same meaning as a formula like (4.17).

(4.16)  [s1] no(woman(f1), walk(e1,f1))
(4.17)  [s1] [e1][woman(f1),walk(e1,f1)] ⇒ [s1]⊥

Intuitively, these formulae have the interpretation that the presence of an event consisting of a woman walking entails a contradiction (ie. no woman walks). The DRS corresponding to the translation of (4.17) is shown in (4.18).

Clause two of the definition for DRS directly translates the discourse markers used in the InL formulae into the names of discourse markers in a discourse representation structure.

There are InL formulae for which there are no corresponding DRSs. Examples of such formulae, which are not of type $m$ or $c$, are shown below.

(4.19)  [m1] and([m1]man)
(4.20)  [s1] impl

Expressions like these can be interpreted as formulae which have undergone lambda abstraction of one or more of their arguments. That is, they behave like the formula shown in (4.21) and (4.22).

(4.21)  $\lambda B$  [m1] and([m1]man)(B)
(4.22)  $\lambda A\lambda B$  [s1] impl(A)(B)

We could amend our translation function so that formula like these would be interpreted as functions over DRSs and discourse markers. For instance,

if $[x]\alpha \in \text{InL}_{<b,\omega}$, then $\text{DRS}([x]\alpha)$ is a function $h$ such that for any $\beta \in \text{InL}_{b}$,
where $\text{DRS}(\beta) = y$, $h(y) = \text{DRS}([x]\alpha(\beta))$

So a formula like the one shown in (4.19), which is of type $<c,c>$, would be translated into a function from DRSs to DRSs.
It is not necessary to translate all formulae involving semantic connectives missing their arguments into functions over DRSs. Our translation function could for example translate formulae of the form \( \text{and}(A) \) directly into DRSs. That is, we might want to propose that our definition of \( \text{COND} \) be modified so that the following definition for non-quantified noun phrases is included.

\[(4.23) \quad \text{COND}([a]\text{and}(A)) = \text{COND}(A)\]

The other semantic connectives that we have introduced would correspond to quantified noun phrases. Partee (1988) introduces a classification which distinguishes between noun phrases which are essentially quantified and those which are not, and suggests that these two classes of noun phrases might have different semantic interpretations. However one decides to interpret noun phrases, the choice does not affect our treatment of anaphora since it is the \( \text{InL} \) formula and not its interpretation which is relevant to anaphora resolution.

Finally, the DRSs that result from our translation procedure differ slightly from those used in (Kamp 1981). The original formulation of DRT had constants instead of discourse markers associated with proper names and these constants were always placed in the top level DRS. Since a constant can always be represented as a special predicate over a discourse marker, the introduction of constants can be avoided. The DRSs resulting from the translation of InL formulae have the markers associated with proper names appearing in the sub-DRS in which they are introduced. Although this will not affect the interpretation of the DRSs, it is relevant for the DRS treatment of pronominal anaphora; discourse markers associated with proper names are 'reachable' from any DRS. However, since the possible antecedents for a pronoun are determined from antecedent information in an FA structure, and not from the DRS associated with an InL formula, the location of these discourse markers in the DRS is not relevant. This anaphoric property of discourse markers associated with proper names can be reflected in constraints on pronominal antecedent information. We will briefly discuss this kind of information in § 8.2.1.4.

4.1.4. R-antecedent Information

The reflexive attribute consists of a list of sorted variables as described in the previous chapter. Associated with this attribute, there may be a restriction of the following form.

\[(4.24) \quad [\ldots x_1 \ldots]\]

The restriction requires the sorted variable \( x \) to be an arbitrary member of the list
corresponding to the reflexive attribute.

To state that an element \( x \) is added to a list \( A \), the notation shown in (4.25) is used.

\[(4.25) \quad [x \uparrow A] \]

Aside from the operation of adding a single element to the list contained in the reflexive attribute, there will be cases where we will want to add several elements. This will require the use of a merge relation `++`. An expression of the form \( A++B \) will denote the list obtained by taking list \( B \) and adding all those elements in \( A \) that are not already present in \( B \). This relation will be useful for describing R-antecedent information associated with unbounded dependencies, and will also be used to describe the interaction of different sources of foot feature information (§ 5.3).

4.2. Function Argument Structures and Specifications

Recall that function argument (FA) structures were introduced as binary trees possessing signs as tree node labels. An FA structure describes how the information associated with various constituents of an expression contributes to the information associated with the entire expression. The explicit manner in which information is organised in these structures allows us to propose an elegant treatment of reflexive anaphora. In this section, we will look at FA structures and partial specifications of these structures in more detail.

An FA structure is a tree. Formally, a tree is a directed acyclic graph. A graph consists of nodes connected by edges. In a directed graph, if there is an edge from node \( A \) to node \( B \), then this edge provides a path from \( A \) to \( B \), but it does not provide a path from \( B \) to \( A \). The path relation between two nodes is transitive. Each tree has a unique root node. For each node in the tree, there is a unique path to it from the root node. Since a tree is an acyclic graph, there is no path from a node to itself. From each node in a binary tree, there are either two edges leading from it to other nodes or no edges leading from it. In the first case, the node is called a nonterminal node, while in the second case it is referred to as a terminal node. An FA structure associates a label with each edge and node of a binary tree. Every node is labelled with a sign. For each nonterminal node, one of the edges leading from it is labelled with the name functor while the other is labelled with argument.

Partial specifications of FA structures are called FA specifications. An FA specification acts as a restriction on the structure of the binary tree which makes up an FA structure, and as a restriction on the labels contained in an FA structure. It describes a set
of FA structures that are compatible with it. FA specifications are combined to provide more and more information about an FA structure. As an FA specification becomes more complex, the number of FA structures described by the specification decreases. In this way, FA specifications acting as lexical entries provide restrictions on the FA structure that can be associated with a linguistic expression containing the lexical entries. The TUG grammar rule provides a means for relating these restrictions. Construction of a complex FA specification is thus an incremental process in that restrictions are proposed and never rescinded.

The distinction between FA structures and FA specifications is similar to that between directed acyclic graphs (DAGs) and DAG descriptions in the PATR-II framework, and that between the structures and descriptions discussed by Kasper and Rounds (1986). In PATR-II, the edges of a DAG are labelled with attributes while the terminal nodes are labelled with values. The DAG description is usually stated in terms of a set of equations from the description language. If we adopt a variation of the attribute-value notation used by PATR-II to describe FA structures, then we can very easily see how FA specifications act as partial descriptions of FA structures which can be combined to eventually yield a single FA structure.

First, an FA structure can be described in terms of an attribute-value structure as illustrated in the feature matrix introduced in Figure 4.1. The description associated with a nonterminal node of an FA structure consists of an attribute for the label of the node, which is called sign, and two attributes for the edges leading out of the node, which are called func and arg. The values for func and arg are descriptions of the functor and argument nodes respectively. A similar attribute-value description is used for terminal nodes, except that the func and arg attributes take on the value nil. A sign itself can be defined in terms of a feature matrix. The phonological, syntactic, semantic and R-antecedent information of a sign is contained in the phon, syn, sem and refl attributes as shown in Figure 4.1. Even the information contained within these attributes can be described in attribute-value notation. For instance, the syn attribute will have attributes for the category, form and predicate features of the syntax (cat, form and prd respectively). We will not concern ourselves with the internal structure of the category attribute. An InL formula contained in the semantics of a sign is described in terms of attributes for its index and its predicate, plus attributes for each argument.

An attribute-value structure or DAG can be described by a description language consisting of path equations. For instance, assume that the name FM1 refers to the feature matrix from Figure 4.1. The path expression FM1:func:sign:sem:index will access the
Mary-walks

<table>
<thead>
<tr>
<th>sign</th>
<th>phon</th>
<th>Mary-walks</th>
</tr>
</thead>
<tbody>
<tr>
<td>syn</td>
<td>cat</td>
<td>sent</td>
</tr>
<tr>
<td></td>
<td>form</td>
<td>fin</td>
</tr>
<tr>
<td>sem</td>
<td>index</td>
<td>e1</td>
</tr>
<tr>
<td></td>
<td>pred</td>
<td>and</td>
</tr>
<tr>
<td>arg1</td>
<td>index</td>
<td>f1</td>
</tr>
<tr>
<td></td>
<td>pred</td>
<td>mary</td>
</tr>
<tr>
<td></td>
<td>arg1</td>
<td>f1</td>
</tr>
<tr>
<td>arg2</td>
<td>index</td>
<td>e1</td>
</tr>
<tr>
<td></td>
<td>pred</td>
<td>walk</td>
</tr>
<tr>
<td></td>
<td>arg1</td>
<td>e1</td>
</tr>
<tr>
<td></td>
<td>arg2</td>
<td>f1</td>
</tr>
<tr>
<td>refl</td>
<td></td>
<td>[f1]</td>
</tr>
</tbody>
</table>

FA Structure

Feature Value Matrix

Figure 4.1. Feature Matrix Corresponding to an FA Structure
index of the functor-sign’s semantics, namely \( eI \). A path equation consists of a path expression and a value assignment. To state that the reflexive attribute of the sign of \( FM1 \) is assigned the value \([\ ]\) the following path equation can be used.

\[
(4.26) \quad FM1: \text{sign:refl} = [\ ]
\]

Figure 4.2 contains the FA specifications for \( Mary \) and \( walks \) along with a series of path equations which correspond to each specification. These equations are displayed in an abbreviated form in which the name of the described structure is not included in the equation. For now, the auxiliary lists of the lexical entries will be ignored. FA specifications are partial descriptions of FA structures just as a series of path equations is a partial description of an attribute-value structure. Observe that there are two edges leading from the functor-sign of the FA specification for \( Mary \) which do not lead to any nodes. Similarly, there are two edges leading from the argument-sign of the FA specification for \( walks \). These hanging edges are associated with nodes whose terminal or nonterminal status has not yet been established. So an FA specification may either state that a constituent has no subconstituents (terminal node signs), it may state that it has subconstituents (nonterminal node sign), or it may say nothing about whether or not a constituent possesses subconstituents (node with hanging edges). For example, while the argument-sign in the FA specification for \( Mary \) is associated with a terminal node in a corresponding FA structure (as indicated by the lack of edges leading from this sign) the node associated with the functor-sign may either be a terminal or nonterminal node in an FA structure (as indicated by the presence of the hanging edges). This indeterminacy concerning subconstituents is reflected in the path equations. In the equations associated with the FA specification for \( Mary \), there are no equations assigning values to \( \text{func:arg} \) or \( \text{func:func} \) (whereas there are equations for \( \text{arg:arg} \) and \( \text{arg:func} \)). So the FA specification for \( Mary \) can either be compatible with an FA structure where the functor is a terminal node, or with an FA structure where the functor is some complex tree. Another interesting property illustrated in the equations introduced in Figure 4.2 is the presence of variables. Dependencies between different unspecified values in these matrices are denoted by the appearance of the same capital letter (variable) as the value of different attributes. Recall from § 1.3 that when the value of one of these attributes is specified (instantiated), then all other occurrences of the variable refer to the same specified value. Any two attributes which have the variable as their value will share the same value.

When the sets of equations for the two FA specifications from Figure 4.2 are unified, information is merged and a description of the FA specification for the complex expression \( Mary \ walks \) is obtained. This is shown in Figure 4.3. The values which were specified
Figure 4.2. Path Equation Description corresponding to an FA Specification
Figure 4.3. Merged Description of an FA Specification
entirely by information contained in the FA specification for Mary are shown in bold print in this figure. If one were to include an additional equation specifying the value of sign:refl to be [], then this set of equations would be describe the attribute-value structure (and FA structure) for Mary walks from Figure 4.1.

Until now, we have considered an FA specification to be characterised by a set of path equations describing its root node. In order to characterise the auxiliary list of an FA specification, it is necessary to impose one additional level of description. An FA specification will be described in terms of two attributes. The root attribute will consist of information describing the sign, func and arg of the FA specification in the manner just described, while the aux attribute will contain a list of path specifications describing different subtrees of the FA specification. This is best illustrated by an example. In Figure 4.4 we introduce an FA specification containing five signs and having an auxiliary list containing two elements. The actual information contained in the signs need not concern us here. The set of path equations associated with this FA specification are also provided in Figure 4.4. The value of the first member of the auxiliary list is specified to be the same as that of the argument of the root-sign's functor (according to the equation labelled α), while the value of the second member of the auxiliary list (i.e. the first member of the rest of the auxiliary list) is the same as that of the root of the FA specification (according to equation β). FA specifications which have empty auxiliary lists, like the depth zero FA specification introduced in Figure 4.5, are specified to have an aux value of nil.

Before we illustrate how grammar rules are used to combine FA specifications, let us briefly summarise some facts about FA structures and FA specifications. An FA specification provides a partial description of an FA structure just like path equations act as descriptions of attribute-value structures. It consists of a binary tree labelled with signs and an auxiliary list containing subtree pointers which are used to access information contained in subtrees of the binary tree. Unlike FA structures, the signs of an FA specification may contain uninstantiated variables. Each node may also be labelled with a subtree pointer which appears in the auxiliary list. Terminal nodes in an FA specification may be labelled with hanging edges to denote that the terminal or nonterminal status of the corresponding node in an FA structure is not yet specified. The nodes of an FA specification may also be labelled with a list of template names. Templates, which will be described during our discussion of the lexicon (§ 4.4.1), are themselves partial descriptions of FA structures which are unified at specified locations in FA specification.
Figure 4.4. Description of FA Specification with Auxiliary List

\[ \langle a, \beta \rangle \quad \beta: \text{Sign1} \]

\( \text{Sign2} \quad \text{Sign3} \)

\( \text{a: Sign4} \quad \text{Sign5} \)

FA Specification

Path Equations

(a) aux: first = root:func:arg
(b) aux: rest: first = root
aux: rest: first = nil

Figure 4.5. Description of FA Specification with Empty Auxiliary List

\( \langle \rangle \quad \text{Sign6} \)

FA Specification

Path Equations

root: sign = Sign6
root: arg = nil
root: func = nil
aux = nil

Figure 4.6. Description of FA Specification after Rule Application

\[ \langle \beta \rangle \quad \beta: \text{Sign1} \]

\( \text{Sign2} \quad \text{Sign3} \)

\( \text{Sign4/6} \quad \text{Sign5} \)

FA Specification

Path Equations

root: sign = Sign1
root: arg: sign = Sign2
root: func: sign = Sign3
root: func: arg: sign = Sign4
root: func: func: sign = Sign5
root: func: func: sign: arg = nil
root: func: func: sign: func = nil
root:func:arg:sign = Sign6
root:func:arg:arg = nil
root:func:arg:func = nil
aux: first = root
aux: rest = nil
4.3. The Grammar Rule

Grammar rule application in TUG corresponds to the unification of the descriptions associated with the different component FA specifications. Viewed in terms of path equations, rule application involves unifying the information associated with the auxiliary FA specification with some specified attribute of the primary FA specification. The unification of FA specifications can be stated in terms of path equations as shown in (4.27), where $FX$, $FP$ and $FR$ are the names of the structures for the auxiliary tree, primary tree, and resulting FA specification respectively.

$$
\begin{align*}
FX: root &= FP: aux: first \\
FR: aux &= FP: aux: rest \\
FR: root &= FP: root
\end{align*}
$$

Grammar rule application will unify the information associated with the root of an auxiliary tree with the value specified by the first member of the aux list of the primary tree, as specified in the first equation. The list left after removing the first element from the auxiliary list of the primary tree will become the auxiliary list of the new specification, according to the second equation. The final equation states that the resulting tree is the same as the primary tree (which has now become more specified as a result of unification).

The effect of rule application is illustrated in Figure 4.6. The FA specification shown in this figure is the result taking the FA specification from Figure 4.4 as the primary tree and the one from Figure 4.5 as the auxiliary tree. Additional information supplied by the auxiliary tree is introduced into the resulting FA specification — this information is shown in bold in the set of path equations from Figure 4.6.

Although the path equation version of the grammar rule (4.27) allows us to describe the effect of grammar rule application, this rule can be stated in a much more transparent form. First let $H_\alpha$ denote an FA specification with auxiliary list $\alpha$. The single grammar rule of TUG can be expressed as shown below.

$$
H_\alpha \rightarrow H_{[C|\alpha]} , \quad C_{[1]}
$$

This rule states that the auxiliary tree $C$ is unified with the subtree of $H$ described by the first element of the auxiliary list of $H$. Again, $[C|\alpha]$ denotes the list formed by adding $C$ to the front of the list $\alpha$. The result of this rule is a more fully instantiated version of the primary tree, $H$. The auxiliary list of the result will consist of all but the first element of the auxiliary list of the primary tree. Rule application requires the auxiliary list of the auxiliary tree to be empty, $[1]$. Viewed procedurally, this rule states how to construct a new FA specification from two pre-existing FA specifications. From a declarative point of
view, the rule merely states a relationship between FA specifications.

The actual order of elements in the auxiliary list does not make a difference; the same FA structure is described regardless of how the component FA specifications are combined. This means that the order in which FA specifications are combined could be based on the surface word order instead of the semantic order used in the auxiliary list of lexical entries that we have seen so far. For instance, a ditransitive verb like *give* appearing in a phrase like $NP_1$-give-$NP_2$-$NP_3$ could have its auxiliary list ordered so that the FA specification for $NP_2$ is combined with that of *give* before that of $NP_3$. In terms of processing this would be advantageous to many data-driven parsing strategies (i.e., parsers which use the words of the sentence being analysed to drive the parser). This is because the auxiliary trees combined by the grammar rule would be associated with adjacent constituents in a linguistic expression; in looking for an FA specification to combine with a given FA specification, only those for adjacent constituents would need to be considered.

We might envisage a more general form of the TUG grammar rule (4.28), shown in (4.29).

\[(4.29) \quad H_\gamma \alpha \rightarrow H_{[C\alpha]} \cdot C_\gamma\]

The juxtaposition of the lists $\gamma$ and $\alpha$ denotes list concatenation. In cases where $\gamma$ is empty, $\gamma \alpha$ is equivalent to $\alpha$ and this rule behaves exactly like (4.28). This rule resembles a functional composition rule of categorial grammar frameworks (4.30), whereas (4.28) is more closely tied to functional application (4.31).

\[(4.30) \quad \alpha / \gamma \rightarrow \alpha / C, \ C / \gamma\]

\[(4.31) \quad \alpha \rightarrow \alpha / C, \ C\]

However, we shall restrict ourselves to the first rule since it is sufficiently powerful for our needs.

Since FA structures, FA specifications and the TUG grammar rule can all be represented in the PATR-II formalism, one might ask why one should use TUG instead of PATR-II? Part of the answer to this question is the same for TUG as it is for other formalisms like UCG and HPSG. PATR-II is a tool for implementing grammars and is not a grammar formalism in itself. In TUG, we want to capture generalisations and observe the interaction of information in a format that is easy to understand and describe. The highly verbose and opaque path equations used in PATR-II are not well suited for this purpose, as is apparent from the complex descriptions in Figures 4.2 and 4.3. We will elaborate on this point in § 4.5.
4.4. The Lexicon

The lexicon of a tree unification grammar is highly structured. Generalisations that are generally captured in the syntax of linguistic formalisms are captured in the lexicon in TUG. FA specifications are used as lexical entries. The auxiliary list of an FA specification corresponds to the subcat list used in frameworks like HPSG, but instead of containing descriptions of signs, it contains descriptions of trees. Lexical entries can be defined in terms of templates and lexical rules.

4.4.1. Templates

Lexical templates (Shieber et al. 1983) can be used to describe structural properties shared by a class of lexical entries, and thus provide a mechanism for capturing linguistic generalisations. Lexical entries can be defined in terms of templates, and templates themselves can be defined in terms of templates.

In (Karttunen 1986), lexical templates are introduced for specifying the structure of directed acyclic graphs (DAGs). They can be used to assign values to attributes, and to specify relations between attributes. For example, based on the DAGs used in (Karttunen 1986), the template NP could be defined with a list of path equations as shown in (4.32).

\[(4.32) \quad (\text{NP} \ [\text{barlevel} = \text{two}, \ \text{cat} = \text{noun}, \ \text{case} = \text{obj}])\]

This simple template describes a noun phrase of the (default) objective case, and corresponds to the feature matrix displayed in (4.33).

\[
\begin{array}{ccc}
\text{barlevel} & \text{two} \\
\text{cat} & \text{noun} \\
\text{case} & \text{obj}
\end{array}
\]

Alternatively, the template definition for NP could make use of other templates. If we define the templates BAR2, NOUN and OBJ as shown in (4.34), then NP could instead be defined as shown in (4.35).

\[
\begin{align*}
(4.34) \quad \text{(BAR2} & \ [\text{barlevel} = \text{two}]) \\
(\text{NOUN} & \ [\text{cat} = \text{noun}]) \\
(\text{OBJ} & \ [\text{case} = \text{obj}])
\end{align*}
\]

\[
(4.35) \quad \text{(NP} & \ [\text{BAR2, NOUN, OBJ}])
\]

Lexical entries consist of an ordered list of templates and path equations which specify the DAGs associated with the entry. So a simple lexical entry for John could look like \([\text{NP, lex}=\text{John}]\). The feature matrix associated with this lexical entry is provided in (4.36).
Structures specified by an equation or template in this ordered list may be overwritten (overridden) by information supplied by equations or templates appearing later in the list. This means that the lexical entry

(4.37) \[ \text{[NP, } \text{lex} = \text{John, case} = \text{nom}] \]

would be equivalent to the following specification.

(4.38) \[
\begin{array}{ll}
\text{barlevel} & \text{two} \\
\text{cat} & \text{noun} \\
\text{case} & \text{nom} \\
\text{lex} & \text{John} \\
\end{array}
\]

The case specified within the \textit{NP} template was overwritten by the equation \textit{case=nom} which appeared later in the list associated with the lexical entry (4.37). So, true unification is not used in the construction of Karttunen’s lexical entries. The use of this ‘overwriting’ provides a means for specifying and overriding defaults.

We will propose templates in which only unification is used — overwriting will not be necessary for our needs. The templates of TUG closely resemble the FA specifications that are used in lexical entries in TUG. Like lexical entries, templates are partial specifications of FA structures and each node in a template may have a list of templates associated with it. Unlike lexical entries, templates are not required to possess auxiliary lists. Lexical entries may be viewed as a special type of template.

In Figure 4.7 we introduce three templates which embody the restrictions governing the distribution of R-antecedent information. These templates and others also appear in the appendix to this thesis. The templates \textit{R-GPR} and \textit{R-PR} from Figure 4.7 describe the interaction of R-antecedent and semantic information for generalised predicative functors and for predicative functors respectively. For functors that do not take noun phrase arguments (ie. non-predicative functors), the R-antecedent information for functor and argument signs is inherited from the root-sign as illustrated by template \textit{R-NPR}.

The three different templates introduced in Figure 4.8 describe the various relationships between the phonological information of the functor, argument and root-signs of any subtree in an FA structure. In \textit{P-PST}, the phonology of the root-sign is that of the argument followed by that of the functor. \textit{P-PRE} embodies the opposite relation, while \textit{P-
Figure 4.7. Templates for R-antecedent Information

Figure 4.8. Templates for Phonological Information
**WRP** is used to describe the wrapping relation between phonologies that was discussed earlier in this chapter.

The two syntactic templates from Figure 4.9 illustrate two different possibilities for how the syntax of the root-sign is formed from that of the functor-sign. Our syntactic templates embody the relationship that the syntactic category of the functor-sign is the same as that of the root-sign in any subtree with the *barlevel* of the root-sign either being the same as or one greater than that of the functor-sign (as shown in *C-EQ* and *C-B2* respectively). The functor acts as the head of the constituent described by the root; it possesses many of the same syntactic features as the complex constituent (Gazdar et al. 1985, Lyons 1968). We shall later see that there are some cases in which neither of these two templates are applicable.

The single semantic template called *S-TR* in Figure 4.10 illustrates how the semantics of the root-sign can be composed of the semantics of the argument-sign acting as a semantic functor over the semantics of the functor-sign, *S*. Additional semantic relations which will be introduced in later examples can be captured in additional templates.

Templates and lexical entries can be defined in terms of other templates. This is done by labelling a node in an FA specification with a list of template names. The template list is displayed to the right of the node in angle brackets. For every name appearing in the list associated with a node, a copy of the corresponding template is unified with the subtree rooted at the node. For a template or a lexical entry to be well formed, this unification operation must always succeed! Instead of unifying templates with the specified subtree of an FA specification, a variant of overwriting could be used instead. In this case, incompatibility of information between a lexical entry and a template would not resulted in an ill-formed FA specification, instead it would result in the overriding of a default.

In Figure 4.11, we introduce a template *NP-OBJ* which embodies information common to all object noun phrases. It is defined in terms of the templates *R-PR*, *S-TR* and *C-EQ*. This template is equivalent to the FA specification shown in Figure 4.12. A similar template, *NP-SUB*, is defined in Figure 4.13 for describing subject noun phrases.

An example of a lexical entry defined in terms of templates is provided in Figure 4.14. The subtree of the FA specification labelled by a template name has a copy of the specified template unified with it. Note that separate invocations of the same template do not introduce the same variables. Since the two invocations of *NP-OBJ* in Figure 4.14 are copies of the same template, the variables like *P* and *S* introduced by the 'higher' invocation of the template will be distinct from the *P"* and *S"* introduced by the 'lower'
Figure 4.9. Templates for Syntactic Information

Figure 4.10. Template for Semantic Information

Figure 4.11. Template for Object Noun Phrase

Figure 4.12. FA Specification for Object Noun Phrase

Figure 4.13. Template for Subject Noun Phrase
Figure 4.14. Lexical Entry (with templates) for Ditransitive Verb

Figure 4.15. Lexical Entry (without templates) for Ditransitive Verb
one. When the template lists contained in the lexical entry are expanded, the FA specification shown in Figure 4.15 is obtained.

The introduction of templates allows many linguistic generalisations to be stated in a concise manner. The distribution of R-antecedent information and the ordering relations on the composition of phonological information are just some of the relationships that can be captured in templates. Since templates may be defined in terms of other templates, linguistic generalisations may be defined in terms of other linguistic generalisations. This results in a hierarchical structure of the lexicon. Since lexical entries can be defined in terms of templates, redundancy of information can be greatly reduced. Lexical entries themselves are actually a special type of template which are used by the grammar rule.

4.4.2. Lexical Rules

Templates are not the only means for capturing linguistic generalisations in the lexicon. Generalisations can also be captured through the use of lexical rules. These rules can be viewed as productions which state how to form new lexical entries from pre-existing lexical entries. Alternatively they can be seen as redundancy conditions which hold between lexical entries.

Lexical rules play basically the same role as the bounded transformations of transformational grammar, the metarules of GPSG, and the lexical rules of LFG and HPSG. For example, the passive transformation of transformational grammar, the passive metarule of GPSG and the passive lexical rule of LFG and HPSG are all responsible for obtaining the derivation of a passive sentence from information describing non-passive sentences. In transformational grammar, the transformation is applied to a syntactic structure. The passive metarule of GPSG operates on grammar rules to produce passivised grammar rules. In LFG and HPSG, passivisation is captured in the lexicon as an operation over lexical entries; a passive lexical entry is created from its non-passive counterpart. All of these various passive rules capture a linguistic generalisation describing the relationship between passive and non-passive sentences. They just differ in where and how the generalisation is captured.

The notation used for these rules will consist of an FA specification (called the restriction) which is separated by an arrow from another FA specification (the result). For example, a lexical rule that can be used for topicalised noun phrases (which will be discussed in § 5.3) is shown in Figure 4.16. Any lexical entry that matches (unifies) with the FA specification forming the restriction of the rule can be modified as stipulated in the FA specification appearing as the result of the rule to produce a new lexical entry. Values introduced in the result can overwrite values present in the original lexical entry. The
Figure 4.16. Lexical Rule for Topicalised Noun Phrases

Figure 4.17. Lexical Entries for Topicalised and Non-topicalised Noun Phrases
lexical rule introduced in Figure 4.16 possesses a restriction that will match the lexical entry for any non-topicalised noun phrase (i.e., a noun phrase that has the same foot feature in both its functor and root-signs). According to the lexical rule, for any such noun phrase there will be a corresponding topicalised noun phrase FA specification which will have all of the information from the argument-sign (displayed in bold) contained in the foot feature of the functor-sign. The foot feature of the root-sign of a topicalised noun phrase is specified to be empty. The specification for an empty auxiliary list in the original lexical entry will be overridden with requirement for the auxiliary list to contain a single value.

Two lexical entries that are related by this lexical rule are shown in Figure 4.17. Not only will this rule be applicable to lexical entries for proper names like Mary, but it will also apply to lexical entries for determiners like every, which possess a root-sign which will match the restriction of the lexical rule as we shall see in §5.3. Notice that the restriction of the lexical rule will not match the lexical entry of a topicalised noun phrase.

We will be using lexical rules to outline relationships between lexical entries. Often they will be highly schematic with many details being left unspecified. Such lexical rules will be sufficient for our needs since we want to concentrate on reflexive phenomena and not on the detailed structure of the lexicon. A more thorough formulation of lexical rules would involve details concerning when values should be unified by the rules, and when and how they should be overwritten (Popowich 1985). A detailed proposal for lexical rules, like the one described in (Pollard and Sag 1987), could be incorporated in order to address these issues and others.

4.4.3. Summary

A tree unification grammar possesses a highly structured lexicon consisting of lexical entries, templates and lexical rules. Through the use of templates and lexical rules, many linguistic generalisations can be captured in the lexicon. It is the lexicon, together with the single TUG grammar rule that determines the language associated with a particular tree unification grammar. For a given start symbol σ and reflexive anaphoric context α, a sequence of words ω from some set W is a member of the language of a grammar iff there is some FA structure with root-sign ω;σ;S;α that is 'obtainable' from the lexicon and the single TUG grammar rule. The semantics of this sequence will be S. In the examples presented so far, we have seen examining finite sentences with empty foot features (σ=[sent,fin],[[]]) in a null reflexive anaphoric context (α=[[]]). Later, in §5.5 and §7.2, we shall see cases where the start symbol corresponds to a multi-sentence discourse instead of a single sentence.
4.5. Comparison with Other Frameworks

Merely by examining the name “Tree Unification Grammar,” one would expect it to be related to other unification-based frameworks, as well as to other tree-based frameworks. We will first consider its relationship to its closest relatives in the unification grammar family, namely UCG and categorial unification grammar (CUG) (Uszkoreit 1986). Then we will see how it differs from the tree-based formalism known as tree adjoining grammar (TAG) (Joshi 1983).

4.5.1. Unification Categorial Grammar

As introduced in § 3.1, UCG does not possess any mechanisms for handling anaphora and unbounded dependencies. So, it would not be fair to compare TUG with the standard UCG framework. In order to treat these constructions, some extensions to UCG have been proposed (Calder, Moens and Zeevat 1986). These extensions involve the addition of grammar rules, and the modification of the structure of the sign to include attributes for binding information.

In addition to the attributes for phonology, category, semantics and order, the sign of extended UCG contains an attribute for binding information entering a constituent, \( in \), and one for binding information leaving a constituent, \( out \). This binding information has separate attributes for \( gap \), \( clause \), \( definite \) and \( indefinite \). The gap information is used for handling unbounded dependencies, while the other three attributes are used in conjunction with an account of anaphora. Each of these attributes behaves as a store that can be used or modified by a constituent. A constituent may use the information from a store of the \( in \) attribute. This information can be modified by the constituent before it is placed into the \( out \) attribute where it can be accessed by another constituent. Consider a simplified sign containing attributes for phonological and categorial information as well as \( in \) and \( out \) attributes. A variation of functional application over these signs is introduced in (4.39).

\[
(4.39) \quad W_1\cdot W_2: \text{sent:} \ I_0; \ I_2 \rightarrow W_2: \text{np:} \ I_0; \ I_1, \ W_1: \text{sent/np:} \ I_1; \ I_2
\]

Any information introduced by the noun phrase will be placed into its \( out \) attribute, \( I_f \). This information will be available to the functor since \( I_f \) is associated with its \( in \) attribute. For handling reflexives, it is the discourse markers contained in the \( clause \) attribute that are relevant. Information about the antecedents of pronouns, which is obtained from the binding information, is incorporated into the semantics of the various constituents with the actual anaphora resolution being performed during a post-processing stage. For example, a general treatment of reflexives in UCG would associate a lexical entry like the following, ignoring type-raising, for the pronoun \textit{herself}.

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The binding information coming into the reflexive, *Bind*, is the same as the information that is going out since the reflexive does not introduce any new discourse markers or restrictions. This binding information is incorporated into the semantics of the reflexive. Now, the semantics of a complete sentence, like *Every woman loves herself*, would contain the binding restrictions introduced in the semantics of the pronoun.

During a post-processing stage, the *refl* condition would be evaluated. In the simplest case, this condition would only require the index of the reflexive to be a member of the clause list. Roughly, it would be translated as shown in (4.42).

\[
\text{(4.42) } \text{x}_{\text{refl}}(\text{[Gap,Clause,Def,Indef]} = \begin{cases} \text{true} & \text{if } x \in \text{Clause} \\ \text{false} & \text{otherwise} \end{cases}
\]

Unlike the above approach to reflexivisation, there is no need to invoke special mechanisms for passing R-antecedent information in TUG. Binding information is treated in the same manner as any other type of information. Only one attribute is required for the R-antecedent information instead two attributes corresponding to potential antecedents passing *in* and *out* of constituents. There is no need to defer reflexive anaphora resolution to a post processing stage.

Instead of treating reflexives with *in* and *out* attributes, one can instead augment the UCG sign with a reflexive attribute that behaves in the same way as the one used in TUG. To obtain the proper distribution of R-antecedent information, different grammar rules are required for generalised predicative, predicative and non-predicative functors. For each rule, the relationship between the R-antecedent information of the functor and the result is different. Essentially, these rules have to capture the relationships described by the TUG templates for R-antecedent information. As discussed in § 3.1.3, this could lead to a proliferation of grammar rules. However, this large increase in the number of rules can be avoided if the arguments of predicative functors are type-raised. With type-raising, an argument can describe how the R-antecedent information of its functor is obtained from that of the result and from that of the argument. Consider the following type-raised noun phrase.
The R-antecedent information, $A$, of the result is the same as that of the argument, $A$, while the R-antecedent information, $[m1|A]$, of the functor over the noun phrase is composed of the index of its argument plus the R-antecedent information of the result. This describes the behaviour of R-antecedent information at non-generalised predicatives. Unfortunately, this approach requires different lexical entries for the arguments of generalised predicative and non-generalised predicative functors. Additional restrictions, like the inclusion of a prd feature, need to be added to these different lexical entries to ensure that they apply at the appropriate locations. So, although this alternative would not entail an increase in the number of grammar rules, it would require widespread type-raising and an increase in the number of lexical entries.

In sum, TUG can be viewed as a generalisation of UCG in which derivational structures are described explicitly in lexical items, instead of indirectly in conjunction with a grammar rule. Relations that are captured in the UCG grammar rules are captured in the TUG lexical entries. One advantage of utilising TUG as a framework in lieu of UCG lies in the greater ease for describing various configurations of features in derivation trees. In particular, it is easier to describe derivational structures (like those required for describing reflexive anaphora) where a functor and its result have different values for the same feature. TUG requires only a single grammar rule and type-raising is not required.

4.5.2. Categorial Unification Grammar

Uszkoreit (1986) introduces Categonal Unification Grammar as a class of grammars which combine the features of categorial grammars with those of unification grammars. UCG is closely related to CUG, and might be viewed as a member of the CUG class of grammars except that UCG is based on term unification while the CUG relies on graph unification. Instead of analysing the differences between CUG and UCG, we will instead briefly describe the CUG formalism and then examine the relationship between it and TUG.

In CUG, directed acyclic graphs (DAGs) are used as the basic grammar structures. Grammatical constituents possess attributes for phonology (lex), syntax (cat, function and agr), and semantics. The function attribute takes on a NIL value for arguments, otherwise it has attributes for specifying the argument (arg), result (value), and direction (dir) of the
functor. These constituents are essentially the signs of CUG. Some examples of constituents are shown in Figure 4.18. The first, $\alpha$, is a possible lexical entry for *walks*, while the second, $\beta$, is one for *Mary*. Two grammar rules, for forward and backward functional application, are used to form new constituents. These grammar rules are highly 'underspecified,' allowing the functor to state how a new constituent, the *value*, is formed from information contained in the functor and from information contained in the argument. The result of functional application of $\alpha$ to $\beta$ is shown as $\delta$ in Figure 4.18. Unlike UCG, the attributes of the *value* can be specified to be different than those of the functor without the need for increasing the number of grammar rules. So, although there is no account for reflexives in the CUG framework, an approach like the one adopted in TUG could be incorporated into CUG.

CUG is similar to PATR-II in that it could serve as a language into which TUGs could be translated. A potential disadvantage of CUG is that it might be too unrestricted in the type of operations that it allows (van Benthem 1987). In addition, the type of structures allowed in TUG is very restricted (binary trees containing only a fixed number of attributes) while those allowed in CUG are much more unrestricted. The structures used by TUG, UCG and other formalisms can be translated into a low-level format consisting of CUG DAGs. A major short-coming of using CUG or PATR-II as a linguistic formalism is that the dependencies that are necessary for determining anaphoric relationships are 'hidden' in the DAG describing the linguistic expression; information is distributed in a flat graph structure with no higher order grouping expressed. Although this may be beneficial with respect to implementing grammars, it can make it difficult to work with the structures. The advantage of the FA structure is that it is an explicitly hierarchical representation structure — a tree with structured nodes — instead of a graph of simple nodes. This hierarchical structure allows many linguistic generalisations, particularly those associated with reflexivisation, to be stated easily and transparently.

4.5.3. Tree Adjoining Grammars

Tree adjoining grammars possess trees as basic grammar structures, and grammar rules are used to alter the structure of these trees. The relationship between TUG and TAG is very superficial as will be illustrated after a short description of the framework.

Tree adjoining grammars contain *initial* trees and *auxiliary* trees which are manipulated by grammatical operations. Initial trees are defined as n-ary trees possessing only terminal symbols as leaves. The leaves of an auxiliary tree are all terminal symbols except for a single nonterminal, the *foot*, which is of the same category as the *root* of the tree. These two types of trees comprise the class of elementary trees. There is a tree
Figure 4.18. Categorial Unification Grammar DAGs
adjoining operation which is used to form derived trees. Application of this rule results in the insertion of auxiliary trees into the middle of initial trees or other derived trees, subject to specific restrictions.

In Figure 4.19 which contains examples taken from Joshi (1983), the initial tree $\alpha$ is associated with the sentence *The girl is a senior.* For forming relative clauses, an auxiliary tree like $\beta$ can be used. The root and foot nodes of $\beta$ are circled in Figure 4.19. It is the root node that is adjoined into an initial or derived tree at the adjoining node, with the constituent that was located at the adjoining node being displaced to the foot of the auxiliary tree. The result of adjoining $\beta$ to the subject NP of $\alpha$, which is displayed in bold, is illustrated by tree $\alpha'$. This derived tree corresponds to the sentence *The girl who met Bill is a senior.*

Dependencies between nodes are denoted with *links* which are represented with curved lines. They are present in elementary trees, as illustrated in $\beta$, and are unaffected by the adjoining operation, as shown in $\alpha'$. Adjoining cannot introduce these links. Conceivably, links might be used as a way for establishing a relation between a reflexive and its antecedent. Unfortunately, this would require all reflexive anaphoric dependencies to be present in the elementary trees, which could lead to difficulties accounting for many picture-noun constructions. Recall that reflexives may be embedded within multiple picture-nouns as was illustrated in (3.12) which is repeated below.

(4.44) John loves a book about a picture of himself.

We would need separate elementary trees for the phrases *loves a book about*, for *loves a book about a picture of* and so on.

TAGs are fundamentally different from TUGs, since the adjoining operation alters the structure of the tree, instead of merely further instantiating it. Adjoining involves the insertion of trees at internal nodes while the TUG operation can be viewed as the overlaying of trees to form larger structures. The TAG framework has fully specified trees that are modified by other fully specified trees in order to obtain more complex fully specified trees. In TUG, partially specified trees are combined (not modified) in order to obtain a more fully specified complex tree.

4.6. Summary

Tree unification grammar possesses FA specifications as lexical entries, and has a single grammar rule which combines these specifications to produce more detailed FA specifications. The lexical entries of TUG can be viewed as contributing constraints to the
Figure 4.19. Tree Adjoining Grammar Structures
A FA structure that is associated with a complex linguistic expression with the single grammar rule being used to combine these constraints. During the analysis of an expression, constraints are continually proposed and never rescinded. Eventually, these constraints will describe the final FA structure(s).

Information is organised in an FA structure in a hierarchical fashion. The FA structure is a tree containing signs which contain the phonological, syntactic, semantic and R-antecedent information of different linguistic constituents. Due to this type of information organisation, many relationships between constituents can be stated concisely and transparently. In particular, the constraints on reflexivisation can be incorporated into a grammar very easily.

Since TUG possesses but a single grammar rule, linguistic generalisations are captured solely in the lexicon. This is achieved through the use of templates and lexical rules. The lexicon itself is hierarchical in that templates can be defined in terms of other templates, and lexical rules can be defined in terms of templates.
Chapter 5
A Grammar for Reflexives

So far, we have been concentrating on the Tree Unification Grammar framework and on how the constraints on reflexivisation outlined in chapter two can be incorporated into a grammar. Our focus will now shift from the discussion of the framework itself to a proposed TUG grammar which will describe the distribution of reflexive pronouns in various constructions. We will see how the general principles concerning R-antecedent information apply to a wide selection of constructions, and how other more specific restrictions associated with individual lexical entries interact with the general principles.

Since Tree Unification Grammar requires only a single grammar rule, most of this chapter will be devoted to the introduction of various lexical entries and to the examination of FA structures described by these lexical entries. Recall that a lexical entry is an FA specification consisting of a partial specification of an FA structure along with an auxiliary list. The auxiliary list specifies subtrees of the FA specification with which other FA specifications must be unified. It is represented as a list of labels contained in angle brackets appearing to the left of the FA specification. In this chapter, lexical templates will be used to highlight aspects of the relationships being discussed. The list of template names associated with a node in a FA specification appears to the right of the node.

In presenting a grammar fragment, we will be concentrating on constructions where proper names, universally quantified noun phrases, indefinite noun phrases and possessive noun phrases introduce discourse markers which act as potential antecedents for reflexive pronouns. Analyses for expressions containing the definite article will not be provided. We shall start by looking at some constructions which contain complement clauses and see how the general principles governing the distribution of R-antecedent information affect the anaphoric relationship between reflexives and their antecedents in these constructions. Possessive constructions will then be examined, followed by a detailed analysis of expressions containing unbounded dependencies. We will then look at an account of the distribution of reflexives in prepositional phrases, concentrating on some notoriously troublesome cases where other restrictions on reflexivisation appear to interact with the general principles. Finally, a TUG account of the sloppy/strict distinction of reflexive pronouns in certain constructions will be introduced.
5.1. Complement Clauses

Up to now, the TUG analyses that have been presented have been limited to single clause sentences. What happens to R-antecedent information when a sentence contains more than one clause? The cases that are the most interesting with respect to reflexivisation are those in which verbs subcategorise for clauses known as finite complements and infinitival complements.

5.1.1. Finite Complements

Finite complements will be distinguished from normal sentences by the appearance of a syntactic feature called \textit{comp}. This feature is introduced by a complementiser, like the word \textit{that}. For finite complements in English, the appearance of this complementiser is often optional. So, the sentences shown in (5.1) and (5.2) both mean the same thing.

\begin{align*}
(5.1) & \quad \text{John said that he loves Mary} \\
(5.2) & \quad \text{John said he loves Mary}
\end{align*}

In (5.1), the complement \textit{he loves Mary} is introduced by an explicit complementiser, \textit{that}, while in (5.2) there is no complementiser.

For constructions where there is an explicit complementiser, a lexical entry like the one shown in Figure 5.1 acts as a primary tree to be combined with the FA specification of a finite sentence. Again, recall that the left to right ordering of functor and argument branches is not relevant in an FA specification or FA structure; branches will usually be displayed in an 'argument-first' manner except when this notation makes it difficult to fit a tree within a figure. In the resulting FA specification, the finite sentence appears as an argument of the complementiser. Notice that the complementiser does not make any semantic contribution to the semantic attribute of the complement clause. A similar lexical entry would allow constructions like \textit{that he be there} where the verb contained in the complement is in its base form (\textit{bse}). Notice that the form feature of a sentence complement contains the specification \textit{comp} instead of something like \textit{fin} or \textit{bse}. There is no need for both \textit{comp} and \textit{fin} to be present on the root sign of the FA specification for the complement clause since the actual verb form of the embedded clause can be obtained from the argument-sign of the FA specification. So for a verb like \textit{say} which can take a finite complement, the requirement need only be specified in the FA specification as shown in bold in Figure 5.2.

Although a lexical entry like the one introduced in Figure 5.1 can account for sentences like (5.1), how do we handle sentences like (5.2) where there is no explicit
Figure 5.1. Lexical Entry for Complementiser

\[ \alpha: W \rightarrow \text{that-W} \]
\[ [\text{sent,comp}] \]
\[ [a]S \]
\[ \lambda \]

Figure 5.2. Lexical Entry for "says"

\[ \beta: W\text{-says-W'} \]
\[ [\text{sent,fin}] \]
\[ \lambda \]
\[ \lambda ]\]
\[ P((x)S) \left[ \lambda e1[\text{say}(e1,x,a),[a]S'] \right] \]
\[ \lambda \]
\[ W \quad \text{says-W'} \]
\[ [\text{np,nom}] \]
\[ \lambda P((x)S) \]
\[ \lambda \]
\[ e1[\text{say}(e1,x,a),[a]S'] \]
\[ [x] \]

\[ \alpha: W' \rightarrow \text{says} \]
\[ [\text{sent,comp}] \]
\[ [a]S' \]
\[ [\lambda x] \]
\[ e1[\text{say}(e1,x,a),[a]S'] \]
\[ [x] \]

Figure 5.3. Lexical Rule for Finite Complements

\[ \text{AUX} \]
\[ [\text{sent,fin}] \]
\[ [a]\text{Sem} \]
\[ \lambda \]

\[ \text{Phon} \]
\[ [\text{sent,fin}] \]
\[ [a]\text{Sem} \]
\[ \lambda \]

\[ \varepsilon \]
\[ [\text{sent,comp,-prd}] \]
\[ \lambda \]
\[ \lambda ]\]
\[ \text{true}(a) \]
\[ \lambda \]
complementiser? We could propose a lexical entry for a null complementiser which would be much like the one for *that* except for possessing a null phonology $e$. By associating a sign with null phonology with the complementiser, we allow the same lexical entry for *say* to be used regardless of whether or not the complement contains an explicit complementiser. Instead of proposing a lexical entry for the null complementiser, a lexical rule can be proposed which introduces a complement version of a sentence for every lexical entry describing a finite sentence. Such a lexical rule is shown in Figure 5.3. For any lexical entry matching the restriction of the lexical rule, there is a lexical entry with the same auxiliary list, *AUX*, which contains the FA specification of the finite sentence as its argument (shown in bold). The functor-sign of the resulting FA specification describes a null complementiser. A similar lexical rule could account for complements with explicit complementisers thus avoiding the need for a lexical entry for complementisers. Regardless of whether one uses a lexical rule or a lexical entry, the resulting FA structures are the same.

Although the lexical entry for *says* allows the complement clause to have either an explicit or null complementiser, not all lexical entries are like this. Some verbs, like *regrets* subcategorise for a finite complement containing an explicit complementiser. Such a requirement would be reflected in the lexical entry for *regret* by the presence of a restriction in the sign associated with the complementiser. This restriction would prevent the use of a null complement — it could specify the phonology of the complementiser to be *that* instead of being unrestricted as it is in the lexical entry for *says*.

It is generally assumed that locally bound reflexive pronouns must be bound within the clause that contains them. For a sentence like *Jane said that Mary loves herself*, the subject of the matrix sentence, *Jane*, is considered to be unavailable as an antecedent for the reflexive due to the presence of a clause boundary between the anaphor and antecedent. The FA structure for this sentence is provided in Figure 5.4. Our restrictions on the distribution of R-antecedent information have not mentioned clause boundaries; the only requirement has been for R-antecedent information to be blocked at generalised predicative boundaries. This restriction results in *Mary* being the only possible antecedent for the reflexive as shown in Figure 5.4 — $f1$ is the only discourse marker contained in the reflexive attribute of the sign for the reflexive pronoun. The sign with phonology *loves-herself* is a generalised predicative and thus its reflexive attribute [$f1$] does not contain any information (ie. the marker $f2$) from the reflexive attribute of its parent sign. However, there is nothing to prevent the R-antecedent information, [$f2$], that is available to the complement from being available to the embedded subject as highlighted in Figure 5.4. So the noun phrase, *NP*, in a construction like
Figure 5.4. Finite Complement with Embedded Reflexive

Figure 5.5. Finite Complement with Picture-Noun Subject
Jane told Mary that NP loves no-one

will have the discourse markers corresponding to Jane and Mary in its R-antecedent information. This raises a question about the grammaticality of sentences where the subject of a finite complement contains a reflexive.

In English, the presence of a reflexive as the subject of a finite complement is prohibited not by the unavailability of an antecedent but rather by a syntactic feature which requires the subject to possess nominative case. Since English does not have a nominative form of the reflexive pronoun, we do not see reflexives as subjects of sentences (Brame 1977). However, in Icelandic subjects do not have to be nominative (Thrainsson 1979); there are constructions where an accusative or dative noun phrase can appear in subject position (Maling 1984b:6c).

Mig vantar peninga.
Me(acc) is-lacking money

We also find that reflexives can appear in subject position as illustrated in the following two sentences taken from (Maling 1984b, p.216).

Marru sagði að sig vantaði peninga.
Maria said that REFL(acc) lacked(subj) money

Marru sagði að sér þaetti vaent um mig.
Maria said that REFL(dat) was(subj) fond of me.

In both cases, the subject of the embedded clause is a reflexive pronoun which has the subject of the main sentence as its antecedent. Since reflexive information is blocked only at generalised predicatives, the discourse marker associated with the subject of the main clause would be present in the reflexive attribute of the reflexive pronoun. There is evidence, however, that the reflexives appearing in these Icelandic sentences are from the class of non-locally bound reflexives. The verbs of the embedded sentences are of the subjunctive mood, and the use of the reflexive in these sentences is apparently in free variation with regular pronouns. Icelandic long distance reflexives will be discussed in detail in chapter seven.

Although English does not have reflexives as subjects, there are instances where the reflexive can occur within a complex noun phrase appearing in the subject position. This is illustrated in the following sentence which contains a picture-noun.
Jane told Mary that a picture of herself hangs in the front room.

As Pollard (1984) notes, the generalised predicative based restriction on the distribution of reflexive pronouns entails that reflexives in such constructions should be able to take antecedents from the main clause. This is illustrated in a section of the FA specification for (5.7) which is shown in Figure 5.5. Observe that the reflexive attribute of the sign associated with the reflexive pronoun contains discourse markers corresponding to both Jane (f2) and Mary (fl); both the subject and the object of the main clause are potential antecedents for the reflexive. In Figure 5.5, we provide an analysis for the case where fl is chosen as the antecedent for the reflexive.

It has been argued (Lebeaux 1984) that the reflexives appearing in sentences like (5.7) are not locally bound reflexives but are drawn from a class of non-locally bound reflexives. These reflexives would have different conditions associated with their distribution than locally bound reflexives and might be similar to the class of stress reflexives introduced in chapter one. There is nothing to prevent us from treating such reflexives as non-locally bound reflexives either, adopting a variation of the treatment that we will be proposing for long distance reflexives in Icelandic in chapter seven. This would entail the introduction of a separate lexical entry for such reflexives.

With our approach, there is no need to treat these reflexives differently than the locally bound reflexives that we have been looking at so far. A single lexical entry can be used in all of the cases. The general predicative restriction taken in conjunction with a grammatical restriction on the case of the reflexive pronoun is sufficient to account for why reflexives (with antecedents from the main clause) can appear within picture-noun subjects of finite complements yet cannot appear as subjects of these complements. There is no need to introduce an additional restriction on R-antecedent information which would be applicable at clause boundaries.

5.1.2i. Infinitival Complements

Finite complements are not the only constructions in which a reflexive can take an antecedent that is located outside of the clause in which it is contained. Locally bound reflexives in infinitival complements can also have antecedents which are from a higher clause. Constructions belonging to this class contain an embedded clause whose main verb is of the infinitival form. The infinitival complements are bracketed in the following examples.
John wants [to eat].

John persuaded himself [to call Mary].

Notice that the complement clause is lacking a subject noun phrase. The non-realised subject of these embedded sentences is often referred to as PRO (Chomsky 1973), and the sentences introduced in (5.8-5.9) are often described as shown in (5.10-5.11).

(5.10) John wants [PRO to eat].

(5.11) John persuaded himself [PRO to call Mary].

PRO acts as an 'empty' pronominal noun phrase which is dependent on some other noun phrase or entity much in the same way that a pronoun is dependent on its antecedent. This dependency involving PRO, which is called control, is associated with so called equi verbs like those introduced in (5.10-5.11). PRO and its controller are italicised in these examples.

In traditional terms, equi verbs possess a noun phrase in the main clause which is also an implicit constituent of an embedded clause. According to standard transformation grammar (Chomsky 1965, Rosenbaum 1967), there was a transformation of noun phrase deletion to account for equi constructions. This transformation would apply to a structure associated with John wants for John to be happy in order to obtain the surface form John wants to be happy. There are also object-equi verbs which differ from subject-equi verbs in that it is the object, not the subject of the main clause verb that is the implicit subject of the subordinate clause: This is illustrated in the sentence John persuaded Mary to be happy; the object of the main clause is also the subject of the subordinate clause.

On a semantic level, PRO and its controller can both be associated with the same variable (or constant) in the semantic translation of an equi construction. This is illustrated in the following examples containing simplified logic formula translations of equi sentences.

(5.12) John wants to be happy.

John wants [PRO to be happy].

want'(John', happy'(John'))

(5.13) John promised Mary to be happy.

John promised Mary [PRO to be happy].

promise'(John', Mary', happy'(John'))
John persuaded Mary to be happy.
John persuaded Mary [PRO to be happy].
persuade'(John', Mary', happy'(Mary'))

Observe that the semantic formula introduced in (5.12) has John' as an argument of the want' predicate and as an argument of the happy' predicate. In (5.13), the translation of the main clause subject is once the argument of the semantic predicate happy', while in (5.14) the translation of the object of the main clause is the same as that of the subject of the subordinate clause.

There are approaches to control which do not rely on the introduction of an explicit constituent corresponding to PRO (Bach 1979, Dowty 1982, Gazdar et al. 1985). The approach taken in HPSG for instance proposes a control agreement principle which is incorporated directly in grammar rule application. Although such a principle could be incorporated into TUG at the cost of complicating the syntax of our grammar formalism, if we propose the introduction of a sign corresponding to PRO then no modification of our grammar rule or of our principles concerning the distribution of R-antecedent information is required (as we shall shortly see).

Recall that the use of FA specifications as lexical entries allows local relationships to be stated explicitly in a lexical entry. Since the type of control (ie. subject or object) exhibited by equi verbs is highly localised and dependent on the verb itself, it is not surprising that the control relation can be encoded within the TUG lexical entry of the verb. Just as the reflexive anaphoric relationship is captured by unifying the semantic indices of the reflexive and its antecedent, control is expressed by the unification of the semantic indices of PRO and its controller. This requires the presence of a sign for PRO, but it does not mean that a separate lexical entry for PRO is required. The sign corresponding to PRO can be introduced by the lexical entry for the equi verb. In this lexical entry, both the sign for PRO and the one for its controller will have the same semantic index.

Before introducing a lexical entry for an equi verb, we should point out that not all forms of control are local. There is also arbitrary or nonobligatory control (Williams 1980, Lebeaux 1984) where the controller of PRO is not locally available. An example of this form of control is illustrated in (5.15), which is based on (Williams 1980:28b).

(5.15) PRO to leave would be a pleasure.

There are also super-equi constructions which contain an ‘unbound control relation’ between PRO and its controller (Grinder 1970, Richardson 1986). An example of super-equi is illustrated in (5.16) (Richardson 1986:2).
Mary was confident that it would turn out that PRO making herself invisible would surprise Tod.

This unbounded but non-arbitrary form of control has much in common with the unbounded reflexive anaphoric relationship displayed by reflexives contained in multiple picture nouns, as illustrated in (5.17).

(5.17) John loves a book about a picture of himself.

In both cases, there is a grammatical antecedent but the distance between anaphor and antecedent is unbounded. Since control is closely related to anaphora, we could treat it in a manner similar to the way that we treat reflexive anaphora. This point will be discussed briefly in chapter eight.

Figure 5.6 introduces the lexical entry for persuades which is responsible for object-equi constructions as exemplified by the sentence John persuades Mary to wash herself. The subtree $\alpha$ of the FA specification for persuades corresponds to an infinitival 'sentence.' This clause is an argument of persuades. The argument-sign of $\alpha$ is required to be a noun phrase with a null phonology, $e$, with a semantic attribute structured like that of a pronoun. It corresponds to PRO, whose index $y$ is obtained from that of its controller, the object of the main verb. We have introduced a syntactic feature on the null noun phrase to distinguish it from other noun phrases. The need for this feature will become apparent shortly. Such a syntactic feature will be introduced on all pronouns, as is common in other linguistic frameworks like GB (Chomsky 1981). The control relationship between the null noun phrase and its controller can be captured in terms of a template as shown in Figure 5.7.

The relationship between the semantic information of the sign associated with the verb persuades and the sign corresponding to the infinitival sentence is captured by the template introduced in Figure 5.8. The semantic information of the complement is conjoined with that of the verb — $S'$ and $[a]S$ are combined with the introduction of the semantic connective and. Recall that $[a][[a]S,S']$ is an abbreviation for $[a]\text{and}([a]S,S')$. According to the relationship embodied in this template, the semantics of a sentence like John persuades Mary to eat would be as shown in (5.18).

(5.18) $[e1] [\text{john}(m1), [e1] [\text{mary}(f1), [e1] [\text{persuade}(e1, m1, f1, e2), \text{eat}(e2, f1)]]]

The semantic formula describing the complement is conjoined with the formula associated with the verb. A different semantic relationship between the verb and complement is possible where the semantic predicate persuade would take an indexed formula, not an
Figure 5.6. Lexical Entry for "persuades"
(obj-equ)

Figure 5.7. Template for Object Control

Figure 5.8. Template for Semantic Conjunction
index, as its fourth argument. So the semantic formula shown in (5.19) could be used in lieu of (5.18).

(5.19) \([e1] \text{[john(m1), [e1][mary(f1), persuade(e1, m1, f1, eat(e2, f1))]]}\)

But what does a formula like (5.19) mean? This question is addressed in (Zeevat, 1987), but it is not of great concern to us here since we are primarily concerned with anaphoric phenomena. Distinctions like those observed between (5.18) and (5.19) can be used to capture differences in meaning associated with opaque contexts. Recall though that our interpretation of InL formula is based on the meaning of an equivalent discourse representation structure. A DRS corresponding to (5.19) would contain a condition for persuade which would have the DRS associated with \([e1]\text{eat}(e1,m1)\) as an argument of this condition.

(5.20)

<table>
<thead>
<tr>
<th>e1</th>
<th>m1</th>
<th>f1</th>
</tr>
</thead>
<tbody>
<tr>
<td>john(m1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>mary(f1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>persuade(e1, m1, f1, eat(e2, f1))</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The meaning of such DRSs is examined in (van Eijck 1985). Roughly speaking, this DRS differs from the one associated with (5.18) in that the former suggests the existence of an eating event while the latter does not. For our needs, it does not matter which of these alternatives is adopted; we will be using formula like (5.18).

Although we have examined the FA specifications of verbs that take infinitival complements, we have not yet considered the structure of the infinitival complements themselves. Syntactically, infinitival complements appear to be verb phrases. In TUG, the FA specification for a verb phrase possesses a non-empty auxiliary list. This list contains a description of the subtree with which the FA specification for the subject noun phrase is to be unified. But if an equi verb is to take the FA specification for a verb phrase as an auxiliary tree, the verb phrase must have an empty auxiliary list — the TUG grammar rule requires an auxiliary tree to have an empty auxiliary list. To allow FA specifications associated with verb phrases (and constructions like adjectival phrases) to act as auxiliary trees, their auxiliary lists must be emptied and information that is normally supplied by their own auxiliary trees must be specified. One could introduce an additional grammar rule which would allow FA specifications with non-empty auxiliary lists to act as auxiliary trees. In keeping with the highly lexical approach adopted in TUG, we will instead...
propose a lexical rule like the one introduced in Figure 5.9.

This lexical rule deletes the last element from the auxiliary list of a lexical entry and introduces information that is normally supplied by the auxiliary tree associated with the deleted element. It instantiates the phonological, syntactic and semantic information associated with the argument-sign, and co-instantiates the semantic indices of the root and functor signs. For example, the lexical entry for a transitive verb like *loves* consists of an FA specification containing two elements in its auxiliary list, one describing where the auxiliary tree for the subject noun phrase should be unified and the other the location for the object noun phrase. The lexical rule for null subject instantiation states that there is an additional lexical entry for *love* containing only the element corresponding to the object noun phrase. This alternative lexical entry, which is shown in Figure 5.10, possesses a functor-sign describing a noun phrase with a null phonology and an essentially vacuous semantics (the semantic attribute contains the condition *true* which is always satisfiable). After this lexical entry has been combined with an auxiliary tree corresponding to an object noun phrase, it will possess an empty auxiliary list. In this way we will have an FA specification for a verb phrase that can be used as an auxiliary tree to be combined with primary trees requiring verb phrase complements.

One may wonder why we do not instead propose a lexical rule in which the argument-sign associated with the subject is simply missing instead of having a subject sign possessing a null phonology and a vacuous semantics. That is, why not propose a lexical entry for *loves* consisting of only the subtree α of Figure 5.10? The reason for not doing this is that the null noun phrase sign that corresponds to PRO and the information contained in this sign is used to mediate the control relationship. Without this sign, it would be very difficult for verbs like *persuades* to state that the discourse marker associated with the controller is the same as the discourse marker corresponding to the subject of the subordinate verb phrase. Furthermore, the presence of this sign will be essential in our account of reflexivisation.

In the lexical rule given in Figure 5.9, the introduction of the null feature on the noun phrase ensures that multiple applications of this lexical rule do not occur, since the restriction of the lexical rule requires the noun phrase to be nonpronominal. The syntactic pro feature will be discussed in detail in § 5.2. Null is one of the possible values that this feature may have. Notice that the order of the elements of the auxiliary list is relevant for this lexical rule. The rule incorporates a notation for removing the last element of the auxiliary list — the auxiliary list of the restriction is <...∪> while that of the result is <...>. This operation is equivalent to the one required by reflexive pronouns for choosing an
Figure 5.9. Lexical Rule for Null Subject Instantiation

Figure 5.10. Alternative Lexical Entry for Transitive Verb

Figure 5.11. Lexical Entry for "to" (verb)
arbitrary antecedent from their store. The use of this operation can be avoided if the lexical rule is treated as a rule schema describing a collection of lexical rules each of which is applicable to lexical entries with auxiliary lists of some fixed length. Lexical rules similar to the one introduced in Figure 5.9 might also be used for describing lexical entries required in certain sentences involving conjunction. This will be discussed briefly in chapter eight.

The lexical entry for to as used in infinitival sentences is introduced in Figure 5.11. Its auxiliary list specifies two auxiliary trees, one corresponding to a base form verb phrase α and another for the subject β of the infinitival sentence. Observe that the index of the null subject of the base form sentence is unified with that of the subject of the infinitival sentence (as highlighted with the bold x in Figure 5.11). The FA specification acting as the auxiliary tree which is unified with α must have a null subject (as specified by the information contained in the argument-sign of α) and must have an empty auxiliary list (as imposed by the TUG grammar rule). So FA specifications of 'regular' sentences cannot be used as auxiliary trees here, only those FA specifications of the form described by the result of the lexical rule shown in Figure 5.9 are allowed. As an alternative to this lexical entry for to, one could propose a separate lexical entry for the infinitival form of a verb (e.g. a separate lexical entry for a verb like to-love). So, just as there are different lexical entries for finite, base, and the many other forms of the verb, there would be a separate FA specification for the infinitival form. The different forms of lexical entries for the verb would be related by lexical rules or templates. Regardless of which of these alternatives is taken, the lexical entry for infinitival verbs like the one shown in Figure 5.11 is subject to the lexical rule introduced in Figure 5.9. Thus an infinitival verb phrase can appear as a complement of an equi verb.

Figure 5.12 shows the complete FA structure for the sentence John persuades Mary to wash herself. Notice that the index fi of Mary appears both as an argument of the semantic predicate persuade and as an argument of the semantic predicate wash. Consider the sign referenced by the label 1 — this label is inserted for the sake of our discussion and is not part of the FA structure. According to the description of object control described earlier, the discourse marker fl associated with Mary is unified (as highlighted in bold) with the anaphoric index of the null noun phrase that is the argument of this sign. The lexical entry for to ensures that this index is unified (as highlighted by underlining) with that of the null noun phrase appearing as the argument of the base verb wash-herself which is labelled as 2. Since this base verb is a generalised predicative, the anaphoric index fi of the argument is used to form the reflexive attribute of the generalised predicative (which is shown in bold italic) and R-antecedent information from the parent-
John persuades Mary to wash herself

Figure 5.12. Object-Equi
sign of the generalised predicative is blocked. In this way, \( fI \) appears in the reflexive attribute of the reflexive pronoun. As a result of the treatment of control, due to the structure of the lexical entry for \( to \) and due to the general principles concerning the distribution of R-antecedent information, the discourse marker associated with \( Mary \) is contained in the the reflexive attribute of the reflexive pronoun even though \( Mary \) is not within the same clause as the reflexive.

An analysis for an ungrammatical sentence like the one introduced in (5.21) would not be allowed; the discourse marker corresponding to \( John \) would not be available to the reflexive pronoun.

(5.21)  *John persuades Mary to wash himself

Only the anaphoric index of the null subject of the verb \( wash \) is available to the reflexive, and we have already seen how this index is unified with that of the controller \( Mary \). The reflexive attribute of the sign associated with the object of \( wash \) would contain \( fI \) not \( mI \), so an FA specification for a masculine reflexive pronoun would not be allowed since it would require a masculine sorted variable to be present in the store.

Subject controlled equi is illustrated in the lexical entry for \( promises \) shown in Figure 5.13. This lexical entry is almost identical to the one for \( persuades \) except that the index of the null noun phrase is unified with the anaphoric index of the subject \( x \) instead of that of the object \( y \). Since this distinction between object and subject control is highly dependent on the lexical entry, it seems appropriate to specify the various control types explicitly in the various lexical entries. Due to the presence of subject control, sentences like \( John promises Mary to wash himself \) would be allowed, while \( John promises Mary to wash herself \) would not be. In subject-equii sentences like these, only the marker associated with \( John \) is available to an embedded reflexive.

In some respects, so-called ‘raising’ verbs are very much like equi verbs; they can introduce infinitival complements containing reflexives which find they antecedents in the main clause. Adopting traditional transformation terminology, raising verbs allow the subject of an embedded clause to be raised into the subject or object position of the main clause. For instance, the noun phrase \( Mary \) which is the subject of the subordinate clause of (5.22) is raised into the subject position of the sentence shown in (5.23).

(5.22)  It seems that Mary is happy.
(5.23)  Mary seems to be happy.

Similarly, the subject of the subordinate clause of (5.24) occurs as the object of the
Figure 5.13. Lexical Entry for "promises" (subj-equi)

Figure 5.14. Lexical Entry for "wants" (ditransitive)
equivalent sentence introduced in (5.25).

(5.24)  John wants for Mary to be happy.
(5.25)  John wants Mary to be happy.

Raising is discussed in detail in (Postal 1974).

Many current linguistic approaches argue against the use of rules like 'raising to object' since it would violate principles like the *theta-criterion* and the *projection principle* (Chomsky 1981:§2.2). The theta-criteria essentially requires each argument to appear in one and only one thematic role while the projection principle requires the same role assignment across different types of structures. Raising would involve treating the raised noun phrase syntactically as an object of the main clause verb yet semantically as the subject of the subordinate clause verb, violating the theta-criteria and the projection principle.

Viewed in terms of simple semantic formula, the translation of the 'raised' constituent is an argument of the semantic predicate associated with the embedded clause, but it is not an argument of the main clause predicate. This is illustrated in the following simplified semantic translations of (5.23) and (5.25).

(5.26)  seem'(happy'(Mary'))
(5.27)  want'(John', happy'(Mary'))

In both cases, Mary' is a semantic argument of happy' but is not an argument of the main clause predicates seem' or want'.

In TUG, raising verbs are treated much like equi verbs. The only difference between these two types of verbs is that the lexical entries for equi verbs have the index of one noun phrase appearing as a semantic argument of both the main and subordinate predicates. A lexical entry for the 'ditransitive' version of wants is introduced in Figure 5.14. Note that the object noun phrase of the lexical entry does not have its index specified as an argument of the semantic predicate want — this semantic predicate takes $s1$, $x$ and $a$ as its semantic arguments. In order to simplify this lexical entry and highlight some relevant features, templates have been used. Like the lexical entry for persuades from Figure 5.6, it is the anaphoric index, $y$, of the object that is unified with that of the null noun phrase contained in the complement as shown in bold in Figure 5.14. The object noun phrase acts like the controller of the null subject of the complement clause. Alternatively the null subject could be a trace, like those appearing in unbounded dependency constructions (§ 5.3), with the object noun phrase acting as its antecedent. Regardless of what this
relationship between the object and the null subject is called, the general principles
describing the distribution of R-antecedent information would allow a sentence like *John
wants Mary to wash herself*, and they would prevent analyses for sentences like *John
wants Mary to wash himself*. As we have already seen in the FA structure containing an
infinitival complement (in Figure 5.12), the anaphoric index of the null subject of the
infinitival sentence is the only marker that is available to a reflexive pronoun appearing as
the object of the embedded clause; the generalised predicative infinitival verb blocks all
other R-antecedent information, introducing only the index of the controlled subject.

The distribution of reflexive pronouns in the various infinitival constructions follows
entirely from our treatment of control and from the general restrictions on reflexivisation
outlined in the previous chapter. For a reflexive appearing as the object in a complement
clause, only the discourse marker corresponding to the controller is available. In our
analysis of raising verbs, the raised noun phrase is a syntactic argument of the raising verb
but it is not a semantic argument of the semantic predicate associated with the verb. For
equi verbs, the marker associated with a single noun phrase is an argument of two different
semantic predicates. Due to the explicit presence of both syntactic and semantic
information in the FA specification, it is easy to describe a noun phrase that can behave
one way syntactically and another way semantically. In TUG many interesting phenomena
can be accounted for by viewing a constituent syntactically in one way yet semantically in
another, as we shall see later in this chapter.

5.2. Possessives

So far, the only generalised predicative functors that have been observed to affect the
distribution of reflexive pronouns have been those associated with verb phrases. In chapter
two, we saw that possessive constructions could be analysed as containing generalised
predicatives, and that this treatment could account for the behaviour of reflexive pronouns
contained in complex noun phrases with possessive determiners. Let us now see how such
a treatment of possessives can be incorporated into TUG.

A generalised predicative analysis of possessive constructions has a possessed
nominal acting as a functor over a possessive noun phrase. Translating this into an FA
specification, a generalised predicative noun takes the genitive 'possessor' as its argument,
as illustrated in the lexical entry for the possessive affix 's in Figure 5.15. The tree is
displayed in a 'functor first' notation in this lexical entry since adopting the usual
'argument first' notation makes it difficult to display the tree so that it fits onto a page.
Observe that the sign associated with the possessive affix 's is a functor which takes a
noun phrase as an argument in order to produce a genitive noun phrase. The *Case* of this
Figure 5.15. Lexical Entry for Possessive

Figure 5.16. Picture-Noun in Possessive
noun phrase argument should actually be restricted to be objective or nominative, instead of being unrestricted as suggested by Figure 5.15. This could be done by arranging the various cases in a subsumption hierarchy and introducing complex cases. For example, unification of the complex case nom+obj with nom would result in nom, while unification with gen would fail. The constituent formed from the generalised predicative noun and its genitive argument is a noun phrase. The auxiliary list of the lexical entry contains entries for the possessed noun, β, and for the noun phrase corresponding to the possessor, α. A semantic possession condition is introduced in the sign corresponding to the possessive affix. Intuitively, the condition \( \text{poss}(y,x) \) means that the entity \( y \) possesses the entity \( x \).

R-antecedent information, \( A \), associated with the complex noun phrase is not incorporated within that of the noun, \( [y] \), since the noun is a generalised predicative. So any markers contained in the reflexive attribute of the complex noun phrase are unavailable to reflexives contained in the FA structure associated with the noun, \( β \). Consequently, derivations like *John loves Mary's picture of himself* are blocked; there is no antecedent of the appropriate sort available to the reflexive. Since the anaphoric index of the argument-sign is introduced into the reflexive attribute of a generalised predicative functor, the marker associated with the possessor is available to reflexives contained in possessed nominals. This is illustrated in the FA specification for *Mary's picture of herself* included in Figure 5.16. The index of *Mary* is contained in the reflexive attribute of *herself*, and R-antecedent information, \( A \), associated with the complex noun phrase is blocked since it is not included in the reflexive attribute of the generalised predicative noun. The anaphoric index, \( ni \), of the noun phrase *Mary's picture of herself* corresponds to the picture, not to *Mary*. Since it is this anaphoric index, not the index from the embedded noun phrase *Mary*, that serves as a possible antecedent for reflexives in more oblique arguments in a sentence, ungrammatical sentences like *John gave Mary's picture of herself to herself* are not allowed. For this sentence, the reflexive store of the final pronoun will contain only the anaphoric indices of *John* and of the *picture*. Based on the same principles, sentences like *Jane told Mary's brother about himself* will be grammatical.

The lexical entry in Figure 5.15 introduces a syntactic restriction on the argument of the possessive affix in order to prevent sentences like *John loves him's mother* and *John loves himself's mother*. It is not a general principle related to anaphora that is responsible for pronouns not being allowed in these positions, as Pollard (1985) also notes. Instead it just a property of the lexical entry for 's that it does not allow a pronoun to appear as the argument of 's. This sort of lexical restriction will be seen in various other lexical entries later in this chapter and it has already been seen in our lexical rule involving null noun phrases. As for why such restrictions are present, the reasons vary from lexical entry to
lexical entry. In this case, it is just a fact of the English language that the genitive form of a pronoun is not formed by adding 's to the objective or nominative form. To incorporate this restriction, the signs associated with pronouns need a syntactic feature which states that the expression is a pronoun or a reflexive. This syntactic pro feature will take on the value refl for reflexive pronouns, per for personal pronouns, null for null pronouns, rel for relative pronouns, and '-' for nonpronouns. Depending on how this feature is propagated from constituent to constituent, it could also be used to prevent certain types of pronouns from appearing in certain locations within a constituent. So, this same feature could be used to prevent constructions like the one shown below if it is propagated to the embedded noun phrase of picture nouns.

(5.28) *John likes a portrait of himself's frame

Just like the different sorts for semantic variables, these pronominal features could be arranged in a subsumption hierarchy where a description like pro=refl+per would unify with either pro=refl or pro=per. There could also be complex features for constructions requiring non-null pronouns (ie. pro=refl+per+rel).

The InL formula associated with the complex possessive noun phrase is composed of the semantic information of its component signs in a manner different than one used in the examples we have so far seen. Figure 5.17 introduces another template which describes how the formula [a']S' from the semantic attribute of the functor-sign is conjoined with the first semantic argument [a]S from the argument-sign. This relation differs from the one introduced in semantic template S-TR in that the semantic information of the functor-sign does not become the second argument of the semantic connective P, instead it is incorporated into the first argument. The motivation behind such a semantic operation becomes apparent if we examine possessive noun phrases containing universal quantifiers.

Recall that the FA specifications for quantified noun phrases and non-quantified noun phrases differ in the relationships exhibited between the semantic indices of functor, argument and root signs. For quantified noun phrases like every and no, the argument-sign and root-sign have a variable of the state sort as a semantic index, while for non-quantified noun phrases the argument-sign has an index of the entity sort and the indices of the functor and root signs are the same. With this in mind, notice that the lexical entry for the possessive introduced in Figure 5.15 can only take FA specifications for non-quantified noun phrases as auxiliary trees to be unified with α; the index of the argument-sign of α is of the entity sort. For quantified noun phrases, the lexical entry introduced in Figure 5.18 is required. This lexical entry is defined in terms of the templates R-GPR, S-POS, C-EQ and P-PST. The structure common to these two lexical entries for the possessive could be
Figure 5.17. Additional Semantic Template

Figure 5.18. Lexical Entry for Possessive (quantified noun phrases)

Figure 5.19. Swedish Possessive Reflexive
contained in a separate template for possessives.

According to this lexical entry, the semantic formula associated with a sentence like (5.29) would be as shown in (5.30).

(5.29) Every woman's husband loves himself

(5.30) \[ [s2] \{ [f1][\text{woman}(f1),\text{poss}(f1,m1)], [m1][\text{husband}(m1)] \Rightarrow \text{love}(s1,m1,m1) \} \]

The effect of the semantic template $S$-$POS$ is to defer the application of the semantic connective $P$ to its second argument. Instead of $P$ having a narrow scope reading (i.e., having scope only over the $\text{poss}$ condition from the semantic attribute of the sign for the possessive affix in Figure 5.18), it is given a wide scope reading so as to have scope over the semantic formula associated with the functor over the complex noun phrase (which in (5.30) is the formula associated with the verb $\text{love}(s1,m1,m1)$). We will return to the issue of quantifier scope in chapter eight.

Although we have introduced a mechanism for preventing reflexive pronouns from appearing in certain positions due to a syntactic constraint, the general principles concerning a flow of $R$-antecedent information remain intact. For example, although pronouns are not allowed to appear as the argument of the possessive affix in Figure 5.15, the $R$-antecedent information of the complex noun phrase, $A$, is available to the genitive noun phrase and to the argument of the possessive affix. English does not have a possessive reflexive pronoun (distinct from the possessive personal pronoun) but some languages, of which Swedish is an example, do have such a form.

The Swedish possessive reflexive, $sin$, differs from English reflexives in that it can only take subject antecedents. As a result, a slightly different restriction would appear on the reflexive attribute of the sign associated with $sin$.

(5.31) $sin$

\[
\begin{align*}
\text{[np,gen]} \\
\text{[x]and(true(x))} \\
\text{[...x]}
\end{align*}
\]

The restriction $[...x]$ on the reflexive attribute permits the selection of only the last marker (the subject) from the reflexive store. Unlike English reflexives, there is no restriction on the gender of the antecedent as reflected by the appearance of a marker $x$ which is unrestricted with respect to gender. A separate lexical entry for the reflexive possessive would be required when it is modifying a neuter object, since it takes on the form $sitt$ in such constructions. The case of the reflexive reflects the grammatical gender of the noun phrase in which it is contained.
Our account of the distribution of R-antecedent information predicts that genitive reflexives embedded in possessive constructions can take their antecedents from the main clause. This prediction follows from the FA structure proposed for possessive constructions. Genitive reflexives are always arguments in the FA structure, and possessors are always arguments not functors. For any subtree, the inheritance of R-antecedent information of an argument-sign from its root-sign is never blocked. In fact, a possessive reflexive embedded arbitrarily deep within a possessive noun phrase construction should still be able to take a main clause antecedent. This prediction is supported by evidence from Swedish.

(5.32) Anna ser sin fars katt.
Anna sees REFL(gen) father(gen) cat
‘Anna sees her father’s cat.’

A fragment of the FA structure for (5.32) is given in Figure 5.19. The R-antecedent information of the sign associated with sin contains the discourse marker fl corresponding to the subject of the sentence. For readability, many of the more complex semantic formulae in this FA specification have been simplified.

This behaviour of the genitive reflexive pronoun is unexpected if we use a traditional phrase structure of possessives in conjunction with a structural relation like c-command. The problem arises when a reflexive is embedded under two NPs, as illustrated in Figure 5.20. If the reflexive pronoun is allowed to have the subject as its antecedent, then why shouldn’t reflexives located elsewhere in a complex noun phrase be able to have the subject as antecedent? For instance, the reflexive located inside the possessed nominal in

(5.33) Anna ser Jons kort på sig själv.
Anna sees Jon(gen) picture of REFL-self
‘Anna sees John’s picture of himself.’

for which the syntactic structure is shown in Figure 5.21, is also embedded two NPs down. Sig själv cannot take the sentential subject, Anna, as its antecedent; it can be anaphorically related to Jon. However, the reflexive sig själv in the following Swedish sentence has two possible antecedents.

(5.34) Anna ser sin fars kort på sig själv.
Anna sees REFL(gen) father(gen) picture of REFL-self
‘Anna sees her father’s picture of himself/herself’

Sig själv can be anaphorically related to either Anna’s father or to Anna. Although we have no explanation for this observation, it seems to be highly dependent on the presence
Anna sees her father's cat

Figure 5.20. Phrase Structure of Swedish Sentence with Possessive

Anna sees John's picture of himself

Figure 5.21. Phrase Structure of Swedish Sentence with Possessive and Picture-noun
of sin, as illustrated by the following sentence which has only a single reading.

\[(5.35)\] Anna ser Jons fars kort på sig själv.
Anna\textsubscript{1} sees Jon\textsubscript{gen}'s father\textsubscript{gen}' picture of REFL-self\textsubscript{*i*j/k}
"Anna sees Jon's father's picture of himself"

In (5.35), the reflexive pronoun can only be anaphorically related to Jon's father.

In English, a reflexive contained in a possessed nominal must have the possessor as its antecedent. That is, a sentence like

\[(5.36)\] John's brother\textsubscript{gen} portrait of himself hangs in the front hall

can only have one reading, namely the one where the brother is the antecedent for the reflexive. Sentences like (5.37-5.38) are predicted to be ungrammatical.

\[(5.37)\] *John's sister\textsubscript{gen}' picture of himself hangs in the front hall.
\[(5.38)\] *Mary sees her father\textsubscript{gen}' picture of herself.

When the reflexive is not used emphatically in English, these predictions are borne out by the observations.

Our account of the distribution of reflexives contained in possessive constructions relies on the proposal for treating the possessive determiner as an argument of the possessed nominal. This results in the possessed nominal acting as a generalised predicative, affecting how the R-antecedent information is passed between constituents. No further restrictions on the passing of R-antecedent information are required to account for reflexives in possessives, although some language-specific lexical restrictions on the appearance of reflexives in specific positions are required. This treatment makes predictions about the distribution of genitive forms of the reflexive which are supported by data from Swedish.

5.3. Unbounded Dependencies

An unbounded dependency is a relationship between two syntactic components of a sentence in which the related constituents are not required to be within some bounded distance from each other. Often, unbounded dependencies are described in terms of 'movement' whereby one constituent is 'moved' some unbounded distance away from its canonical location and a binding relation is established between the moved constituent and a trace inserted in the canonical location (Chomsky 1975). In this section, the distribution of reflexive pronouns in unbounded dependency constructions will be examined. The types of unbounded dependencies that will be discussed will include those involved in relative
clauses, topicalised constructions, and cleft constructions. Unbounded dependencies associated with interrogative constructions will not be examined since we will not be addressing the issues concerning the semantics of questions.

5.3.1. Relative Clauses

Although there are several classes of relative clauses, the discussion here will be limited to restrictive and appositive (or nonrestrictive) relatives. Free relatives will not be examined. Restrictive relative clauses can be distinguished from appositive relatives by noting that the former generally restrict a head noun, while the latter give additional information about a noun phrase. In this sense, restrictive relatives act like post-nominal adjectives and appositive relatives act as noun phrase modifiers. These relatives also differ in the type of relative pronoun that may be used; appositive relatives cannot contain the relative pronoun that. The sentences shown in (5.39) contain examples of restrictive relatives, while the second group, (5.40), contains appositive relatives.

(5.39) A man that loves a woman loves himself.
A man who loves a woman loves himself.
Every man who loves a woman loves himself.
*John who loves Mary loves himself.

(5.40) *A man, that loves a woman, loves himself.
A man, who loves a woman, loves himself.
*Every man, who loves a woman, loves himself.
John, who loves Mary, loves himself.

Often, these two classes of relatives can also be distinguished in text by the presence of commas around the clause. For the moment we will focus our attention on restrictive relative clauses.

Relative clauses contain a relative pronoun plus a sentential component which is 'missing' a noun phrase. In some cases the relative pronoun can be omitted, but we will not be concerned with the details of this right now. The location of the missing noun phrase is often referenced by the insertion of a trace $t_i$ into the sentence — the trace is in a binding relation with the relative pronoun. The unbounded nature of the relationship between the trace and the relative pronoun is exemplified in constructions like (5.41).

(5.41) a woman that$_{t_i}$John wants his brother's son to marry $t_i$

Subscripting is used to illustrate the binding relation.
5.3.1.1. Restrictive Relative Clauses in TUG

The treatment of relative clauses in TUG is based on our proposals for unbounded dependencies which were briefly outlined in § 4.1.2. We do not wish to give a detailed analysis of such constructions in TUG — we are only concerned with them to the extent that they interact significantly with reflexives. With this in mind, let us look at the factors affecting the distribution of the foot feature information in the TUG account of unbounded dependencies.

Recall that the foot feature forms part of the syntax attribute of a TUG sign. Its value can either be an empty list nil (i.e. []), or a list containing a single sign which is used to mediate an unbounded dependency. Since a sign contains more than just syntactic information, an unbounded dependency can be more than just a syntactic relationship in TUG. For example, the sign associated with a clause containing a noun phrase trace would be of the form shown in (5.42) where the foot feature is shown in bold.

\[(5.42) \text{John-loves-e}\]
\[
\begin{align*}
\text{[sent, fin]} & \ , \ [e; [np,\text{obj}]; [x]\text{and(true}(x)); \_] \\
\text{[s1]} & \ [\text{john}(m1), \text{love}(s1,m1,x)]
\end{align*}
\]

The foot feature can thus contain phonological, syntactic, semantic and R-antecedent information.

For expository purposes, we will be discussing unbounded dependencies in a top-down manner relative to an FA specification. The storage-based treatment of unbounded dependencies that was briefly outlined in § 4.1.2 can be broken down into three stages (cf. Gazdar et. al. 1985:§7.1). First, there is the introduction of the unbounded dependency; a sign containing information relevant to the dependency is introduced into the foot feature of a sign. The propagation stage entails passing this information down through the tree. Finally, the resolution of the unbounded dependency involves the removal of the information from the foot feature for its use by the trace. Before we look at these different stages, let us first examine the information contained in the foot feature in more detail.

In the various lexical entries that we have introduced so far, the foot feature has not been included. The default relationship between the foot features is embodied in the template C-FOOT shown in Figure 5.22. This template shows that the information contained in the foot feature of the root-sign of a subtree will be the result of merging the information from the foot features of its functor-sign and argument-sign. This is the same merging relation that was defined for combining R-antecedent information (§ 4.1.4). Given two lists \(F\) and \(F'\), the result of merging the two lists \((F++F')\) is a list containing all the
elements of the second list plus those of the first that are not already present in the second.

We have adopted the working hypothesis that the TUG foot feature may contain at most one element. This is in accordance with the treatment of foot feature information contained in the \textit{SLASH} features of GPSG and HPSG. Under this assumption and assuming that template \textit{C-FOOT} holds at every nonterminal node in an FA structure, if a functor-sign and an argument-sign in some FA structure both have a non-nil value for their foot features, then these values must be the same. If they did not, say the foot feature of the functor-sign consisted of a list containing the single element $X$ and that of the argument-sign contained a different element $Y$, then the foot-feature of the root-sign (which would be the result of merging these two lists) would contain both $X$ and $Y$. This violates our assumption that the foot feature may contain at most one element. The different possible relationships between the foot features of a root-sign and that of its functor and argument signs is summarised in (5.43).

\begin{equation}
\begin{array}{lll}
\text{functor-sign} & \text{argument-sign} & \text{root-sign} \\
[] & [] & [] \\
[] & [X] & [X] \\
[X] & [] & [X] \\
[X] & [X] & [X] \\
\end{array}
\end{equation}

In most instances, one of the first three of these cases will hold. The fourth case is relevant for constructions involving parasitic gaps (Engdahl 1983) as we shall shortly see.

Our restrictions on foot feature information turn out to be very similar to the GPSG treatment of the \textit{SLASH} feature, assuming the functor in an FA structure is treated as a head. Since \textit{SLASH} is a head feature in GPSG, by default it is the same on the mother and head daughter constituents (ie. root-sign and functor-sign). It is not inherited by lexical heads (ie. functor-signs associated with terminal nodes in an FA structure). With \textit{SLASH} being a foot feature, two daughters cannot have different elements contained in
their respective SLASH features (ie. the signs contained in the foot feature of a functor and argument sign must be the same). The parasitic relationship exhibited by SLASH features is a consequence of the interaction of the foot and head feature principles — if a non-head daughter possess a SLASH feature then so must its mother (foot feature principle) and so must the head daughter (head feature convention).

There are some languages where it appears that the requirement on the foot feature to contain at most one sign is too restrictive (Engdahl and Ejerhed 1982). Even in English there are cases where this requirement appears to be too strict, particularly in questions containing infinitivals and ‘tough’ constructions as illustrated in the following example (Fodor 1983:32).

(5.44) I wonder what \(i\) (he said that the paint was (easy \(j\) (to stir \(j\) with \(i\))))

The dependencies in this example are highlighted through the use of indexed trace elements like \(t_i\). Due to the structure of this sentence, the foot feature of the bracketed verb phrase would be required to contain two entries, one for the unbounded dependency indexed with \(i\) and another for \(j\). An alternative analysis (Chomsky 1977) where \(t_i\) is not within the same clause as \(t_j\) would not require the foot feature to contain two elements (Maxwell 1985:15).

(5.45) I wonder what \(i\) (he said that the paint was (easy \(j\) (to stir \(j\)) with \(i\)))

In Norwegian, nested unbounded dependencies can appear in constructions containing relative clauses and topicalised constructions (Christensen 1982:1).

(5.46) Slike problemer \(j\) bør vi hjelpe (alle \(i\) (som \(i\) sliter med \(j\))).
Such problems \(j\) we should help (everybody \(i\) (who \(i\) struggles with \(j\)))

Although a detailed analysis of constructions like those introduced in (5.44-5.46) is beyond the scope of this thesis, our approach could be extended to allow for the observed behaviour. One direction would involve allowing the foot feature to contain more than one entry. Additional restrictions on the foot feature information would be required in order to obtain the nesting behaviour and in order to restrict the distribution of ‘double foot featured’ constituents (Fodor 1983). For example, although sentences like (5.46) are allowed, those like (5.47) are not (Christensen 1982:2).

(5.47) *Slike problemer \(j\) bør vi gi (alle \(i\) (som \(i\) sliter med \(j\))) hjelpe.
*Such problems \(j\) we should give (everybody \(i\) (who \(i\) struggles with \(j\))) help

Constraints on such Norwegian constructions are discussed in detail by Christensen (1982).
Let us now consider what the lexical entry for a restrictive relative pronoun should look like in TUG. In standard categorial grammar, the 'embedded sentence' of the relative clause is often assigned the category $\wedge np$ — it is a constituent looking to its left for a noun phrase to give a sentence. Restrictive relative clauses are taken to be noun modifiers of category $noun\backslash noun$. Based on these category assignments, a restrictive relative pronoun like *that* must be treated as a functor of category $noun\backslash noun/(\wedge np)$. In TUG, the relative pronoun can be treated as an argument just like other pronouns, and the category associated with the relative clause can be closer to the sentential category proposed in traditional phrase structure grammars.

In an FA structure, the sign associated with a relative pronoun will have category $np$, and its semantic attribute will be like that of other pronouns. It will be marked with the syntax feature $pro=rel$ (which was discussed in § 5.2) to distinguish it from other noun phrases and pronouns. The category of the sign associated with the relative clause will be $sent$. If we for the moment ignore details concerning R-antecedent information, we can tentatively introduce the lexical entry for the restrictive relative pronoun *that* as shown in Figure 5.23.

The lexical entry for the relative pronoun introduces a sign into the foot feature of the root-sign of subtree $\alpha$ which contains information responsible for mediating an unbounded dependency. The foot feature associated with the complete relative clause (ie. the argument-sign of the FA specification in Figure 5.23) is stipulated to be empty. Such relationships between foot feature information and signs are associated with the introduction of unbounded dependencies. Since much of the foot feature information originates from the syntactic and semantic attributes of the relative pronoun (as highlighted in bold in the lexical entry), a binding relationship will be established between the relative pronoun and the trace that uses the information present in the foot feature. The case of the relative pronoun is stipulated to be the same as that of the sign in the foot feature through the presence of the same unification variable $C$ in both locations. Since the relative clause semantically gives more information about the entity described by the head noun, the index of the noun, $x$, and the index of the relative pronoun are the same. The appearance of $\varepsilon$ in the phonology of the sign contained in the foot feature reflects the fact that there is a noun phrase with null phonology in the relative clause (ie. a trace). For the root-node of the FA specification, its foot feature information is related to that of its functor and argument signs according to the relationship embodied in template $C$-FOOT.

To account for relative clauses lacking explicit relative pronouns, as seen in sentences like *Harry loves a woman John loves*, we can introduce a separate lexical entry for the
Figure 5.23. Tentative Lexical Entry for Restrictive Relative Pronoun

Figure 5.24. Lexical Entry for a Trace
head nouns in such constructions. Lexical entries for head nouns of relative clauses contain signs for relative pronouns with null phonologies. FA specifications for these nouns would be much like the one introduced in Figure 5.23. These lexical entries would be related to those of 'regular' nouns by a lexical rule much like the one for topicalised constructions introduced in § 4.4.2. The restriction (left hand side) of this lexical rule matches a lexical entry for a noun while the result is a lexical entry for the head noun of a relative clause. There would be additional restrictions on these lexical entries to disallow constructions with subject traces as illustrated in ungrammatical sentences like A woman loves John left.

So lexical entries like those associated with relative pronouns are responsible for introducing unbounded dependencies; they introduce information into the foot feature associated with a constituent. The unbounded dependency is propagated according to the merging relation embodied in template C-FOOT. Until now, the lexical entries that have been introduced have not specified the foot features of any of their nodes and consequently have not described how an unbounded dependency is propagated. As an abbreviatory convention, if the foot feature of a terminal node of an FA specification is not specified, then it is assumed to be empty (i.e. $\emptyset$). At all other nodes, the foot feature by default consists of the merged foot features of its functor and arguments as illustrated in template C-FOOT. In FA structures, the foot feature of a node is empty unless otherwise specified. An unbounded dependency is resolved with the removal of the sign from the foot feature of a constituent and with the unification of information contained in the foot feature with the information associated with the trace.

There are several ways in which the resolution of an unbounded dependency can be incorporated into TUG. In GPSG, there are special grammar rules for both introducing and resolving unbounded dependencies. We have so far been able to avoid the introduction of extra grammar rules and there is no need to resort to such an alternative for these cases either! Instead of introducing a new rule, a separate lexical entry for the trace can be proposed as shown in Figure 5.24. In this lexical entry, the sign associated with the trace possesses a foot feature which contains all the phonological, syntactic, semantic and R-antecedent information of the trace. Aside from the presence of a non-empty foot feature, its structure closely resembles that of a pronoun or proper name. An FA specification created from such a lexical entry will be wellformed only if an unbounded dependency is introduced by some relative pronoun. This is illustrated in the FA specification for the expression woman that John loves in Figure 5.25. Observe that the relative pronoun obtains the same case as that of the trace due to the unification of the information contained in the foot feature with that contained in the sign for the trace. The
woman that-John-loves
   [noun], [ ]
   [fl] [woman(f1), [s1] [john(m1), love(s1, m1, f1)]]

A

that-John-loves
   [noun], [ ]
   [sent, fin], [ ]

woman(f1) [s1] [john(m1), love(s1, m1, f1)]

A

John loves
   [np, nom], [ ]
   [v, fin, gprd], [ ]
   [m1] and (john(m1))
   [fl] love(s1, m1, f1)

loves
   [v, fin, + prd], [ ]
   [fl, m1]

Figure 5.25. Restrictive Relative Clause

that-John-filed-c-without-reading-c
   [noun], [ ]
   [sent], [ ]

that-John-filed-c-without-reading-c
   [np], [ ]
   [sent], [F]

John filed-c-without-reading-c
   [np], [ ]
   [vp], [F]

filed-c without-reading-c
   [vp], [F]

Figure 5.26. Parasitic Gaps
sign mediating the unbounded dependency is introduced into the foot feature of the sign for the 'sentence' *John loves* by the lexical entry for the relative pronoun. Since the template \textit{C-FOOT} is specified at every nonterminal node of the lexical entry for *love* and since the signs associated with *John* and *loves* have empty foot features (all according to the convention on foot feature information described in the previous paragraph), there is only one possible assignment of foot features that will not violate the various constraints. This assignment results in the propagation of foot feature information between the trace and the relative pronoun. The sign associated with the trace is the only terminal node sign which has a non-empty foot feature (shown in bold-italic in Figure 5.25). In this way, the use of the trace resolves the dependency. If an unbounded dependency is introduced, then it must be resolved by the appearance of a trace, otherwise the merging relation will be violated — all signs at terminal nodes in an FA structure, except the trace sign, have empty foot features. Similarly, a trace cannot appear without its corresponding relative pronoun since this would result in an unbounded dependency propagating to the root-node of the FA structure containing the trace — complete linguistic expressions are required to have empty foot features associated with their root-signs (§ 4.4.3) and the use of the merging relation in lexical entries ensures that foot features are propagated.

For any subtree in an FA structure, the relation embodied in the template \textit{C-FOOT} allows a functor-sign and the argument-sign to both contain the same sign in their foot features (as was shown in (5.43)). In cases where this occurs, we will say that the foot feature of the argument-sign is in a parasitic relationship to that of the functor-sign; the appearance of a trace within the subtree associated with the argument is dependent on the appearance of one in the subtree associated with the functor. That is, the trace cannot appear within the argument subtree unless it also appears within the functor subtree. So there can be two (or more) traces associated with a single relative pronoun. This accounts for the following data which is based on examples discussed in (Engdahl 1983).

(5.48) the article \(_1\) ( that John filed \(_1\) without reading \(_1\) )

(5.49) *the article \(_1\) ( that John filed dossiers without reading \(_1\) )

(5.50) the article \(_1\) ( that John filed \(_1\) without reading more than the title )

The trace contained in the prepositional phrase (PP) \textit{without reading} is parasitic; its presence depends on the appearance of the other trace. An FA structure of (5.48), for which we have only provided the phonological and syntactic information of the various signs, is outlined in Figure 5.26. The PP in this FA structure acts as a modifier of a verb phrase just like a restrictive relative clause acts as a modifier of a noun. For this reason it is treated as an argument with the head verb phrase as a functor. We will be discussing
PPs in detail in §5.4. The presence of the relative pronoun results in the introduction of a sign $F$ into the foot feature of the functor sentence. If the argument PP without reading contained a trace but the modified verb phrase (functor) did not, then we would have a violation of our parasitic relationship on foot feature information — the sentence would be ungrammatical. One instance where this parasitic relationship must be violated in the FA structure for a grammatical sentence is when the functor-sign is at a terminal node of the FA structure. Here we can have an argument-sign possessing a non-empty foot feature where the functor-sign has an empty foot feature (as shown in Figure 5.25). Still, the relationship embodied in template $C$-FOOT is not violated.

The parasitic dependency between functor and arguments is also illustrated in examples where a parasitic gap is contained within the subject noun phrase. Consider the following sentences which are based on (Gazdar et.al. 1985:7.9).

(5.51)  the author$_i$ (that reviewers of $t_i$ always detested $t_i$)
(5.52)  *the author$_i$ (that reviewers of $t_i$ always detested meeting deadlines)
(5.53)  the author$_i$ (that reviewers of the journal always detested $t_i$)

Again, the ungrammatical sentence is one in which there is a subtree possessing an argument-sign with a non-empty foot feature and a functor-sign with an empty one.

There are various other observations concerning parasitic gaps which are discussed in (Engdahl 1983) which will not be examined here. For instance, parasitic gaps apparently cannot appear in subject position and they appear to be in complementary distribution to reflexive pronouns. Such constraints would need to be incorporated into the sign associated with the parasitic trace in a complete TUG account of parasitic gaps.

Our formulation of constraints on the distribution of foot feature information will result in unbounded dependency relations being ruled out in certain cases where they should be allowed. In particular, the distribution of foot feature information shown in Figure 5.27 is not be allowed. This means that constructions like the following will be disallowed in the grammar fragment that we have been presenting.

(5.54)  a man who$_i$ ( $t_i$ loves himself)
(5.55)  a man who$_i$ (Mary believes ( $t_i$ loves himself) )
(5.56)  a man that$_i$ (Mary told $t_i$ about himself)

In the FA structures for these sentences, there are cases where the foot feature of a root-sign is passed onto only argument-signs and not (nonterminal) functor-signs (in the manner outlined in Figure 5.27). Constructions like (5.54) could be handled in a more complete
Figure 5.27. Violation of Parasitic Relationship

Figure 5.28. Lexical Entry Containing a Trace
grammar by adopting the GPSG account in which subject traces are not allowed — the relative pronoun combines with a verb phrase to produce a relative clause. Another possibility might be that our restrictions on the distribution of foot feature information are too strict. Perhaps the parasitic relationship only holds at specified nodes? These are issues that should be examined in a detailed account of unbounded dependencies in TUG. For our needs, we only need to be aware of the general mechanisms that are used in the treatment of unbounded dependencies so that we can see how they affect the distribution of reflexive pronouns.

Instead of proposing separate lexical entries for traces, they can be incorporated directly into the FA specifications of the lexical entries which subcategorise for them. Take the transitive verb *loves* for instance. There would be a separate lexical entry for the standard case where it takes two non-trace arguments, one entry for when it has a trace subject (if we adopt a proposal which requires trace subjects), and another for constructions where it has a trace object. No lexical entry need be proposed for the case where it has both a subject and object trace, at least not for English. These different lexical entries could all be defined in terms of some *love* template which would embody the common structure shared by all of the entries. We might also want to propose some lexical rule which would relate lexical entries with inserted traces to those in which traces have not been inserted. A lexical entry for *love* where there is a trace object is shown in Figure 5.28. The auxiliary list of this specification contains an entry only for the auxiliary tree corresponding to the subject noun phrase — no auxiliary tree needs to be unified with the object noun phrase.

The trace-inserted lexical entries illustrate the potential locations of traces but they do not determine the distribution of traces. The distribution of traces and the applicability of these trace-inserted lexical entries is governed by our general principles concerning foot feature information. For example, the FA structure resulting from a lexical entry like the one introduced in Figure 5.28 will be required to contain some constituent (like a relative pronoun) that introduces the unbounded dependency.

For traces appearing within complex arguments of the verb, as shown in (5.57)

\[(5.57) \quad \text{a man that}_i \text{ John talked to Mary about } t_i\]

the standard lexical entry of the verb without traces would be used, while a trace-inserted version of the lexical entry associated with the preposition *about* would introduce the trace. It is the presence of the relative pronoun *that* that allows the trace-inserted version of *about* to be used; the FA specification for the relative pronoun introduces a sign into the foot
feature, the distribution of the foot feature is determined by our general principles, and the FA specification for *about* removes the sign from the foot feature. The resulting FA specification is the same as the one that would be obtained if a lexical entry for the trace were combined with a non-trace inserted version of the preposition *about*. The use of trace-inserted lexical entries removes the need for introducing separate lexical entries for traces, but the distribution of the traces is still determined by the foot feature information.

5.3.1.2. Reflexives in Relative Clauses

Let us now turn our attention from the distribution of traces to the distribution of reflexives in relative clauses. Consider the following pair of expressions.

(5.58)  a man that$_i$ (Mary told t$_i$ about himself$_i$ )
(5.59)  *a man that$_i$ (Mary told himself$_i$ about t$_i$ )

Let us examine the behaviour of the R-antecedent information in the relative clauses by looking at the FA specification for (5.58) provided in Figure 5.29. It is the anaphoric index of the trace that is chosen as the index of the reflexive pronoun (as shown in bold) — the trace acts as the antecedent for the reflexive. The anaphoric index of the trace is in turn obtained from the information contained in the foot feature of the relative clause. This information (shown in italic) is introduced by the relative pronoun which stipulated this index to be the same as that of the head noun *man*.

Although the anaphoric index of the relative pronoun is introduced into the reflexive attribute of the relative clause, it is blocked from making its way into the reflexive attribute of the reflexive pronoun due to the presence of a generalised predicative (shown in bold). For the expression introduced in (5.59), the reflexive attribute of the reflexive pronoun will only contain the discourse marker associated with *Mary*. The marker associated with the relative pronoun is not contained in this attribute due to the presence of the generalised predicative associated with the expression *told himself about*. The anaphoric index of the trace is not present in this attribute due to its location in the sentence; the trace is a more oblique argument of the verb than the reflexive. Since the reflexive attribute of the masculine reflexive pronoun does not contain a marker of the masculine sort, anaphora resolution fails. So, like in controlled complements where the anaphoric index of the null noun phrase is used to introduce the marker of the controller as a potential antecedent, the anaphoric index of the trace is used to introduce into the relative clause the marker associated with the head of a relative clause construction.

Notice that there are two generalised predicatives in the FA specification introduced in Figure 5.29, one associated with the relative clause, and one with the verb phrase.
man-that-Mary-told-about-himself
[noun], [ ]
[ml][man(ml), [e1][mary(fl), tell(e1, fl, ml, ml)]]
A

man
that-Mary told-about-himself
[noun, -prd], [ ]
[ml]
man(ml)
[e1][mary(fl), tell(e1, fl, ml, ml)]
A
A

that
Mary-told-about-himself
[np, obj, rel], [ ]
[ml]and(true(ml))
A

Mary
told-about-himself
[np, nom], [ ]
[f1]and(mary(f1))
[ml]

ε
[np, obj], [ e[np, obj], ]; [ml]and(true(ml)); [f1]
[ml]and(true(ml))
[f1]

about-himself
told
[pp, about], [ ]
[m1]and(true(ml))
[m1, f1]

Figure 5.29. Relative Containing a Reflexive
as a verb phrase is a functor that takes a noun phrase argument (the subject) to produce a sentence, the relative clause contains a functor that takes a noun phrase argument (the relative pronoun) to produce a sentence. Both of these functors are generalised predicatives, since they take noun phrase arguments to produce sentences, so the R-antecedent information of the functor-signs contains only the anaphoric indices of their argument-signs. The generalised predicative associated with the sentence blocks the R-antecedent information $A$ of the superordinate clause from entering the relative clause; the anaphoric index of the relative pronoun is also introduced into the reflexive attribute of the generalised predicative. It is the generalised predicative functor associated with the verb phrase that is responsible for preventing the discourse marker from the relative pronoun from acting as a possible antecedent for reflexives contained within the verb phrase.

There is an interesting observation that can be made about the distribution of R-antecedent information in Figure 5.29. Note that the anaphoric index of the relative pronoun is contained in the reflexive attribute of the subject of the relative clause. As we noted in the previous paragraph, our generalised predicative restriction only blocks this information from entering the verb phrase. This means that we would obtain an FA specification for the following ungrammatical expression.

(5.60) *a woman that a picture of herself resembles

By blocking R-antecedent information at generalised predicative boundaries instead of clause boundaries, we have allowed reflexives appearing in subordinate clause subjects to take antecedents from constituents introduced in the superordinate clause. This allowed us to propose analyses for grammatical sentences like (5.61) but it also allows analyses for ungrammatical sentences like (5.60).

(5.61) John says that a picture of himself is hanging in the office

Perhaps there is some additional restriction which prevents relative pronouns from acting as antecedents for reflexives? There is evidence from Norwegian for a similar restriction that prevents locally bound reflexive pronouns from acting as the antecedents for other reflexives (Hellan forthcoming, p.5.18a).

(5.62) *Jon fortalte seg selv om ham selv.
Jon told REFL-self, about him-self,
‘John told himself about himself.’

Recall from chapter one that the reflexive ham selv is used in Norwegian when the antecedent is not a subject. In (5.62), the reflexive seg selv cannot be the antecedent for
the reflexive *ham selv*. From the following two examples, we see that a reflexive taking a subject antecedent is allowed in the PP as is a reflexive taking a non-reflexive non-subject antecedent (Hellan forthcoming, p.5.18a, p.2.17).

(5.63) Jon fortalte seg selv om seg selv.
Jon told REFL-self about REFL-self,
'John told himself about himself.'

(5.64) Vi fortalte Jon om ham selv.
We told Jon about him-self*
'We told Jon about himself.'

So relative pronouns would not be alone in not being able to act as antecedents for reflexives. However, we cannot make the generalisation that all pronouns are prohibited from acting as antecedents for reflexives. Reflexives can take personal pronouns as antecedents!

(5.65) He told her about herself.

Also, we have already seen that many explanations rely on empty pronouns (PRO) acting as antecedents for reflexives.

So an explanation for why sentences like (5.60) are ungrammatical relies on relative pronouns being unable to act as antecedents for reflexive pronouns. But why are some pronouns not allowed to act as antecedents for reflexives while others are? We will return to this question in § 5.3.2.

5.3.1.3. Reflexives in Relative Heads

Probably the most interesting constructions involving relative clauses and reflexives are those that contain a reflexive in the head of the nominal. This is illustrated in the sentence

(5.66) Mary wrote a story about herself that John liked.

Generally, the anaphoric properties of such reflexives seem to be the same as those that are contained in similar constructions without relative clauses — they find their antecedents in the main clause, not the relative clause. This is illustrated by the following ungrammatical sentence.

(5.67) *Mary wrote a story about himself that John liked.

However, there are exceptions to this behaviour.
A picture of himself that John loves was painted by Mary.

When the noun phrase containing the relative is the topic of the sentence, as in (5.68), it appears that an anaphoric relationship with an antecedent from the subordinate clause is possible. The antecedent need not even be referential as illustrated in (5.69).

The picture of herself that every girl likes best is the one that was taken at her wedding.

Furthermore, there are some sentences in which a reflexive contained in the head noun can take an antecedent either from the subordinate (downstairs) clause or the main (upstairs) clause. Consider the following sentence which is based on examples from (Kuno 1987:6.20,6.22).

Mary threw away a picture of herself that Susan took in Maine a few years back.

Either Mary or Susan can act as the antecedent for the reflexive.

As Jackendoff (1972) notes, the grammaticality of constructions involving reflexives in the head nouns of relative clause constructions is highly dependent on the choice of verbs appearing in the main and relative clauses. Kuno (1987) introduces a series of principles for determining the relative grammaticality of sentences containing reflexives. He notes that factors such as focus and perspective can affect acceptability. Since we are interested in determining the possible antecedents for reflexive pronouns, and not in the relative acceptability of the possible antecedents, we will be adopting a 'least restrictive' approach to reflexives in relative clauses. We will determine the maximal set of possible antecedents. Other factors can then be responsible for determining the degree of acceptability for members of this set. In chapter eight we will briefly outline how relative acceptability might be incorporated into a TUG grammar.

In the most general case, the R-antecedent information available to a reflexive contained in the head noun of a relative clause can come from both the upstairs and downstairs clause. Based on this observation, we will propose a lexical entry for the relative pronoun shown in Figure 5.30. The reflexive attribute of the head noun consists of the R-antecedent information A of the root-sign (upstairs clause) merged with the R-antecedent information R from the foot feature of the relative clause (downstairs clause). Again, this merging is described by the expression $R++A$. Anaphorically, the head noun can act as if it were located where the trace is since it contains all the R-antecedent information associated with the trace; there is an anaphoric relationship between the head noun and the trace which is mediated through the foot feature (cf. Engdahl (1986)). The
Figure 5.30. Lexical Entry for a Relative Pronoun

Figure 5.31. Upstairs and Downstairs R-antecedent Information
semantic information contained in the foot feature, \([x]\text{and}([x]/S)\) in Figure 5.30, is obtained from that of the head noun, \([x]/S\). This semantic dependency of the trace on the head noun mirrors the anaphoric dependency of the head noun on the trace. Although the need for such a semantic relationship is not obvious when discussing relative clauses, it will become clear when we look at other kinds of unbounded dependency constructions.

In Figure 5.31 we outline a section of the FA structure associated with a simplified version of (5.70), namely

(5.71) Mary loves a picture of herself that Susan took.

Observe that the R-antecedent information of the head noun functor-sign is obtained from the foot feature of the subordinate sentence (bold) and from the reflexive attribute of the root-sign (italic). This results in the markers \(f1\) and \(f2\), corresponding to Susan and Mary respectively, both being available to the reflexive pronoun contained in the head noun. The analysis presented in Figure 5.31 is for the case where Susan acts as the antecedent. Since the downstairs R-antecedent information comes from the trace, arguments in the downstairs clause that are more 'oblique' than the trace cannot serve as antecedents for a reflexive in the head noun. This prevents FA specifications for ungrammatical sentences like the following.

(5.72) *Mary loves the picture of himself that (Susan gave to John.)

5.3.1.4. Reflexives and Appositive Relatives

There is very little difference in the behaviour of R-antecedent information in appositive as compared to restrictive relative clauses. We will provide a brief outline of a TUG treatment of appositive relatives since there is an interesting observation concerning their distribution that can be accounted for quite easily in our framework. Appositive relative clauses modify noun phrases, as opposed to restrictive relatives which modify nouns. They are allowed to modify only non-quantified noun phrases. Recall that in § 4.1.3.3, we described a classification of noun phrases which was closely tied to one proposed by Partee (1988). In the signs for quantified noun phrases, which correspond to Partee's \textit{essentially quantified noun phrases}, the semantic formula possesses an index of the \textit{state} sort (eg. \([s1]\text{impl}(\text{man}(x)))\. For non-quantified noun phrases, or noun phrases which are not \textit{essentially quantified}, their signs have a semantic formula with an index of the \textit{entity} sort and contain the semantic connective \textit{and} (eg. \([x]\text{and}(\text{man}(x)))\. To restrict appositive relatives to be applicable to only non-quantified noun phrases, a semantic-based restriction can be incorporated into the lexical entry for the appositive relative pronoun.
In the FA specification for *who* introduced in Figure 5.32, the appositive relative is restricted to occur with only non-quantified noun phrases since the semantic attribute of the noun phrase is required to contain the connective *and*. So appositive relatives are not allowed to appear with noun phrases possessing semantic connectives like *impl* or *no*. For instance, the sentences

\( (5.73) \) *Every man, who breathes, loves a woman.*

\( (5.74) \) *No man, who loves someone, loves Mary.*

are ungrammatical on the appositive reading. The appositive relative pronoun *who* possesses a lexical entry similar to the one for the restrictive relative pronoun except that the relative clause has a noun phrase as its functor instead of a noun; the relative clause is always an argument and the head of the construction is always a functor. Just as with restrictive relatives, the reflexive attribute of the head noun phrase contains R-antecedent information from both the upstairs and downstairs clauses (as highlighted in bold in Figure 5.32. The semantic information associated with the trace is stipulated to be the same as that of the head noun phrase (as shown in bold-italic). Relative pronouns that can appear in both restrictive and appositive relative clauses will have multiple lexical entries.

Notice that this is the first time that we see a noun phrase acting as a functor instead of an argument in an FA specification. As all of the noun phrase lexical entries that we have introduced so far treat the noun phrase sign as an argument, we need a separate lexical entry for noun phrases appearing with appositive relative clauses. One could propose an alternative TUG grammar in which noun phrases were structured differently to avoid this duplication of lexical entries. It may be argued that the modified noun should be the argument with the relative clause being the functor. In this case, an additional lexical entry for the noun phrase would not be required. However, we have always been treating modifiers as arguments in FA specifications, and we have adopted the convention that the functor acts as the head of the constituent in which it is contained (§ 4.4.1). Therefore, we will treat the noun phrase that is modified by the relative clause as a functor.

Part of the FA specification for the sentence shown in (5.75) is given in Figure 5.33.

\( (5.75) \) John, who, \( t \), loves himself, loves Mary.

As with restrictive relatives, the *trace* introduces the discourse marker which serves as the antecedent for the reflexive (shown in italic). The semantic attribute of the trace is obtained via the foot feature from that of the head noun phrase. Although there is a duplication of semantic information in the InL formula associated with the expression *John*
Figure 5.32. Lexical Entry for Appositive Relative Pronoun

Figure 5.33. Appositive Relative Containing a Reflexive
who loves himself, it does not affect its interpretation. Furthermore, we shall see that a semantically meaningful trace is necessary in our analysis of other kinds of unbounded dependencies.

5.3.2. Topicalised Constructions

Just as the foot feature is used in the analysis of relative clauses, it can also be used to account for the unbounded dependencies present in topicalised constructions. Topicalisation is a phenomenon in which a constituent appears at the beginning of a sentence instead of its normal position. The binding relation holds between this preposed constituent and a trace which is associated with the constituent's usual location. Since we will want to examine topicalised constituents containing reflexive pronouns, our discussion will centre on topicalised noun phrases. Some examples of topicalised constructions are introduced below.

(5.76) Mary, I love. Joan, I hate.
(5.77) A picture of himself, John loves.

Topicalisation is commonly used to emphasise the topicalised constituent or for contrastive purposes as exemplified in (5.76). As these 'pragmatic' factors are not described by our semantic notation, the semantic formula associated with a topicalised construction will be the same as the one of the non-topicalised form of the sentence.

Although topicalisation might be handled by the introduction of an additional grammar rule, we have already seen a lexical alternative utilising a lexical rule that introduces topicalised versions of the lexical entries for the various topicalised constituents. This lexical rule, which was first introduced in Figure 4.16, is shown in a more refined form in Figure 5.34. It differs from the earlier version with respect to the content of the semantic and reflexive attributes of the topicalised constituent. As with relative clause constructions, the reflexive attribute of the topicalised constituent is obtained by merging the R-antecedent information from the upstairs clause (A) with that of the downstairs clause (R). The semantic information [x]S' that is associated with the non-topicalised noun phrase appears in the foot feature in the topicalised construction thus being associated with the semantics of the trace. So the sign associated with topicalised noun phrase itself does not make any meaningful semantic contribution but the sign associated with the trace (which is contained in the foot feature) does. In this way, the topicalised noun phrase behaves semantically as if it were in the location associated with the trace. Multiple topicalisations are prevented since the foot feature of the root-sign of a topicalised noun phrase is stipulated to be empty — a topicalised sentence thus cannot appear as the functor in the
Figure 5.34. Lexical Rule for Topicalised Noun Phrases

Figure 5.35. Lexical Entry for Topicalised Noun Phrase Containing Indefinite Article
FA structure of some other topicalised sentence.

This lexical rule is applicable to more than just the lexical entries for proper names. Any FA specification having an argument-sign corresponding to a noun phrase will match the restriction of this rule. Not only will there be topicalised lexical entries for noun phrases, there will also be topicalised lexical entries for expressions like determiners. To prevent this lexical rule from being applicable to even the lexical entries for verbs, some minor modification is needed. Such a modification could involve requiring the phonology attribute of the functor-sign to be uninstantiated. The lexical entry for an indefinite article appearing in a topicalised noun phrase is shown in Figure 5.35. This lexical entry is combined with an auxiliary tree $\alpha$ for a noun along with another $\beta$ for a sentence containing a trace to produce an FA specification for a topicalised sentence. Although the syntactic information of the topicalised constituent is the same as that of the trace, the information that is normally contributed by the semantic attribute of the topicalised constituent is placed into the semantic attribute of the sign contained in the foot feature (as highlighted in italic in Figure 5.35). The reflexive attribute of the topicalised noun phrase is determined by R-antecedent information associated with the trace, $R$, plus R-antecedent information associated with the root sign, $A$ — reflexives contained in topicalised constituents can find their antecedents either in the 'upstairs' or 'downstairs' clause. Cases where reflexives in topicalised constituents take an 'upstairs' constituent are less common since topicalised constituents are usually in a sentence initial position. However, topicalised sentences can appear as complements clauses and we see behaviour reminiscent of picture-nouns in relative clauses. This means that sentences like (5.78) (Engdahl pers.com.) are allowed analyses where either Susan or Mary can act as the antecedent for the reflexive.

(5.78) Mary believes that this picture of herself Susan really likes.

An FA structure for the sentence introduced in (5.79) is provided in Figure 5.36.

(5.79) A picture of herself, every girl loves.

The dependency between the trace and the topicalised constituent is maintained through the use of the foot feature. Since the R-antecedent information of the trace contributes to that of the topicalised constituent, the marker $fl$ associated with girl is available to the reflexive pronoun contained in the topicalised constituent (according to the general principles concerning the distribution of R-antecedent information).
a-picture-of-herself-every-girl-loves
[sent,fin,[]
[s1][girl(f1) -- > [s2][PIC(n1,f1),love(s2,f1,n1)]
[

Figure 5.36. Sentence with Topicalised Picture-Noun

<α,β> it-is-W-that-W'
[sent,fin,[]
[α']S'
A

β: is-W-that-W'
[np,nom,[]
[v,fin,gprd,[]
[x]and(true)
[α']S'
A

W
is-that-W'
[np,C,[]
[v,fin, + prd,[]
[x]and(true)
[α']S'
R

is
that-W'
[v,fin,-prd,[]
[sent,fin],[ ε ; [np,C,[]; a]P(x|S) ; R]
true(α')
[α']S'
[

that
W'
[np,rel,[]
[sent,fin,gprd][ ε ; [np,C,[]; a]P(x|S) ; R]
[x]and(true)
[α']S'
[

Figure 5.37. Lexical Entry for Clefts

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With our analysis of topicalised constructions there is a problem similar to the one encountered with relative clauses. The anaphoric index of the topicalised constituent is contained in the reflexive attribute of the sign with phonology *every-girl-loves*. This means that there would be FA specifications for ungrammatical sentences like (5.80).

(5.80) *Mary, a picture of herself resembles.*

In an FA specification for (5.80) the reflexive attribute of the sign for the reflexive would contain the anaphoric index introduced by the topicalised constituent. As was the case with relative pronouns and reflexive pronouns, we have encountered yet another case where we do not want a specific noun phrase to introduce a possible antecedent for a reflexive. It appears that we need a restriction whereby the signs for relative pronouns, locally bound reflexives, and topicalised constituents are not allowed to introduce an anaphoric index into the reflexive attribute of their functors; we want to prevent these noun phrases from acting as antecedents for reflexives. However we do want personal pronouns, PRO, traces and non-pronominal noun phrases to introduce possible antecedents. Such a restriction can easily be incorporated into a TUG grammar, but why do these different types of noun phrases behave in different ways with respect to R-antecedent information?

One possible explanation relies on classifying noun phrases into three broad groups. The first group contains noun phrases that are not semantically vacuous — that is, the semantic attributes of their signs contain something more meaningful than \( \{x \} \text{and}(\text{true}(x)) \). These noun phrases possess anaphoric indices which are included in the reflexive attributes of the functors which take them as arguments. Therefore they can act as potential antecedents. Non-pronominal noun phrases and the traces used in unbounded dependencies fall into this class. The second group of noun phrases consists of what in GB terms is referred to as the class of pronominals (Chomsky 1981). Personal pronouns and PRO are the only members of this class. We have been representing these elements as semantically vacuous, but we will propose that they semantically assert the existence of a discourse marker and that they have an anaphoric index. The third group of noun phrases, which includes relative pronouns, locally bound reflexive pronouns (ie. the reflexives that we have been discussing in this chapter) and topicalised noun phrases are truly semantically vacuous. They do not assert the existence of discourse markers and thus they do not have anaphoric indices. Since all of these noun phrases do not introduce anaphoric indices into the reflexive attributes of their functors, this means that they cannot act as antecedents for reflexives. It is not surprising that neither relative pronouns nor locally bound reflexives can act as potential antecedents for reflexive pronouns since they are not capable of establishing an independent entity; they are anaphors in GB terms. One might think that
topicalised noun phrases should introduce possible antecedents for reflexives. However, we have commented that these noun phrases behave semantically as if they were present at the location of their trace. So, we would expect that they would introduce possible antecedents at their trace locations instead of introducing them at their topicalised locations.

Our templates for R-antecedent information embody the hypothesis that all noun phrases introduce anaphoric indices into the reflexive attributes of their functors. Without having to change our templates for R-antecedent information, we can encode the fact that one class of noun phrases do not introduce possible antecedents. This requires modifying our lattice of sorts for InL variables to reflect the distinction discussed in the previous paragraph; the variables will also be marked with respect to whether or not they can act as antecedents for locally bound reflexives. So all noun phrases will introduce their anaphoric indices into the reflexive attribute of their functors, but a restriction in the sign associated with the reflexive pronoun will disallow certain variables being chosen as antecedents; only markers of the 'non-vacuous noun phrase' sort will be allowed as possible antecedents. To simplify our discussions, we will not introduce this more complicated proposal for sorts into our examples. Instead, we will simply not introduce discourse markers corresponding to the vacuous noun phrases into the reflexive attributes of their functors. To distinguish the truly semantic vacuous noun phrases from those that do introduce anaphoric indices, we will specify their semantic attributes to be of the form $[x]and(true)$ instead of $[x]and(true(x))$ as we shall see in the next section.

5.3.3. Clefts and Pseudo-Clefts

Two final classes of constructions containing unbounded dependencies that we will briefly examine are those involving clefts and pseudo-clefts. These two types of constructions, which are also known as it-clefts and wh-clefts respectively, are illustrated in the following two forms of the sentence John loves a picture of himself.

(5.81) It is a picture of himself that John loves.

(5.82) What John loves is a picture of himself.

Although it is commonly noun phrases that are involved in cleft-sentences, subordinate clauses, adverbial phrases and adjectival phrases can also play the role of the constituent involved in the unbounded dependency. Once again, since we are primarily interested in the distribution of reflexive pronouns, we will only be looking at cleft and pseudo-cleft constructions involving noun phrases.

As with topicalisation, the subtle differences in meaning between cleft and pseudo-cleft sentences and their canonical form counterparts cannot be expressed in our semantic
notation. Cleft constructions are introduced by a lexical entry for is like the one outlined in Figure 5.37. This lexical entry is combined with two auxiliary trees, one for the noun phrase β, and one for the sentence missing the noun phrase α, in order to produce an FA specification for a cleft sentence. The structure of the embedded clause need not concern us here. Observe that this FA specification does not need to be combined with a noun phrase for the semantically vacuous dummy subject it — this subject is already specified as being a component of the cleft sentence. The FA specification for the noun phrase that unifies with β must have a semantically vacuous argument-sign (i.e., its semantic attribute must be \([x] and(\text{true})\)). It must also introduce the semantic information \((\alpha a P(\{x\} S))\) normally associated with the noun phrase into the foot feature of its functor as shown in bold-italic in Figure 5.37. So the lexical entry for noun phrases used in cleft constructions is much like the one used in topicalised constructions. Since the noun phrase involved in the unbounded dependency is semantically vacuous, it does not contribute a possible antecedent to the R-antecedent information of the functor-sign. Observe that the R-antecedent information, A, from the root-sign of the cleft construction is not available to any reflexives introduced in the cleft noun phrase; the reflexive attribute of the noun phrase is just R (i.e., \(R++\{\})\). So sentences like the one introduced in (5.83) would not have an FA specification associated with them.

(5.83) John said that it is a picture of himself that Mary loves.

To handle constructions like these, the lexical entry for clefts would have to be restructured to allow the argument-sign of β to be \(R++A\). Such a restructuring could involve not treating the functor-sign as a generalised predicative over the dummy subject it. If this were done, then the R-antecedent information of the root-sign would not be blocked from entering the functor-sign, and the cleft noun phrase would have a reflexive attribute containing \(R++A\) instead of \(R++\{\}\).

There is a lexical entry similar to the one introduced in Figure 5.37 for cleft constructions like (5.84) that do not contain a relative pronoun.

(5.84) It is a picture of himself John loves.

Both of these classes of lexical entries would be structured essentially the same since (5.84) is equivalent to (5.81). There are various restrictions on the distribution of these two types of cleft constructions (Akmajian 1970, Halvorsen 1978), but these restrictions will not be discussed here.
An FA structure for the sentence *It is a picture of himself that John likes* is shown in Figure 5.38. The information responsible for establishing the unbounded dependency is highlighted in bold in this figure. Again, it is the foot feature that is responsible for the R-antecedent information of the trace being able to contribute to that of the sign associated with *a picture of himself*. The normal propagation of R-antecedent information from this sign to that of the sign for the reflexive pronoun results in the reflexive having an antecedent.

In Figure 5.39, we outline a lexical entry for the verb *is* as it appears in pseudo-cleft constructions. We have proposed a lexical entry that is almost identical to the one used for cleft constructions to capture the close relationship between these two kinds of constructions. Again, the noun phrase involved in the unbounded dependency introduces information into the foot feature of its functor. The reflexive attribute for this noun phrase contains information merged from the upstairs and downstairs clauses. This allows two analyses for sentences like (5.85) to be obtained.

(5.85) Mary believes that what Susan likes is a picture of herself.

It is really only differences in the treatment of phonological information that distinguish the lexical entries for clefts and pseudo-clefts. In pseudo-cleft constructions, the noun phrase is placed in a sentence final position when in cleft sentences it appears towards the beginning. These two classes of constructions also differ in the type of pronoun that introduces the sentence containing the 'missing' noun phrase. Aside from these differences, the cleft construction also contains a dummy subject which a pseudo-cleft construction does not.

A derivation for the sentence *What John likes is a picture of himself* is provided in Figure 5.40. Notice that the FA structure of this sentence is almost identical to the one provided in Figure 5.38. The semantic formula associated with the root of the FA structure is the same for both structures — our semantic notation does not reflect any difference in meaning between the two sentences.

5.3.4. **Summary**

We have outlined an account for the unbounded dependencies appearing in relative clauses, cleft constructions, and pseudo-cleft constructions relying on information contained in a foot feature to mediate the dependency. As the foot feature contains the phonological, syntactic, semantic and R-antecedent information associated with the trace, unbounded dependencies are treated as more than just syntactic relationships between a constituent and its trace. Through the use of the foot feature, the semantic information associated with a
Figure 5.38. Cleft Sentence

Figure 5.39. Lexical Entry for Pseudo-Clefts
trace can be obtained from the constituent involved in the unbounded dependency. This means that the constituent can behave semantically as if it were located in the position occupied by its trace. The R-antecedent information associated with the constituent can access the R-antecedent information associated with the trace plus information that is locally available. Consequently, unbounded dependency constituents can obtain their R-antecedent information from more than one source — the R-antecedent information from the trace is merged with the R-antecedent information that is normally obtained from the environment of the unbounded dependency constituent. They have the potential to choose an antecedent either from the clause in which they are contained or from the clause in which their trace is contained. With a TUG grammar, we are once again able to describe constituents which behave one way syntactically yet another way semantically and anaphorically.

The distribution of unbounded dependency constructions is determined by the general principles governing the distribution of foot feature information. In particular, it is these principles that are responsible for parasitic gap phenomena and the distribution of traces. As with anaphoric phenomena, many of the principles can be stated in terms of the actual functor-argument relationships which are embodied in FA structures. Further investigation into the syntax of unbounded dependency constructions will allow more precise restrictions on the distribution of foot feature information to be formulated.

Finally, in examining unbounded dependency constructions, we have observed that different groups of noun phrases behave differently with respect to R-antecedent information. Semantically vacuous constituents do not contribute to the R-antecedent
information of functors that take them as arguments; they cannot act as antecedents for reflexives. Personal pronouns, PRO, traces and non-pronominal noun phrases do introduce R-antecedent information and thus can act as reflexive antecedents.

5.4. Prepositional Phrases

Accounting for the distribution of reflexives in prepositional phrases (PPs) has lead to numerous problems for different theories of reflexivisation. Solutions for these problems have often resorted to a 'special case' treatment, like prohibiting reflexives from appearing in locatives and permitting them to have only subject antecedents when they appear in other PPs. Instead of merely stating these restrictions, it would be nice to explain why restrictions like these arise. Before outlining a TUG account of the distribution of reflexives in various PPs, we will first outline a classification of PPs.

The distribution of prepositions and PPs has been the source of a great deal of research within various linguistic formalisms (Jackendoff 1973, van Riemsdijk 1978, Reinhart 1981, Gawron 1986). Some of the varied uses of PPs are illustrated in the following sentences.

(5.86) John gave a picture to Mary.
(5.87) Every man in the pub was drunk.
(5.88) John hit Mary in the park.
(5.89) John hit Mary in the eye.

In the first sentence, the PP is used to introduce an obligatory argument of the verb gave — the verb subcategorises for the PP. The second sentence illustrates a PP which acts as a modifier of a noun. Sentence (5.88) illustrates a PP which appears to modify the verb phrase. This use of the PP is different from the one shown in (5.89), which appears to be more closely tied to the main verb. Chomsky (1965) proposes that PPs can be divided into three classes based on the degrees of cohesion that a PP has to the main verb of the clause. Gawron (1986) makes a similar classification using semantic criteria in a situation semantic framework. Based on these proposals, we will classify PPs into prepositional noun phrases, co-predicating PPs and modifier PPs.

5.4.1. Prepositional Noun Phrases

It has often been observed that many prepositions seem to act as 'case-markers' for noun phrases (Fillmore 1968, Dowty 1978, Gazdar 1982). PPs containing these prepositions are subcategorised for by verbs and seem to act semantically like noun phrases. The preposition in these phrases seems to be semantically vacuous, and is often
present just to distinguish the various arguments of the verb. Examples of PPs that fall into this category are italicised in the following sentences.

(5.90) John talks to Mary.
(5.91) John gives a picture to Mary.
(5.92) John talks with Mary.

Gawron (1986) proposes that prepositions like these are not semantically vacuous. By adapting the Gawron’s situation semantic treatment, the sentences shown in (5.90-5.92) can be translated into the simplified InL formulae shown in (5.93-5.95).

(5.93) \[ [e1] [john(m1), mary(f1), to(e1, fl), talk(e1, m1, fl)] \]
(5.94) \[ [e1] [john(m1), picture(n1), mary(f1), to(e1, fl), give(e1, m1, n1, fl)] \]
(5.95) \[ [e1] [john(m1), mary(f1), with(e1, fl), talk(e1, m1, fl)] \]

For the semantic predicate associated with each verb (shown in bold), notice that the entity introduced by the PP (shown in italic) is also an argument of the predicate. Gawron notes that the semantic relation associated with the verb entails the relation introduced by the preposition in cases like these. This means that for a condition like the one involving talk in (5.93), we get the following relationship.

(5.96) talk(e, x, y) \implies to(e, y)

In our examples, we have assumed that talk to and talk with mean the same thing. If we wanted to distinguish the meaning of these two phrases, two different semantic predicates for talk would be needed. Due to the entailment relationship associated with the prepositions introduced in (5.90-5.92), the formulae introduced in (5.93-5.95) can be simplified as shown below by deleting the condition introduced by the preposition — it does not supply any additional information.

(5.97) \[ [e1] [john(m1), mary(f1), talk(e1, m1, fl)] \]
(5.98) \[ [e1] [john(m1), picture(n1), mary(f1), give(e1, m1, n1, fl)] \]
(5.99) \[ [e1] [john(m1), mary(f1), talk(e1, m1, fl)] \]

We will generally use these simplified formulae when providing InL translations of phrases containing these prepositions.

In order to account for many of the phenomena associated with these PPs, one could say that syntactically they are actually noun phrases (Pollard 1984). However, in TUG we can treat such PPs semantically and anaphorically as noun phrases and still label them as
syntactic PPs. Hence, we shall refer to this class of PPs as *prepositional noun phrases* (PNPs). This class corresponds to the class of *non-predicative* PPs discussed by Pollard (1984).

A lexical entry for a preposition that forms a PNP is introduced in Figure 5.41. The preposition is restricted to be applicable only to noun phrases of the objective case as reflected in the lexical entry. The value assigned to the prd feature of the preposition is not significant to the distribution of reflexive pronouns since the different values of prd would only affect the R-antecedent information contained in the sign for the preposition; the R-antecedent information of the argument-sign is always inherited from its parent sign. We have labelled the preposition as non-predicative (-prd) to reflect the non-predicative nature of these PPs (Pollard 1984). As we saw in possessive constructions, the semantic attribute of the functor of α is not used as the second argument of the connective and introduced by the noun phrase — it is instead conjoined with the first argument of the semantic connective and to yield the formula shown below.

(5.100) \([x]\) and( \([x][S, to(a,x)]\) )

Once again, due to the structure of our FA specifications for noun phrases, a separate lexical entry is required for auxiliary trees α corresponding to quantified and non-quantified noun phrases.

PNPs behave just like noun phrases with respect to R-antecedent information; they can introduce antecedents for reflexives and they can contain reflexive pronouns which have less oblique arguments of the verb as their antecedents (Gazdar and Sag 1980, Pollard 1984, Chierchia 1988). The anaphoric index of an argument PP is introduced into the reflexive attribute of its functor, and the R-antecedent information of the sign for the PP is the same as that of the noun phrase. This is illustrated in Figure 5.42 which contains the FA structure for *John talks to himself*. The \([pp, to]\) constituent is treated exactly as if it were a noun phrase. Note that we have used the simplified InL formula \(talk(e_1,m_1,m_1)\) in the sign associated with the verb phrase instead of the more complex formula shown in (5.101).

(5.101) \([e_1] [to(e_1, m_1), talk(e_1, m_1, m_1)]\)

Our approach suggests that the sentence shown in (5.102) where the reflexive has a non-subject antecedent should be grammatical.
Figure 5.41. Lexical Entry for Preposition

Figure 5.42. Sentence Containing Prepositional Noun Phrase
(5.102) I sold a slave to himself.

It was suggested by Postal (1971) that direct and indirect objects cannot be co-referential. So, a sentence like (5.102) should be ungrammatical on his criteria. However, this sentence is a perfectly grammatical response to a question like Who did you sell a slave to? Even if the use of a reflexive pronoun is marginal in some cases, it is by far preferable to the use of a personal pronoun referring to the slave.

(5.103) *I sold a slave to him.

So there is no strong motivation for restricting the R-antecedent information that may 'enter' a PNP; with respect to the distribution of this information, PNPs can be treated just like ordinary noun phrases. However, there may be restrictions associated with specific lexical entries which normally prohibit the appearance of a reflexive pronoun in a certain argument position. We shall return to this point shortly.

At this point, one should note that a preposition can be associated with more than one class of PPs. For example, the preposition with appears in more than just PNPs as illustrated in (5.104).

(5.104) John went to the pub with Harry.

In this case, the semantic contribution of with Harry is not implicit in the going to the pub event. This means that different lexical entries will be required for the different uses of with. As used in (5.104), with Harry is an example of a co-predicating PP.

5.4.2. Co-Predicating PPs

Like PNPs, co-predicating PPs are subcategorised for by verbs (and nouns). Included in this class is the one of adverbial PPs described by Chomsky (1965) (like those referring to direction, place, ...), for which verbs subcategorise. They differ from PNPs in that the semantic contribution of the preposition is not entailed by the semantic condition introduced by the verb (or noun). Instances of co-predicating PPs are italicised in the following sentences.

(5.105) John talks to Mary about herself.
(5.106) John loves a picture of himself.
(5.107) John hits Mary in the eye.
Adapting Gawron’s situation semantic treatment of these prepositions, co-predicating PPs introduce a predicate over the semantic index associated with the constituents that subcategorise for them. Unlike PNPs, they do not act as arguments of the semantic predicate associated with the constituent which subcategorises for them. This is illustrated in the following InL formulae associated with (5.105-5.107).

(5.108) \[ [el]Ijohn(ml), mary(\text{fl}), about(el, \text{fl}), talk(e1, m1, f1)] \]
(5.109) \[ [sl][john(ml)], [nh][picture(n1), of(n1, ml)], love(sl, ml, nl) ] \]
(5.110) \[ [ci][john(ml), mary(\text{fl}), eye(n1), in(e1, n1), hit(e1, m1, f1)] \]

The InL expression associated with the PP is shown in italic and the semantic predicate of the verb or noun which subcategorises for the PP is shown in bold. Consider the translation of (5.105) which is shown in (5.108). The different arguments of the talk predicate are associated with the event, the ‘talker’ and the ‘listener’ — there is no argument for the entity being talked about. The PP introduces a condition about(el, fl) on the talking event requiring it to be about f1 (i.e. Mary). For co-predicating PPs, we do not get the semantic entailment associated with PNPs as illustrated in (5.111).

(5.111) talk(e, x, y) ∇ about(e, y)

Talking to some person does not imply talking about that same person. We will not be going into any more detail concerning the semantics of PPs in InL. More information about the InL treatment of prepositions can be found in (Zeevat, Klein and Calder 1987).

Lexical entries for a co-predicating preposition are shown in Figure 5.43. As with PNP prepositions, separate lexical entries are needed for quantified and non-quantified noun phrases appearing within the PPs. Again, the semantic information associated with the preposition, about(a, x), is incorporated into the first argument of the semantic connective associated with the noun phrase. Recall that this relation is embodied in semantic template S-POS which was initially introduced for use in possessive constructions.

With respect to R-antecedent information, co-predicating PPs act like noun phrases, except that they cannot introduce entities which may act as antecedents for reflexive pronouns. So the noun phrase contained in the PP cannot be an antecedent for a reflexive pronoun contained in some more oblique verbal argument. This is not unexpected since the index associated with this embedded noun phrase is not a semantic argument of the verb — potential antecedents are usually semantic arguments of the verb. The difference between PNPs and co-predicating PPs will be reflected in their respective semantic indices; the anaphoric index of a PNP is an entity while that of the co-predicating PP is not. This
Non-Quantified Noun Phrases

Quantified Noun Phrases

Figure 5.43. Lexical Entries for Co-predicating Preposition

Mary
[p,np, obj]
[fl] and (mary(fl1))
[x]

about
[p, about, + prd]
[fl, x]

to-herself
[p, to]
[x] and ([x] to (e1, x))
[e1, x]

talks
[p, fin, + prd]
[x, e1, x]

talks-to-herself
[v, fin, + prd]
talk (e1, x, x)
[e1, x]

herself
[p, np, obj]
[fl, x]
and (true(x))
to (e1, x)
[e1, x]

talks-about-Mary-to-herself
[s, sent, fin, gprd]
[e1] [e1] [mary(fl1), about(e1, fl1)], talk (e1, x, x)
[x]

about-Mary
[p, pp, about]
[e1] and ([e1] [mary(fl1), about(e1, fl1)])
[x]

talks-about-Marv-to-herself
[s, prd]
[a] and (a) [x] about (a, x)

Figure 5.44. FA Specification Containing Co-predicating PP
is illustrated in Figure 5.44 in the FA specification for the expression *talks about Mary to herself*. First note that this expression contains a co-predicating PP, *about Mary*, and a PNP, *to herself*. As with other verb arguments, PPs are combined in order of obliqueness. The most oblique argument is the first one combined with the verb. When subsequent arguments are combined, the resulting phonologies are formed with the use of the head wrapping operation embodied in phonological template *P-WRP*. If we treat the PPs as noun phrases and introduce their anaphoric indices into the reflexive attribute of their functors, as highlighted in bold in Figure 5.44, then the reflexive attribute of the sign associated with the reflexive pronoun will contain only two markers. One of the markers \( x \) is associated with the as yet uninstantiated subject noun phrase, while the other \( eI \) is an event variable obtained from the co-predicating PP. Since the sign associated with a reflexive pronoun requires the marker of its antecedent to be of the feminine sort, \( x \) is the only possible antecedent. The selection of \( eI \) would lead to a type clash. So the subject of the sentence is the only possible antecedent for the feminine reflexive (and thus \( x \) should be replaced with \( f \) in Figure 5.44). This means that there would be no FA specification for the ungrammatical sentence *John talks about Mary to herself* which has a masculine subject.

We have assumed that co-predicating PPs are treated like noun phrases in an FA specification. Functors that take these PPs as arguments in FA specifications have therefore been treated as predicatives (+prd). Alternatively, one could treat these functors as non-predicatives (-prd) without affecting the distribution of reflexive pronouns — it would only result in the state or event marker associated with the PP (like \( eI \) in Figure 5.44) not being included in the R-antecedent information of the functor-sign.

Our treatment of co-predicating PPs can account for the behaviour illustrated in the following two sentences from (Postal 1971, Chapter 5).

\[
\begin{align*}
(5.112) & \ I \ talked \ to \ Thmug \ about \ himself. \\
(5.113) & *I \ talked \ about \ Thmug \ to \ himself.
\end{align*}
\]

Although Postal (1971) has to rely on *cross-over* to account for this data and Hellan (forthcoming) explains constructions like these in terms of *role-command*, the grammaticality judgements associated with these sentences follow directly from our general principles concerning the distribution of R-antecedent information if in this case we treat *to* as part of a PNP, and *about* as part of a co-predicating PP as discussed in conjunction with Figure 5.44. In (5.113), the co-predicating PP does not introduce the index of *Thmug* into the reflexive store of its functor, and thus *Thmug* is unavailable as an antecedent for the
reflexive in the more oblique argument. In (5.112), the PNP does introduce a marker for \textit{Thnug} which is available to the reflexive pronoun. This also explains the grammaticality variations in sentence pairs like (5.114) and (5.115), where \textit{with} is contained in a PNP.

(5.114) John talks with Mary about herself
(5.115) *John talks about Mary with herself

Different lexical entries are required for the verb \textit{talks} as used in sentences like \textit{John talks to Mary about Joan} as compared to sentences like \textit{John talks about Joan to Mary}. This is because each of these occurrences of the verb requires a different FA structure. In general, whenever a verb subcategories for 'optional' arguments, a different FA specification is required for each case. For these two sentences, the two lexical entries can be related by a lexical rule which merely changes the location of the signs corresponding to the two PPs. Alternatively, we might want to propose a lexical rule which would insert co-predicating PPs into some (non-initial) argument position in the lexical entry of the verb. Such a lexical rule is roughly outlined in Figure 5.45. It alters the FA specification to insert some structure (which is circled in Figure 5.45) associated with an additional argument in between a less oblique \textit{np} or \textit{pp} argument and its functor. So from a lexical entry for \textit{talk} responsible for sentences containing a single PNP and no co-predicating PPs (eg. \textit{John talks to Mary}), we could get an infinite number of alternative lexical entries for sentences like the ones shown in (5.116).

(5.116) John talks to Mary about Joan.
    John talks about Joan to Mary.
    John talks in French to Mary about Joan.
    etc...

This highlights the capacity for co-predicating PPs to iterate (Gawron 1986), and shows the highly unrestrictive word order associated with them. A more restrictive approach would require having a lexical entry where arguments are specified as optional. Then, a lexical rule could result in the deletion of these elements. In this case, there would not be an infinite number of lexical entries for a verb like \textit{talks}.

5.4.3. Modifier PPs

Our final class of PPs are not subcategorised for by verbs and nouns. As Chomsky (1965) notes, their distribution is independent of the constituent they modify. Modifier PPs are usually seen modifying verb phrases and will include the class of PPs often referred to as adjunct PPs. Most commonly, modifier PPs specify locative or temporal information about the entire action or entity described by the constituent it modifies. This is illustrated
Figure 5.45. Lexical Rule for Co-predicating
PP Introduction
in the following examples.

(5.117) John hits Mary in London.
(5.118) Mary hits John during a fight.
(5.119) John from London hates John from New York.

An InL translation of (5.117) is shown below.

(5.120) \([e1] [\text{john(m1), in(e1, n1), london(n1), mary(f1), hit(e1, m1, f1)}]\)

The semantics of this sentence is very similar to that of the sentence John hits Mary in the eye, which is presented in (5.121).

(5.121) \([e1] [\text{john(m1), mary(f1), eye(n1), in(e1, n1), hit(e1, m1, f1)}]\)

Although we do not want to get involved in a detailed study of modifiers, one possible way of semantically representing the difference between co-predicating and modifier PPs would be to associate a formula like (5.122) instead of (5.120) with the sentence John hits Mary in London.

(5.122) \([e1] [\text{john(m1), london(n1), in(e1, n1), [e2][mary(f1), hit(e2, m1, f1)]}]\)

The semantic formula associated with a modifier preposition would contain an indexed formula describing the modified event as one of its arguments, as highlighted in (5.122). This type of semantic treatment is in the spirit of the proposals suggested in (Gawron 1986).

A lexical entry for a modifier preposition is introduced in Figure 5.46. It takes an auxiliary tree associated with a noun phrase \(\alpha\) and one corresponding to a 'verb phrase' \(\beta\) to produce an FA specification corresponding to a verb phrase (ie. an FA specification for a sentence with an auxiliary list containing an entry \(\delta\) for the as yet uninstantiated subject). Although conceptually the PP modifies a verb phrase, the grammar rule is not allowed to structurally alter the FA specification for the verb phrase by adjoining a PP; it can only combine partial specifications! Like for the treatment of infinitival verb phrase complements § 4.1.2, we are required to treat auxiliary trees for verb phrases as FA specifications for sentences containing null instantiated subjects. Recall that in order for the FA specification for a verb phrase to act as an auxiliary tree it must have an empty auxiliary list. Alternative lexical entries are required for verbs producing such verb phrases. These lexical entries are related to 'normal' verb specifications by the lexical rule for null subject instantiation which was introduced in Figure 5.9. The subtree associated
John criticises-Mary-in-a-story-about-himself
[np,nom] [v,fin,gprd]
[m1] and(john(m1)) [e1][STORY(n1,m1),in(e1,n1,#1)] [m1]

criticises-Mary
[sent,fin,prd]
1 ≠ [e2][mary(f1),criticise(e2,m1,f1)] [m1]
[m1]

criticises-Mary
[np,nom,null] [v,fin,gprd]
[m1] and(true(m1)) [e2][mary(f1),criticise(e2,m1,f1)] [m1]
[m1]

in-a-story-about-himself
[pp, in]
[e1][STORY(n1,m1),in(e1,n1,#1)] [m1]

a-story-about-himself
[np, obj] [p, in, + prd]
STORY(n1,m1) in(e1,n1,#1) [m1] [m1]

Figure 5.47. Sentence Containing Modifier PP
with the modified verb phrase \( \beta \) resembles the FA specification for a sentence, except that the subject of this ‘sentence’ possesses a null phonology, and its index \( x \) is determined by the index of the subject of the new verb phrase. The sign associated with the modifier PP is an argument of the modified verb phrase \( \beta \). In fact, with respect to the distribution of R-antecedent information, it does not matter whether it is the functor or the argument.

Since we have treated noun modifiers and noun phrase modifiers as arguments in an FA structure, it seems appropriate that modifier PPs should also be treated as arguments. The lexical entry from Figure 5.46 can only modify verb phrases possessing semantic indices of the event type, and it introduces a new index of the same type. This allows a semantic analysis of the kind exemplified by the InL formula introduced in (5.122). A separate lexical entry would be required for modifying verb phrases describing states. Only a single lexical entry would be required if the sort of the modified verb phrase could be accessed without also accessing the entire discourse marker.

An extract from the FA structure corresponding to the sentence *John criticises Mary in a story about himself* (Jackendoff 1972:4.278) is shown in Figure 5.47. \( \text{STORY}(n_1,m_1) \) is used as an abbreviation for the formula shown in (5.123).

\[
(5.123) \quad [n_1] \ [\text{story}(n_1), \text{about}(n_1,m_1)]
\]

Due to the constraints on the distribution of R-antecedent information, only the index of the subject of the sentence is available as an antecedent to a reflexive contained in the PP as illustrated in bold font. This illustrates the correspondence between modifier PPs and those PPs where only the subject of the sentence is available as a potential antecedent to a reflexive contained in the PP. If the PP in this sentence were a co-predicating PP, then it would be positioned in an FA structure so that both the subject and object would be available as potential antecedents to a reflexive contained in the PP. As it is, the ungrammatical sentence *John criticises Mary in a story about herself* would not have an FA specification associated with it because the discourse marker for Mary would not be available to the reflexive.

5.4.4. Analysis of Classification

Let us now briefly summarise how our classification of PPs relates to the distribution of R-antecedent information. First PNPs behave just like ordinary noun phrases with respect to R-antecedent information. Reflexives contained in these PPs have the potential to take either subject or non-subject antecedents. Also, the indices of these PPs are of the entity sort, and consequently these PPs can introduce antecedents for reflexives. Co-predicating PPs are like PNPs in that they have the potential to take either subject or non-
subject antecedents. However, they do not introduce discourse markers that can act as potential antecedents for reflexives contained in more oblique arguments. Finally, due to the FA structure associated with modifier PPs, only the subject of the sentence is available to reflexives contained in these PPs.

As with many linguistic classifications, many occurrences of PPs are difficult to group into the classification and some PPs can occur in more than one class. It is often difficult to determine whether or not the meaning of the preposition is entailed by that of the verb; intuitions may vary from individual to individual. Gawron (1986) notes that what we call PNPs differ from the other classes in that members of the other classes can iterate while PNPs cannot. That is, since co-predicating and modifier PPs introduce new entities which are not semantic arguments of the semantic predicate associated with the verb, there is nothing to prevent an indefinite number of them occurring. This is illustrated in the following example (Gawron 1986:p.347).

(5.124) Joan hit the ball through the alley between the buildings and into Mrs. Magillacuddy's window.

Unfortunately, it is often not as easy to distinguish between co-predicating PPs and modifier PPs. How does one decide if the PP is a modifier of a verb or of an entire verb phrase? There is no simple answer to this question, and Gawron himself limits his discussion of modifiers (adjuncts) to what he calls the relatively clear cases involving locatives and benefactives. Perhaps this difficulty in placing a PP into one of these two classes accounts for why the intuitions of individuals varies with respect to whether or not a reflexive occurring in a PP can take a non-subject antecedent?

So far, we have made proposals concerning why reflexives contained in certain PPs can take only subject antecedents and why noun phrases introduced in only some PPs can act as antecedents for reflexives contained in more oblique arguments. These proposals all follow from the FA specifications proposed for the sentences containing the PPs and from the general principles concerning the distribution of R-antecedent information. However, there are some cases where we would expect the use of a reflexive to be grammatical and yet many people think that it is not. These exceptions will require additional restrictions to be associated with certain lexical entries.

5.4.5. Passive Constructions

It is generally assumed that passive sentences cannot contain a reflexive pronoun in their by-PP. So, the sentences shown in (5.125) and (5.126) are often deemed to be ungrammatical in a normal context.
(5.125) John was shaved by himself.
(5.126) John was loved by himself.

This follows directly from the thematic hierarchy restriction on reflexives which was discussed in chapter two. However, it is acknowledged by Jackendoff (1972) that these sentences are grammatical responses to questions like those shown below.

(5.127) Who was John shaved by?
(5.128) Who was John loved by?

Although the use of (5.125-5.126) may be questionable in normal (nonemphatic) contexts, they are undoubtably superior to a sentence like (5.129) where the him is intended to be coreferential with John.

(5.129) *John was loved by him.

It appears that R-antecedent information should not be blocked from entering the prepositional phrases introduced by passives, since there are cases where this information is needed in grammatical sentences. If there is any restriction, it may just be a simple syntactic restriction (involving our pro feature discussed in § 5.2) prohibiting the use of a bare reflexive in the passive. The preference for disallowing reflexives may be due to the influence of a thematic hierarchy restriction as discussed in chapter two. But we have seen that this restriction can be overridden.

5.4.6. Locative Constructions

As with passive constructions, there is a problem with some locative PPs in which the appearance of a reflexive is apparently ungrammatical when our proposal would predict that it should be allowed. Consider the following sentence in which the use of the reflexive is generally considered ungrammatical unless it is used for an emphatic reading.

(5.130) *John saw a snake near himself.

Unlike the other PPs that we have been looking at, a personal pronoun which takes the subject as its antecedent is allowed.

(5.131) John saw a snake near him.

There are examples of verbs with which the use of the reflexive in such modifier PPs is more acceptable. Consider the following sentences from (Kuno 1987:9.17-9.19).
(5.132) John hid the book behind him/himself.
(5.133) John pulled the blanket over him/himself.
(5.134) John put the blanket next to him/himself.

Kuno suggests that the meaning of these sentences is different when the reflexive as opposed to the personal pronoun is used. The reflexive versions supposedly suggest a more intimate contact with the antecedent than the nonreflexive versions. For example, the reflexive version of (5.132)

... implies that John held the book with his hand and put it behind his back. The book was directly touching him. On the other hand, [the other reading] implies that perhaps the book was on a chair, and he was standing in front of the chair so that the book could not be seen. In other words, it is most likely that there was no physical contact between John and the book. (Kuno 1987, p.66)

Based on this observation, we may want to introduce separate lexical entries for locative prepositions that introduce reflexives and for those that do not (since the meaning of the preposition varies). Once again, the syntactic pro feature could be used to this end. For certain verb phrases, like the one in (5.130), we may want to prevent the occurrence of these reflexive inducing prepositions, perhaps due to some semantic properties of the verb and preposition that make them incompatible (e.g. Kuno's (1987) semantic constraint on reflexives).

We have already seen that reflexives can occur in locative PPs in sentences like John criticises Mary in a story about himself. Further support for not blocking R-antecedent information comes from the distribution of the possessive reflexive in Swedish. The reflexive pronoun sitt can appear in locative PPs and have the subject of the sentence as its antecedent.

(5.135) Johan kysste Maria i sitt hus.
Johan kissed Maria in REFL(gen), house
'Johan kissed Maria in his house.'

There is no motivation for proposing a sweeping restriction to block R-antecedent information from entering all modifier PPs. Instead, there seem to be other restrictions associated with certain prepositions and verbs which do not allow certain arguments of theirs to be (or contain) reflexives. The source of these restrictions appears to be related to aspects of the meaning of the various lexical entries, and could conceivably be influenced by thematic role and empathy perspective (Kuno 1987).
5.4.7. Summary

By distinguishing between PNPs, co-predicating PPs and modifier PPs, it is possible to account for most of the confusing data concerning the distribution of reflexives in prepositional phrases. The outstanding exceptions seem to be highly dependent on specific lexical items, and can be accounted for in the various lexical entries without the need for modifying the general principles concerning the distribution of R-antecedent information.

5.5. Strict and Sloppy Antecedents

For the grammar fragment that we have presented so far, each reflexive pronoun has required only a single lexical entry (ignoring the effects of lexical rules), regardless of whether the reflexive takes a subject or non-subject antecedent. This is possible since the reflexive attribute contains information that originates from the anaphoric indices of subjects (as embodied in the template for generalised predicatives $R$-$GPR$) and from the anaphoric indices of non-subjects (as embodied in the template for predicatives $R$-$PR$). As discussed in chapter two, some languages permit the reflexive to take strict as well as sloppy antecedents in certain constructions. This is usually illustrated in conjunction with VP ellipsis and in sentences like Only John voted for himself. In this section we will be concentrating on VP ellipsis constructions. Although a detailed study of VP ellipsis is beyond the scope of this thesis, we will illustrate how a proposal for obtaining strict and sloppy readings from chapter two can be incorporated into TUG. After taking a brief look at the circumstances under which a sentence containing a reflexive can have both strict and sloppy readings we shall see how the information associated with these various readings can be incorporated into a tree unification grammar without requiring the introduction of an additional lexical entry for the reflexive.

One of the interesting properties of ‘strict’ readings of reflexive pronouns is that they only seem to be allowed in conjunction with the class of what we have called non-quantified noun phrases. For instance, each of the two sentence discourses introduced in (5.136) and (5.137) allow strict interpretations.

(5.137) Some politician voted for himself. John did too.

The first discourse can be interpreted as meaning that John hates Neil and the second that John voted for the politician that voted for himself. A strict reading is not possible for the following sentence which contains a quantified noun phrase.
Every politician voted for himself. John did too.

Another property of sloppy and strict interpretations is that they are not restricted to cases where reflexives are arguments of a verb. The two readings are possible even if the reflexive is embedded within a complex noun phrase.

The president loves the portrait of himself. The party chairman does too.

There is a further interesting observation which illustrates that a reflexive taking a non-subject antecedent can be subject to both sloppy and strict interpretations.

Nancy gave the president a portrait of himself. She gave George one too.

However, this example illustrates one anaphora, not VP ellipsis. Further illustrations of the wide range of constructions exhibiting sloppy and strict readings are provided in (Reinhart 1983).

As discussed in § 2.2, Klein (1987b) proposed a DRT-based account of sloppy and strict readings for pronouns in which separate discourse markers were used as antecedents in order to obtain the different readings. Such an approach will form the basis of the TUG treatment. We will associate distinct information with the strict and sloppy readings of reflexives. For reflexives that have non-quantified antecedents, there will be separate discourse markers associated with strict and sloppy antecedents. All of these markers will still be contained in the same reflexive attribute; they will come from different sources just like subject and non-subject antecedents come from different sources. For quantified noun phrases there will only be one marker, corresponding to the sloppy reading, introduced into the reflexive attribute of its functor. The marker responsible for the sloppy interpretation is what we have called the anaphoric index of the noun phrase. What marker should we use for obtaining a strict interpretation though?

Recall that the semantic attribute of noun phrases is of the form

\[(5.141) \ [a]P([b]S)\]

where \(P\) is a semantic connective like \(\text{and}\) or \(\text{impl}\) and \(S\) contains the condition associated with the noun phrase. For non-quantified noun phrases, \(a\) and \(b\) are unified with each other and they are both of the entity sort.

\[(5.142) \ \text{a man} \quad [m1] \ \text{and(} \ [m1]\text{man(m1))} \\
\text{John} \quad [m1] \ \text{and(} \ [m1]\text{john(m1))} \]
For quantified noun phrases, *a* is of the state sort while *b* is of the entity sort.

\[(5.143)\] 

\[
\begin{align*}
\text{every man} & \quad [s1] \text{impl}([ml]\text{man}(m1)) \\
\text{no man} & \quad [s1] \text{no}([ml]\text{man}(m1))
\end{align*}
\]

In all of these formula, the anaphoric index (shown in italic) is of a sort appropriate for the antecedent of a reflexive pronoun. For non-quantified noun phrases, the index of the formula is also of a sort appropriate for an antecedent of a reflexive pronoun. It is this index, which we will call the *descriptive* index (it describes the sort of object associated with the noun phrase), that will be used as the antecedent for strict readings of the reflexive. For an argument-sign corresponding to a non-quantified noun phrase, the R-antecedent information of the functor-sign will contain the descriptive and anaphoric indices of the argument-sign. This is illustrated in two FA specifications for the verb phrase *loves himself* in Figure 5.48. Since the reflexive attribute of the sign associated with the reflexive pronoun contains two markers which can serve as possible antecedents, there are two possible specifications that can be associated with the verb phrase. The marker chosen by the reflexive pronoun is shown in italic in these FA specifications.

When the FA specification for a non-quantified nominative noun phrase is unified with a in either of these specifications, *x* and *m* will be unified (since non-quantified noun phrases have identical descriptive and anaphoric indices) and each of the resulting specifications will describe the same FA structure. The descriptive index of a quantified noun phrase is not of the sort appropriate for an antecedent of a reflexive pronoun. In order to see how the different indices result in different interpretations, we need to outline an approach to VP ellipsis which can be incorporated into TUG.

In Klein's (1987b) treatment of VP ellipsis, which is based on proposals by Keenan (1971), he introduces *predicate-DRSs* (pDRSs) which are associated with verb phrases. Recall that a pDRS is essentially a DRS out of which a discourse marker has been lambda abstracted (§ 2.2). Based on (Keenan 1971) and (Klein 1987b), we could propose that a *predicate InL* (pInL) formulae be associated with all verb phrases. Application of a pInL formula to a discourse marker is a variation of lambda conversion; the resulting formula is equivalent to one in which the argument of the pInL formula is unified with the abstracted marker. This is illustrated by the equation in (5.144).

\[(5.144)\] 

\[
\lambda x[s1][\text{mary}(fl),\text{love}(s1,x,fl)](m1) = [s1][\text{mary}(fl),\text{love}(s1,m1,fl)]
\]

The variable *x* is called the *parameter marker*. With respect to reflexive information, the reflexive attribute of the sign associated with a verb phrase will contain both the descriptive index of its functor and its parameter marker. This is illustrated in excerpts
Figure 5.48. FA Specifications with Sloppy and Strict Antecedents

Figure 5.49. FA Specifications containing πL Formulae
from the FA specifications for *loves himself* introduced in Figure 5.49. The marker \( y \) appearing as the argument of the pInL formulae in the root-signs of these FA specifications is the anaphoric index of the subject noun phrase. Application of the pInL formula to its argument will result in the unification of the parameter marker with the anaphoric index. Depending on the choice of the antecedent, we once again get two interpretations. A treatment of VP ellipsis would then involve making the pInL formula associated with the antecedent VP available to the sign associated with a phrase like *does too* (possibly through the use of another storage mechanism). Since there are two possible FA specifications for the initial verb phrase, there would be two possible interpretations for a discourse like (5.145).

(5.145) John loves himself. Harry does too.

The FA structure for the strict reading of the discourse from (5.145) is shown in Figure 5.50. Observe that the root-sign of this FA structure corresponds to a discourse and possesses the syntactic feature `disc`. In this structure, we introduce signs which have a 'phonology' consisting of a full stop (period). Such a sign can act either as a functor which takes a single sentence as an argument to produce a discourse (as it does for the sentence *Harry does too* in Figure 5.50), or it can act as a functor which combines a sentence with another discourse (like the sign shown in bold does). In the first case, there is no real semantic contribution made by the functor. Essentially the same pInL formula appears in the semantic attribute of the sign for *loves-himself* and of the sign for *does-too*; these formulae differ only in their semantic indices. Again, we will not be concerned with the details of how the relationship between these two formulae is established. The semantic formula associated with the complete discourse describes a state which is formed by conjoining the semantic formulae associated with the component sentences. When the semantic formula associated with the root sign of the FA structure is simplified by applying the pInL formula to their respective arguments, the formula shown in (5.146) will result.

(5.146) \[ [s3][\text{[s2][harry(m2), love(s2,m2,m1)]}, [s1][john(m1), love(s1, m1, m1)]] \]

The discourse marker associated with *John* appears as the final argument of both occurrences of the semantic condition *love* — we have a strict reading of the reflexive. This is a consequence of the descriptive index from the sign with phonology *John* acting as the antecedent for the reflexive. Had the parameter marker been chosen as the antecedent instead, then we would have obtained a sloppy reading for the reflexive.
John loves himself. Harry does too.

John loves himself.

Harry does too.

Figure 5.50. Discourse Containing VP Ellipsis
There are a few points concerning this treatment of VP ellipsis which require further discussion. First, we want to avoid FA specifications for ungrammatical sentences like *Mary loves himself*. An excerpt from a possible FA specification for this sentence is shown in Figure 5.51. It seems that we may want to unify the parameter marker \( m \) and its argument \( f \) in order to prevent FA specifications like this one; we need to perform lambda conversion during the construction of the FA specification. For sentences like this one, lambda conversion would fail (since the variables would not unify) and an FA specification would not be created. In cases where lambda conversion does not fail, like for the sentence *John loves himself*, an FA specification like the one shown in Figure 5.52 is obtained. The semantic formula shown in italics in this FA specification results from evaluating the expression shown in (5.147).

(5.147) \( \lambda m \text{love}(s1,m,m) \ (m1) \)

Our treatment of the distinction between strict and sloppy readings of reflexive pronouns in VP ellipsis constructions relies on associating separate discourse markers with the different readings of the reflexive. The anaphoric index, which becomes unified with the parameter marker in the plInL formula used in our treatment of VP ellipsis, is associated with sloppy readings of the reflexive while the descriptive index is responsible for strict readings. Only non-quantified noun phrases have descriptive indices which can act as antecedents for reflexive pronouns, thus only they can have strict readings.

5.6. Summary

The distribution of reflexive pronouns in Tree Unification Grammar is dependent on: the tree structure associated with lexical entries; the general principles describing the distribution of R-antecedent information for generalised predicative, predicative and non-predicative functors; and syntactic restrictions, introduced by specific lexical entries, on the appearance of reflexive pronouns in certain argument positions. For the lexical entries that have been introduced in this chapter, the tree structures are for the most part based on categorial grammar derivation trees. Although argument-signs are arranged in order of semantic obliqueness, there is some disagreement on the actual ordering of semantic arguments. This issue is discussed in (Dowty 1982). The general principles concerning the distribution of R-antecedent information are based on the *predicative* status of the various functors. For the functor-signs in an FA specification, the assignment of the \( \text{prd} \) value has been based on the syntactic and semantic properties of the argument and root-signs. The introduction of individual restrictions on reflexive pronouns that are present in various lexical entries seems to be attributable to various sources, as was discussed in the
Figure 5.51. Ungrammatical Sentence containing pL1 Formula

Figure 5.52. Sentence containing pL1 Formula
R-antecedent information associated with both subject and non-subject antecedents, and with sloppy and strict readings of reflexive pronouns, is all combined into the reflexive attribute of signs allowing a single lexical entry for the reflexive pronoun to be used for all of these cases. The reflexive attribute of signs has a status like the other attributes of the sign — no special treatment is awarded to R-antecedent information. Just like other forms of information, it can be used to restrict the possible analyses for a linguistic expression. If the reflexive attribute of a sign corresponding to a reflexive pronoun does not contain a variable of the appropriate sort for the antecedent, then there is no FA specification for the linguistic expression. The information contained in the reflexive attributes of signs is present in case it is ever needed. In this way, when a reflexive pronoun is encountered its potential antecedents are locally accessible — no complicated procedure is required to search for antecedents. The amount of information contained in reflexive attributes is small, and it is built up according to very simple and well founded relations (which are embodied in the reflexive templates). So the 'space' and 'effort' associated with this information is minimal. For signs associated with linguistic expressions that are not reflexive pronouns, although this information is not 'used' (ie. there are no restrictions on the reflexive attribute) it will be relevant to the distribution of reflexive pronouns contained within the expression. The R-antecedent information is present so that anaphora resolution can be stated in very simple terms. In addition to the way that the distribution of reflexives is accounted for within our grammar fragment, there are some interesting observations concerning how other phenomena are treated.

Many constructions rely on the presence of signs with a null phonology e. For instance, infinitival verb phrases are treated as sentences possessing null phonology subjects and the traces involved in unbounded dependencies have signs with null phonology associated with them. The presence of null phonology signs does not require us to propose lexical entries for null lexical items. These signs are an integral part of our treatment of control, unbounded dependencies and reflexivisation.

Within TUG, constituents can be treated syntactically in one way yet semantically in another. This is most clearly illustrated in the treatment of equi verbs, raising verbs, and unbounded dependencies. In the FA structures for these constructions, a noun phrase is syntactically in one clause and semantically in a different clause.

Our analysis of reflexives has caused us to look at classifications for noun phrases and prepositional phrases. We have seen how the semantic contribution of a noun phrase seems to affect how it behaves in reflexive constructions. Semantically vacuous noun
phrases appear to be unable to act as antecedents for reflexive pronouns, while true
*pronominals* (in the GB sense, as opposed to *anaphors*) and non-vacuous noun phrases
can. Furthermore, non-quantified noun phrases behave differently with respect to
reflexivisation than quantified noun phrases; they allow sloppy/strict distinctions. The
classification of PPs into PNPs, co-predicating PPs and modifier PPs corresponds to three
different behaviours of PPs with respect to reflexivisation. This classification is based on
both syntactic and semantic criteria. With respect to R-antecedent information, PPs from
the first class behave just like noun phrases. Those from the second class cannot introduce
antecedents for reflexive pronouns, and reflexive contained within them can take non-
subject as well as subject antecedents. Modifier PPs cannot introduce antecedents either,
and any reflexives they contain can only take subject antecedents.

Various linguistic generalisations associated with reflexivisation and other phenomena
are captured in the templates and lexical rules that were introduced with the grammar
fragment. The use of templates allows the lexicon to be stated more concisely with less
duplication of information. Within our grammar fragment, the full potential of templates
as abbreviatory mechanisms has not been exploited, since we were interested in illustrating
many relations explicitly in the lexical entry. The reflexive templates embody the relations
governing the distribution of R-antecedent information in English. For other languages,
these relations may need to be modified. Lexical rules have been used to illustrate how
structural alterations can be performed to one lexical entry to obtain another lexical entry.
Many details concerning how lexical rules work have been glossed over, since we were
just interested in outlining that the various lexical entries can be related and showing how
the reflexive attributes of the various signs were affected by lexical rules. One interesting
aspect of lexical rules is that they have the potential to result in an infinite lexicon. For
example, if we have a lexical rule for argument PP insertion, then there will be an infinite
number of lexical entries for each verb. This is not a desirable aspect for a grammar,
especially from a computational point of view. Therefore care must be taken to avoid such
consequences when writing a grammar.

In presenting our grammar fragment, we have been able to avoid the introduction of
any additional grammar rules. Only a single grammar rule has been required and all
grammatical generalisations have been captured in the lexicon. This has been at the cost of
introducing multiple lexical entries for various linguistic expressions. However, these
lexical entries are still related by templates or lexical rules. By capturing the relations in a
lexical entry, instead of in a grammar rule, we avoid the problems associated with the
interaction of grammar rules and lexical entries that were discussed in chapter three.
The grammar fragment presented in this chapter embodies the necessary constraints for the constructions being analysed; there may be additional constraints on sentences which might make them ungrammatical. An extended grammar could incorporate such constraints. Our analysis of cleft constructions and VP ellipsis has been extremely superficial since we have been interested in examining the behaviour of R-antecedent information. A detailed analysis for such constructions would be enlightening but unfortunately such an analysis is beyond the scope of this thesis. Finally, a more detailed formulation of the various lexical rules would result in a better understanding of the relationship between lexical entries but again it would probably not result in any greater insights into the distribution of reflexives.
Chapter 6
Comparison with Other Accounts for Reflexives

In the previous chapter, we have illustrated how the distribution of locally bound reflexive pronouns in a varied selection of constructions can be accounted for within the TUG framework. In what way is our proposal different from the numerous other accounts of reflexivisation? What are the advantages of describing reflexives within TUG as compared to some other framework? We have already discussed many of the constraints on reflexivisation and how those of other frameworks relate to those used in TUG. In this section we will look more closely at the mechanisms used for reflexivisation. Since the TUG account of reflexives relies on the use of a storage mechanism in conjunction with categorial grammar like derivation structures and a DRT-oriented semantics, we will compare our account with some other storage-based accounts, with some other proposals that incorporate DRT, and with an approach using categorial grammar.

6.1. Reflexives and Storage Mechanisms

The storage mechanism used in many accounts of anaphora, quantifier scoping, and unbounded dependencies can be traced back to the Cooper store (Cooper 1983). During the analysis of a sentential constituent $A$, information can be placed into a store for future use in the analysis of some other constituent $B$. This information is transferred from one constituent to another until it makes its way to $B$. It can then be removed from the store during the analysis of $B$. With respect to reflexivisation, the store is often used to hold information about a reflexive pronoun $A$ for which an antecedent $B$ is being sought. Let us now examine in detail the storage-based treatments of reflexivisation proposed in HPSG (Pollard and Sag 1987) and in Extended Montague Grammar (Partee and Bach 1981) and see how they relate to our TUG-based proposal.

6.1.1. Head-driven Phrase Structure Grammar

Our treatment of reflexivisation is similar to a proposal for reflexives in HPSG. The HPSG treatment of reflexives reported here is based on a proposal introduced in Pollard (1984) which has been incorporated into the current HPSG framework (Pollard and Sag 1987) according to the treatment outlined in (Proudian and Pollard 1985). An alternative treatment of reflexivisation which relies on semantic instead of syntactic features is being developed and is briefly outlined in (Pollard and Sag 1987). Not only is the structure of TUG and the HPSG framework similar, but the same notion of a generalised predicative is used as the criteria for determining whether anaphoric information should or should not be
blocked. Before actually comparing our approach to the one used in HPSG, it will first be necessary to provide a short description of this framework.

Like TUG, HPSG is a unification-based framework but it relies on the lexicon to a lesser degree. Instead of having highly complex lexical entries, it possesses a series of rule application principles which operate in conjunction with the grammar rules (Pollard and Sag 1987). The various principles determine how the information contained in constituent signs is used by grammar rules in order to obtain more complex signs.

The signs of HPSG are feature value matrices possessing top level features for phonological, syntactic and semantic information. With respect to a treatment of reflexives, it is the information contained in the SUBCAT, REFL, AGR and CONTROL attributes that is relevant. The SUBCAT feature consists of a list of signs corresponding to arguments in order of decreasing semantic obliqueness. For example, the SUBCAT feature of a ditransitive verb would contain signs for the indirect object, direct object, and subject in that order. This information plays the same role as the auxiliary list of TUG. REFL is a so-called ‘binding feature’ which acts as a store of reflexive anaphors; it may contain at most one sign at a time. Other binding features are used for handling unbounded dependencies, so reflexivisation is treated as a syntactic phenomenon just as unbounded dependencies are. The AGR feature is used for specifying agreement between constituents. It is used to require the person and number of the pronoun to be the same as that of the antecedent. In addition, it is used for subject verb agreement. The CONTROL attribute encodes the semantic type of the constituent. For instance, generalised predicatives will have a control type of intransitive (INT). The various control types are discussed in detail in (Pollard 1984).

A grammar rule is used to form new signs from a head and complement sign. Two commonly used grammar rules, adapted from (Pollard and Sag 1987), are shown in (6.1) and (6.2).

\[
\begin{align*}
(6.1) & \quad x[\text{SUBCAT:<}>] & \rightarrow & \text{COMPLEMENT HEAD} \\
(6.2) & \quad x[\text{SUBCAT:<Y>}] & \rightarrow & \text{HEAD COMPLEMENT}^+
\end{align*}
\]

In conjunction with these rules, a principle known as the head feature principle results in \( X \) inheriting the head features of HEAD. The subcategorisation principle is responsible for unifying elements from the SUBCAT list of the HEAD with their corresponding COMPLEMENTs and then removing these elements from the SUBCAT list. There are additional principles responsible for treating binding information, but before we introduce them let us first outline the derivation of a simple sentence like John loves Mary.
The lexical entries for *loves* and for *Mary* are provided in (6.3) and (6.4).

(6.3) **PHONOLOGY:** loves

<table>
<thead>
<tr>
<th>SYNTAX:</th>
<th>HEAD:</th>
<th>[MAJ: V]</th>
</tr>
</thead>
<tbody>
<tr>
<td>SUBCAT:</td>
<td>&lt;NP; NP-3RDSG;&gt;</td>
<td></td>
</tr>
<tr>
<td>CON:</td>
<td>TRN</td>
<td></td>
</tr>
<tr>
<td>REFL:</td>
<td>&lt;&gt;</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SEMANTICS:</th>
<th>RELATION:</th>
<th>love</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOVER:</td>
<td>i</td>
<td></td>
</tr>
<tr>
<td>LOVEE:</td>
<td>j</td>
<td></td>
</tr>
</tbody>
</table>

(6.4) **PHONOLOGY:** Mary

<table>
<thead>
<tr>
<th>SYNTAX:</th>
<th>HEAD:</th>
<th>[MAJ: N]</th>
</tr>
</thead>
<tbody>
<tr>
<td>SUBCAT:</td>
<td>&lt;&gt;</td>
<td></td>
</tr>
<tr>
<td>AGR:</td>
<td>3RDSG</td>
<td></td>
</tr>
<tr>
<td>REFL:</td>
<td>&lt;&gt;</td>
<td></td>
</tr>
</tbody>
</table>

| SEMANTICS: | Mary |

The SUBCAT feature of (6.3) consists of a list of signs corresponding to the two noun phrases for which the verb subcategorises. For abbreviatory purposes, a specification like *NP-3RDSG* is used to refer to a structure like the following.

(6.5) **SYNTAX:**

<table>
<thead>
<tr>
<th>HEAD:</th>
<th>[MAJ: N]</th>
</tr>
</thead>
<tbody>
<tr>
<td>SUBCAT:</td>
<td>&lt;&gt;</td>
</tr>
<tr>
<td>AGR:</td>
<td>3RDSG</td>
</tr>
</tbody>
</table>

| SEMANTICS: | i |

Application of the second rule, (6.2), according to the various principles and constraints will result in the first sign from the SUBCAT list of the verb being unified with the sign for the noun phrase (6.4). This sign is then removed from the subcat list of the verb, resulting in the sign shown in (6.6).

(6.6) **PHONOLOGY:** loves Mary

<table>
<thead>
<tr>
<th>SYNTAX:</th>
<th>HEAD:</th>
<th>[MAJ: V]</th>
</tr>
</thead>
<tbody>
<tr>
<td>SUBCAT:</td>
<td>&lt;NP-3RDSG;&gt;</td>
<td></td>
</tr>
<tr>
<td>CON:</td>
<td>INT</td>
<td></td>
</tr>
<tr>
<td>REFL:</td>
<td>&lt;&gt;</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SEMANTICS:</th>
<th>RELATION:</th>
<th>love</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOVER:</td>
<td>i</td>
<td></td>
</tr>
<tr>
<td>LOVEE:</td>
<td>Mary</td>
<td></td>
</tr>
</tbody>
</table>
Other principles which are responsible for manipulating control features will not be discussed here. Observe that the first rule, (6.1), was not applicable in this case since the SUBCAT list of (6.6) was not empty. Application of the first rule with (6.6) as the head and a sign for *John*, which would be much like (6.4), as the complement will result in the sign presented in (6.7).

\[(6.7) \text{ PHONOLOGY:} \text{John loves} \text{ Mary}\]

| SYNTAX:      | HEAD:   | [MAJ: V] |
|             | SUBCAT: | <>       |
|             | CON:    | 0        |
|             | REFL:   | <>       |

| SEMANTICS:  | RELATION: | love     |
|             | LOVER:    | John     |
|             | LOVEE:    | Mary     |

During this last rule application, the complement was required to have a third personal singular agreement feature.

The lexical entry for a reflexive pronoun places a sign into the REFL attribute. An anaphoric relationship is established by the later removal of this sign and its unification with a sign corresponding to the antecedent. The lexical entry for a reflexive looks something like (6.8).

\[(6.8) \text{ PHONOLOGY:} \text{himself}\]

| SYNTAX:      | HEAD:   | [MAJ: N] |
|             | SUBCAT: | <>       |
|             | AGR:    | 3RDSG    |
|             | REFL:   | <NP-3RDSG> |

| SEMANTICS:  | y        |

The contents of the store describes the syntax of the reflexive and includes a variable *y* for its semantics. Binding feature propagation principles are responsible for combining the binding feature of a head and complement in order to obtain the value of the binding feature for the result. A separate principle is responsible for the actual binding. Consider the case where the second grammar rule (6.2) is used to combine the sign for a verb (6.3) with that of a reflexive pronoun (6.8). The complement is first unified with the first element of the head's SUBCAT list, and a new sign is formed containing the other elements from the head's SUBCAT list.
At this point though, the sign contained in the store can be removed and unified with the first element of the SUBCAT list according to the binding principles. This results in the unification of \( i \) and \( y \).

In this way, the semantics associated with the reflexive pronoun is unified with that of its antecedent, with agreement being mediated through the syntactic feature specification \( NP-3RDSG \). Instances of object antecedent reflexives are handled by having binding occur just before the head sign is applied to the direct object. At this point, the sign for the direct object would be at the front of the SUBCAT list.

The locality restriction on reflexivisation used in HPSG is based on the same generalised predicative notion that was adopted for use in TUG. Generalised predicatives have signs possessing a CONTROL feature with value \( \text{INT} \). There is a restriction which prohibits a non-empty REFL store being associated with signs possessing a CONTROL feature of this value. The distribution of reflexives predicted by this treatment, which is discussed in detail in (Pollard 1984), is much the same as for our proposal. Like our approach, there is a uniform treatment of subject and non-subject antecedent pronouns, although the HPSG account is more complicated in that binding involves the interaction of numerous principles. There are fundamental differences though in the role and contents of the store in the two approaches.
In HPSG, the store contains a sign corresponding to the unbound reflexive pronoun. For an element in the store, an antecedent must be found. The antecedent must be a single constituent having the same category as the pronoun. This is a very syntactic approach to reflexivisation. Since the store used in TUG contains discourse markers of potential antecedents, this means there is no restriction on the category of the antecedent. A TUG grammar could easily be provided to allow constructions like *a picture of itself* where a noun serves as the antecedent for the reflexive. In HPSG, since the treatment is essentially syntactic, the category of the antecedent and anaphor must be the same unless the binding principle is modified. This shortcoming is overcome in the more semantic-based treatment currently under development (Pollard and Sag 1987).

The presence of multiple potential antecedents (in lieu of a single entry corresponding to an unbound reflexive pronoun) in the reflexive attribute of TUG signs provides the means for handling some forms of plural reflexives. Plural reflexives with singular antecedents could be handled by allowing the reflexive pronoun to choose a group of two or more markers from its reflexive store. This could be incorporated as a condition, say \textit{group(v,A)}, in the semantics of the reflexive.

\begin{equation}
(6.11) \text{themselves; [np,obj]; [v]and(group(v,A)); A}
\end{equation}

The variable \( v \) would be a discourse marker of a plural type and could perhaps correspond to a set of markers. Then for a sentence like

\begin{equation}
(6.12) \text{Every boy told a girl a story about themselves.}
\end{equation}

we would get an InL translation of the form illustrated in (6.13).

\begin{equation}
(6.13) \text{[e1][boy(m1) \Rightarrow [e1][girl(f1), group(v,\{m1,f1\}), story(n1), tell(e1,m1,f1), about(e1,v)]}}
\end{equation}

Although there are many more factors that need to be considered for plurals, the TUG-based proposal appears to have the potential for handling some of the cases.

Unlike HPSG, TUG does not require an elaborate binding principle for establishing a relationship between a reflexive pronoun and its antecedent; there is no special treatment needed for R-antecedent information. In TUG, all the possible antecedents are contained in the sign of the reflexive pronoun. No ‘antecedent hunting’ is required, for the antecedent is merely selected from a locally available set. This set is built up according to a simple restriction on the passing of R-antecedent information that is incorporated within the lexical entries.
6.1.2. Extended Montague Grammar

The first thorough account of reflexivisation which relied on the use of a store was put forward by Partee and Bach (1981). This proposal provided an account of reflexives in a Montague grammar framework. While HPSG used the store to hold syntactic information, the direction advocated by Partee and Bach required the store to contain a semantic formula associated with the meaning of the reflexive. In this way, they relaxed the compositionality requirement associated with Montague grammar and allowed contextual information to play a role in determining the meaning of an expression.

It was the quantifier store (QST) that was used for the propagation of information relevant for reflexivisation. A reflexive pronoun would place a pair $<\alpha, i>$ into the QST, where $\alpha$ was a predicate logic formula which formed part of the 'special meaning' of the reflexive and $i$ was an integer corresponding to the index of the variable introduced by the reflexive pronoun. The special meaning of the reflexive was responsible for lambda abstracting over the variable associated with the reflexive and binding it to a variable that would be associated with the antecedent. The treatment of reflexives is probably best illustrated with an example.

Let us examine the derivation of the semantics for the sentence *John told Mary about himself*. In tracing the derivation, we will use a sign-like notation to express the syntax, semantics and store of the various constituents. First, the lexical entry for *himself* can be expressed as in (6.14).

\[(6.14) \text{NP} \\ \lambda P[P(x)] \< \lambda R \lambda x[R(x)(\lambda P[P(x)])], 3> \]

Inserted into the store is the pair consisting of the ‘special meaning’ of the reflexive (ie. $\lambda R \lambda x[R(x)(\lambda P[P(x)])]$) and the integer 3, which corresponds to the index of the variable $x_3$ introduced in the semantic formula associated with the reflexive. The sentence is built up compositionally by grammar rule application and the contents of the store are inherited by the more complex constituents. A grammar rule treats all prepositions as simple syntactic modifiers (like the case-marking prepositions described in §5.4), so the prepositional phrase *about himself* would be structured as follows.

\[(6.15) \text{PP}[about] \\ \lambda P[P(x)] \< \lambda R \lambda x[R(x)(\lambda P[P(x)])], 3> \]

At this point the sentence would consist of a noun phrase *John*, a ditransitive verb *told of*...
category \textit{TVP/PP[about]}, another noun phrase \textit{Mary}, and a prepositional phrase \textit{about himself}. The grammar rule responsible for combining the verb with the prepositional phrase (Partee and Bach 1981:R8) can be expressed as shown in (6.16) if we translate it into a sign-like notation.

\[(6.16) \text{TVP} \quad \text{TVP/PP[about]} \quad \text{PP[about]}\]

\[
\begin{array}{c}
S_1(S_2) \\
Q_1 \cup Q_2
\end{array} \quad \rightarrow \quad
\begin{array}{c}
S_1 \\
Q_1
\end{array}, \quad \begin{array}{c}
S_2 \\
Q_2
\end{array}
\]

The contents of the store of the resulting constituent is the union of that of its components. The semantic formula associated with the TVP is formed by treating the meaning of the verb as a semantic function over the intension of the meaning of the PP. Given the representation for \textit{told} shown in (6.17), application of this rule to \textit{told} and \textit{about himself} results in the structure provided in (6.18).

\[(6.17) \text{TVP/PP[about]} \quad \text{told'} \quad \phi\]

\[(6.18) \text{TVP} \quad \text{told'} (\lambda P[P(x)]) \quad \langle \lambda R \lambda x [R(x)(\lambda P[P(x)])], 3 > \]

\(\phi\) is used to denote an empty store. A rule similar to (6.16) is responsible for converting a transitive verb phrase (TVP) into a verb phrase.

\[(6.19) \text{VP} \quad \text{TVP} \quad \text{NP} \]

\[
\begin{array}{c}
S_1(S_2) \\
Q_1 \cup Q_2
\end{array} \quad \rightarrow \quad
\begin{array}{c}
S_1 \\
Q_1
\end{array}, \quad \begin{array}{c}
S_2 \\
Q_2
\end{array}
\]

Application of this rule to the consituents for \textit{Mary} and the TVP \textit{told about himself} (6.18) results in the following structure.

\[(6.20) \text{VP} \quad \text{told'} (\lambda P[P(x)]) (\lambda P[P(m)]) \quad \langle \lambda R \lambda x [R(x)(\lambda P[P(x)])], 3 > \]

A wrapping operation, as discussed in § 3.4.2, is responsible for obtaining the correct word order. It is at this time that the subject control reflexivisation rule (Partee and Bach 1981:R20) can be applied.
This rule removes a reflexive entry of the form \(<R,i>\) from the store, and uses this entry in conjunction with the meaning of the verb phrase \(S\) to produce a formula which has the same variable representing the anaphor and antecedent. The result of applying the reflexive rule to the verb phrase described in (6.20) is provided in (6.22).

\[
\text{(6.22) VP} \\
\lambda P \left[ P[\lambda x (\lambda R \lambda P[R(x)(\lambda P[P(x)]) (\lambda x_3 [\text{told}' (\lambda P[P(x_3)]) (\lambda P[P[m]])]]) \right]
\]

The semantics of this structure can be simplified to yield the following.

\[
\text{(6.23) VP} \\
\lambda P \left[ P[\lambda x [\text{told}' (\lambda P[P(x)]) (\lambda P[P[m]]) (\lambda P[P(x)])]] \right]
\]

Finally, there is another rule for combining verb phrases with their subjects (Partee and Bach 1981:R6).

\[
\text{(6.24) S} \quad \text{NP} \quad \text{VP} \\
S_1(S_1) \quad \rightarrow \quad S_1, \quad S_2, \quad S_2 \quad Q_1 \cup Q_2 \quad Q_1 \quad Q_2 \quad <R,i> \not\in Q_2
\]

The restriction on the quantifier store of the verb phrase in (6.24) ensures that no reflexive entries are present in the store. When a verb phrase like (6.23) is combined with the noun phrase corresponding to John according to this rule, the resulting semantics will be as shown in (6.25).

\[
\text{(6.25) } \lambda P \left[ P[\lambda x [\text{told}' (\lambda P[P(x)]) (\lambda P[P[m]]) (\lambda P[P(x)])]] (\lambda P[P[j]]) \right]
\]

This expression can be simplified by simple lambda conversion if we assume that proper names are rigid designators, recalling that \(\lambda P(x) = P(x)\).

\[
\text{(6.26) } \text{told'} (\lambda P[P[j]]) (\lambda P[P[m]]) (\lambda P[P[j]])
\]

This approach to reflexivisation uses essentially the same blocking criteria as TUG does. Restrictions on the QST, like the one in (6.24), are introduced in accordance with the function argument structure of an expression. The actual locality restriction is not explicitly stated in the grammar; it is implicit in rules like (6.24). Unfortunately, there is no uniform account of subject and non-subject antecedent reflexives. Separate lexical
entries are required to introduce these reflexives and separate grammar rules are required to bind them. As with HPSG, any information present in a store must be used — the store contains information about a single anaphor, not potential antecedents. Mechanisms for gender agreement are not specified in (Partee and Bach 1981) but it is suggested that this could be handled by syntactic mechanisms. In fact, Chierchia (1988) extends the Partee and Bach treatment of reflexives to incorporate agreement phenomena. Partee and Bach acknowledge that there are problems with sentences containing more than one reflexive, and that their proposal does not account for the 'strict' readings of reflexive pronouns.

Another major point of difference between TUG and their approach lies in the status of the intermediate level of representation. While the intensional logic formulae used by Partee and Bach are dispensible, the InL formulae used by TUG are not.

6.2. Reflexives and DRT

TUG differs from many other formalisms in that it is discourse-based; it is not restricted to analysing single sentences in isolation. The semantics used relies on proposals from discourse representation theory. Since the original formulation of DRT in (Kamp 1981) does not have an account of local anaphoric phenomena, there have been proposals for modifications and extentions to DRT to allow treatment of local anaphoric phenomena like reflexivisation. In this section, we shall examine proposals introduced in (Klein 1987a) and in (Sells, Zaenen and Zec 1987).

6.2.1. Klein's approach

The starting point for Klein's approach to reflexivisation is much the same as that for the TUG proposal. Since unification categorial grammar did not possess the mechanisms required for a thorough account of anaphora, extensions were proposed which allowed reflexives and other anaphoric phenomena to be treated. The approach taken in (Klein 1987a) distinguishes between top-down and bottom-up semantic information flowing into and out of constituents during a derivation. Each constituent can make a contribution to the incoming DRS to produce the outgoing DRS.

Reflexives are treated as type-raised noun phrases, and they determine their sets of possible antecedents from the category attribute of their arguments. The semantic contribution of a reflexive pronoun to its DRS consists of a condition requiring the discourse marker associated with the reflexive to be a member of this set of possible antecedents. Ignoring the details of semantic notation, this means that a reflexive pronoun would have a lexical entry something like the following.
The reflexive takes as its argument a functor which is itself looking for a noun phrase. \( f_i \) denotes the discourse marker that is associated with the reflexive. The condition \( f_i \in U_C \) is interpreted as a restriction on the structures that can be associated with the expression. Unlike the TUG approach which associates a different FA specification with each possible antecedent for a reflexive, the approach taken here will result in a single description regardless of the number of potential antecedents. So for instance, a sentence like *John told Bill about himself* would have only a single analysis, which could represent two different structures depending on which noun phrase is the antecedent of the reflexive. Likewise, the sentence *John loves herself* would have a single analysis. In this case there would be no structures that would be described by the analysis since there is no structure where a variable of the feminine sort could represent an entity of the masculine sort. In TUG, the first sentence would have two analyses while the second would have none. The failure to establish an anaphoric link between anaphor and antecedent results in the lack of a wellformed FA specification in TUG; with Klein’s proposal, there will be an analysis regardless of whether or not a reflexive has an antecedent.

The set of possible antecedents for a reflexive, \( U_C \) in (6.27), is defined according to the following specification taken from (Klein 1987b:42).

\[
(6.28) \begin{align*}
\text{(i)} & \quad \text{C is a basic category. If C=NP, with associated semantics } x, \\
& \quad \text{then } U_C = \{x\}, \text{ else } U_C = \{\}. \\
\text{(ii)} & \quad \text{C is a complex category C/C''}. \text{ If C''=NP, with associated semantics } x, \\
& \quad \text{then } U_C = \{x U_C\}, \text{ else } U_C = U_C'.
\end{align*}
\]

This definition amounts to the requirement for the antecedent of a reflexive to be the discourse marker of one of the NPs that the reflexive subcategorises for. Since noun phrases do not normally take arguments, type-raising is essential to this treatment of reflexivisation. The use of a unification variable in the category specification of the reflexive, \( C \) in (6.27), allows many different possible categories for the reflexive to be captured in a single lexical entry. The set of potential antecedents described by (6.28) is very similar to the set obtained according to the restrictions used in TUG. Here though, it is not built up as a side effect of rule application; there is a separate definition for describing this set.
One problem with the approach proposed by Klein is that the locality restriction which is implicit in (6.28) is too strict. The first clause of this specification results in R-antecedent information being blocked by not only generalised predicatives but also by common nouns. So, the reflexive in a sentence like *John loves a picture of himself* would not have the marker corresponding to *John* in its set of possible antecedents. To handle cases like this, the first clause of (6.28) would have to be amended to look something like the following.

(6.29) (i) \[ C \text{ is a basic category.} \]
- if \( C = \text{NP:x} \) then \( U_C = \{x\} \)
- if \( C = \text{S} \) then \( U_C = \{\} \)
- if \( C = \text{N} \) then \( U_C = U_{\text{parent}(C)} \)

The parent function returns the set of antecedents associated with the category of the function that takes something of category *N* as its argument. By treating picture-nouns as type-raised nouns it would be possible to avoid including this additional restriction. Picture-nouns would be of the following category.

(6.30) \( (C / (C/np)) / (C / (C/np) / \text{noun}) / \text{np[of]} \)

A picture-noun would take an np[of] as its first argument. It would then take a constituent that is looking for a noun as its next argument. The resulting constituent would then be a type-raised noun phrase. Adopting this treatment of picture-nouns results in additional complications when possessives are considered. As was illustrated in chapter two, a locally bound reflexive contained in a picture-noun having a possessive determiner cannot take constituents from the main clause as potential antecedents.

(6.31) *John loves Mary's picture of himself.*

The simplest treatment of possessives would have a possessive noun phrase being assigned a category that is the same as that of a determiner. It would take a noun as an argument and result in a type-raised noun phrase.

(6.32) \( C / (C/np) / \text{noun} \)

Unfortunately, this would not only prevent grammatical sentences like *John loves Mary's picture of herself*, but it would also allow sentences like (6.31). Following the direction taken in TUG, the possessed nominal could act as a functor over its possessor. So possessed nominals would have the following category associated with them.
(6.33)  C / (C/np) / np[poss]

The lexical entry for the possessor could have the category shown in (6.34).

(6.34)  C / (C / np[poss])

In this way, the possessor would be a possible antecedent for reflexives contained in the picture-noun and possessive reflexive pronouns could also be treated. Again though, sentences like (6.31) would be allowed. One way to solve this problem would involve modifying clause two of our definition of the set of possible antecedents as follows.

(6.35)  (ii)  C is a complex category C'/C''.

If C''=NP, with associated semantics x, then U_c=[x]U_c.
if C''=NP[poss], with associated semantics x, then U_c=[x],
else U_c=U_c.

This modification could be avoided by proposing (6.36) as the category for a picture-noun contained in a possessive.

(6.36)  np / np[poss] / np[of]

But this would require a very unintuitive category to be proposed for a possessive noun phrase like Mary's.

(6.37)  C / (C/np) / (np/np[poss])

Type-raising is essential to Klein's approach to reflexivisation, and this results in highly complex syntactic categories that obscure many simple relations. Under his approach, a sentence in which a reflexive does not have an antecedent is provided with an analysis. A separate definition is provided for determining the set of possible antecedents for a reflexive. In TUG, this set is built up as a side effect of rule application using very simple primitive operations; no complex definition is required. Extensions to Klein's proposal to handle both possessives and picture-nouns could result in further complications to the definition of the set of possible antecedents and could require additional type raising, making the entire proposal less attractive.

6.2.2. DRT and LFG

The approach to reflexivisation taken by Sells, Zaenen and Zec (1987), which was briefly mentioned in chapter two, will now be examined in a bit more detail to see how it differs from our approach. First, this proposal is concerned with the lexical, syntactic and semantic properties of the reflexive but not with the constraints on reflexivisation. Lexical
functional grammar (LFG) (Kaplan and Bresnan 1982) is used to discuss the syntactic and lexical properties, with DRT being used for the semantics. The use of DRT for the semantics allows the different meanings of the reflexive pronouns to be expressed but does not participate in placing restrictions on possible syntactic analyses. Many of the restrictions on reflexivisation are part of a general principle of anaphoric binding. We will briefly examine a general theory of anaphoric binding for LFG being developed by Bresnan, Halvorsen and Maling (Kameyama 1985).

The LFG theory of binding is based on the syntactic features $sb$, $ncl$ and $log$ which are associated with every pronoun. Permissible values for these features are plus, minus and unspecified. The value for the $sb$ feature is related to whether the pronoun takes subject antecedents, $ncl$ is used to describe whether the antecedent is in the same nucleus as the pronoun, and $log$ determines the role that logophoricity plays with respect to the antecedent. Locally bound reflexive pronouns in English possess a $+ncl$ feature and have unspecified values for their $sb$ and $log$ features. This means that reflexives must be in the same nucleus as their antecedents. Two elements that are from the same nucleus are both subcategorised for by the same lexical item. For example, in the sentence *John loves himself* both *John* and *himself* are in the same nucleus, while in *John says that Mary loves himself* they are not.

Anaphoric relationships in LFG are established based on information contained in the functional structure (f-structure) associated with a linguistic expression. An f-structure is a feature value matrix containing all the information relevant for the semantic interpretation of a linguistic expression. The c(onsituent)-structure, which describes the configuration of words and phrases, does not play a direct role in anaphora resolution. The notion of nucleus is actually defined in terms of f-structure — a nucleus is an f-structure whose PRED feature consists of a relation name plus a list of grammatical functions. The f-structure introduced in (6.38), which corresponds to the sentence *John tells Mary that Bill walks*, is a nucleus.

\[(6.38) \begin{array}{l}
\text{SUBJ} \mid \text{PRED} \mid 'JOHN' \\
\text{OBJ} \mid \text{PRED} \mid 'MARY' \\
\text{COMP} \mid \text{PRED} \mid 'BILL' \\
\mid \text{PRED} \mid 'WALK <(SUBJ)>' \\
\mid \text{PRED} \mid 'TELL <(SUBJ)(OBJ)(COMP)>'
\end{array}\]

Its PRED feature consists of a relation *TELL* followed by the a list of grammatical functions *SUBJ*, *OBJ* and *COMP*. The value of the COMP feature corresponds to a separate nucleus which is embedded within the first. So while *JOHN* and *MARY* are within the same nucleus, *JOHN* and *BILL* are not. Relative to an f-structure, one can
define the \textit{f-command} relation. For two grammatical function features $\alpha$ and $\beta$ in an f-structure, $\alpha$ f-commands $\beta$ iff $\alpha$ does not contain $\beta$ and every f-structure that contains $\alpha$ also contains $\beta$. So in (6.38), the top level subject (SUBJ) and object (OBJ) f-command each other, and each of them f-commands the embedded subject. The embedded subject does not f-command any grammatical function.

For an expression containing an English reflexive pronoun, the set of possible antecedents for the pronoun is defined with respect to the f-structure of the expression. This set consists of all those elements which are in the same nucleus as the reflexive and which f-command it. Like in TUG, the anaphoric relationship between reflexive and antecedent is defined in terms of properties which are more semantic (based on f-structure) than syntactic (based on c-structure).

Unfortunately, the account of locally bound reflexives described in (Kameyama 1985) is very superficial, since the author concentrates on other forms of anaphora. Apparently, the appearance of verbs (and possessives) corresponds to the appearance of separate nuclei in the f-structure of an expression thus accounting for why these constructions block reflexivisation. It appears that English picture-nouns will also have a separate nucleus associated with them. So how do we account for the observation that reflexives in picture-nouns can take antecedents from the main clause while those in possessives cannot? Once again, we encounter the problem of providing a uniform account of the distribution of locally bound reflexives in possessive and picture-noun constructions. In addition, to prevent ungrammatical sentences like \textit{John sold herself Mary} where the reflexive precedes its antecedent requires some kind of ordering restriction which is not present in the f-structure. Kaplan and Bresnan suggest the introduction of an \textit{f-precede} relation that captures within f-structures some of the orderings present in\textit{c-structures} (Kaplan 1987). The result is an increasingly complicated account of locally bound reflexivisation.

6.3. Reflexives and Categorial Grammar

Since TUG owes a great deal to work done in categorial grammar, it is appropriate to examine how its treatment of reflexives differs from a proposal based on a non-unification categorial formalism. Let us look at a proposal for reflexives within a combinatorial categorial grammar (CCG) framework (Szabolcsi 1987).

CCGs (Steedman 1987) use \textit{combinators} (Curry and Feys 1958) to create a compositional semantics for complex expressions. In combinatory logic, variables are not necessary but they can be used for convenience. Some combinators that are used in semantic formula are provided in (6.39), which is taken from (Szabolcsi 1987:6).
The syntax of CCGs tends to rely on operations like functional composition and type-raising in addition to traditional functional application. Ignoring directionality variations, functional composition and type-raising can be described by the following two rules.

\[(\text{6.40}) \quad \frac{X}{Z} \rightarrow \frac{X}{Y}, \frac{Y}{Z}\]
\[(\text{6.41}) \quad X \rightarrow \frac{Y}{(Y \setminus X)}\]

Szabolcsi proposes that reflexives are noun phrases with type-raised lexical entries. Since variables are dispensible in combinatory logic, the semantics of a reflexive cannot introduce an unbound variable which would be bound later in the derivation, as is done in the Partee and Bach approach. Instead, the semantic formula of the reflexive operates over the semantics of a verb replacing two arguments of the verb with identical bound variables. The phonology, syntax, and semantics of a lexical entry for himself is provided in (6.42).

\[(\text{6.42}) \quad \text{himself}\]
\[\left(\text{SNP}\right) \setminus \left((\text{SNP})/\text{NP}\right)\]
\[\lambda h \lambda u \left[huu\right]\]

This reflexive is a function that is 'looking for' an argument which is itself a function over two noun phrases. The semantics of the reflexive corresponds to the combinator W.

Application of (6.42) to the lexical entry for loves (6.43) will yield the constituent displayed in (6.44).

\[(\text{6.43}) \quad \text{loves}\]
\[\left(\text{SNP}\right)/\text{NP}\]
\[\lambda y \lambda z \left[\text{love'}yz\right]\]

\[(\text{6.44}) \quad \text{loves himself}\]
\[\text{SNP}\]
\[\lambda u \left[\text{love'}uu\right]\]

When (6.44) is applied to a noun phrase argument, the semantics of the NP will be placed in both argument slots of the love' predicate. In terms of combinators, the semantics of John loves himself would be

\[(\text{6.45}) \quad W \text{ love'} \text{ John'}\]
Different lexical entries are required for the reflexive pronoun depending on the structure of the sentence. In ditransitive verb phrases, different lexical entries are required for subject and object antecedent reflexives. Reflexives that appear in prepositional phrases or in picture-nouns yet again require different lexical entries. The description shown in (6.46) corresponds to the lexical entry used for the reflexive appearing in sentences like *John told Mary about himself* (Szabolcsi 1987:35,39).

(6.46) **himself**

\[( (SNP) \setminus ((SNP)/PP) ) \setminus (PP/NP) \]

\[C (B (B W) B)\]

Further problems arise for sentences containing reflexives embedded in multiple picture-nouns. The lexical entry for *himself* required for the sentence *John loves a picture of himself* would be different than the one required for *John loves a book about a picture of himself*. So this approach to reflexivisation would require an enormous assortment of lexical entries to be proposed for reflexive pronouns. Reflexive pronouns would have to subcategorise for different sentence structures.

Finally, Szabolcsi states that her treatment does not impose any notion of locality to reflexivisation. She notes though that a “brute force” restriction could be added to “require W to apply to functors that are lexical in some sense,” (Szabolcsi 1987, p.30). She comments that since these locality conditions vary from language to language, then perhaps they should not be captured with the more universal phenomena that she is examining.
Chapter 7
Long Distance Reflexives

The existence of languages containing long distance reflexive pronouns has caused problems for numerous theories of reflexivisation. Since the description of long distance reflexivisation in Icelandic by Thrainsson (1976), similar phenomena have been examined in languages like Norwegian (Hellan forthcoming) and Japanese (Kuno 1987). In this chapter, we will look at several constraints on long distance reflexivisation in Icelandic. Various constructions will be examined to consider the validity of the different constraints. After seeing how these constraints can be incorporated within the TUG framework, we will look at TUG analyses for constructions involving long distance reflexivisation.

7.1. Restrictions

Long distance reflexives are characterised by a different set of restrictions than locally bound reflexives. Aside from the obvious difference of taking antecedents that are from different clauses than the reflexive, these reflexives also possess the property of only taking subjects as antecedents. Furthermore, personal pronouns can generally be used in place of a long distance reflexive with the same antecedent (i.e. long distance reflexivisation is optional). Although these constraints may be sufficient to distinguish this class of pronouns from others, as was discussed in §1.2, there are other restrictions responsible for characterising the distribution of these reflexives in sentences and discourses. Attempts to capture these additional constraints have relied on the use of the mood of the expression containing the reflexive or on the notion of logophoricity. In an attempt to formulate some general restrictions on long distance reflexives we will first examine some proposals that rely on the presence of the subjunctive mood. After highlighting the advantages and disadvantages of these proposals, we will consider some restrictions based on logophoricity.

7.1.1. Subjunctive Mood

In Thrainsson (1976), it was noted that there appears to be a relationship between the presence of a subjunctive mood and the distribution of the Icelandic long distance reflexive. Long distance reflexivisation seems to be allowed only when the reflexive is contained in a complement possessing a subjunctive mood and when the antecedent is c-commanding the reflexive pronoun. For instance in (7.1), where the subordinate clause is in the indicative mood, the long distance reflexive pronoun sig cannot have the subject (Jón) of the main clause as its antecedent.
(7.1) *Jón vet að María elskar sig.  
Jon_i knows that María loves(I) REFL_i  

However, if the verb from the main clause introduces a complement possessing a subjunctive mood then a reflexive is allowed.

(7.2) Jón segir að María elski sig.  
Jon_i says that María loves(S) REFL_i  

The use of the reflexive is grammatical even when it is embedded arbitrarily deep within a subjunctive complement. This was illustrated in (1.28) which is repeated as (7.3).

(7.3) Jón segir að María telji að Haraldur vilji að Billi heimsæki sig.  
Jon_i says(I) that María believes(S) that Harold wants(S) that Billy visits(S) REFL_i  

The subject of the main clause, as well as those of any of the intermediate clauses, can act as the antecedent to the reflexive. The verb segir introduces a subjunctive mood into its complement which is propagated throughout the embedded complements in a so-called 'domino effect.'

Maling (1984b) notes that long distance reflexives can also appear in the subject position of an embedded clause in constructions where the subject has a case other than nominative. This is illustrated in (7.4) which originally appeared as (5.5).

(7.4) María sagði að sig vantaði peninga.  
Maria said that SELF(acc) lacked(S) money  

The use of an indicative in the embedded clause containing a reflexive results in an ungrammatical sentence.

The presence of the subjunctive is also tied to the appearance of long distance reflexivisation in constructions other than those involving finite complements. The following examples from (Maling 1984b:43) illustrate that a reflexive contained in a relative clause cannot take an antecedent from outside of the clause unless the clause possesses subjunctive mood.

(7.5) *Ólafur hefur ekki enn fundið vinnu, sem sér líkar.  
Olaf has(I) not yet found a-job, that REFL pleases(I)  
'Olaf has not yet found a job that he likes.'

(7.6) Jón segir að Ólafur hafi ekki enn fundið vinnu, sem sér líki.  
Jon_i says(I) that Olaf_j has(S) not yet found a-job, that REFL_{ij} pleases(S)  

Sér is the dative form of the long distance reflexive. Just as with finite complements either
Jon or Ólafur can be the antecedent for séð in (7.6).

Unfortunately, a proposal to account for long distance reflexivisation in terms of the presence of the subjunctive mood in conjunction with a c-command relationship between reflexive and antecedent is doomed to failure. There are cases where long distance reflexivisation is allowed even though the antecedent does not c-command the reflexive. Again, the presence of a subjunctive mood is related to the appearance of long distance reflexivisation. Consider the following sentence from (Maling 1984b:20b).

(7.7) Skoðun Siggu er að sig vanti hæfileika.
   opinion Sigga’s is that REFL lacks(S) talent

Siggu does not c-command the reflexive pronoun sig yet the sentence is grammatical.

There are numerous examples in which reflexives are not allowed in subordinate clauses possessing a subjunctive mood. Consider the following sentence from Maling (1984b:22a) in which Jón c-commands séð.

(7.8) *Jón yrði glaður ef Sigga byði séð.
   Jon would-be(S) glad if Sigga invited(S) REFL

Whether the verb of the main or adverbial clause is indicative or subjunctive, the use of the long distance reflexive is not allowed. As an additional example, the following sentence does not have a reading where the reflexive takes Jón as its antecedent.

(7.9) Haraldur segir að Jón komi fyrbth Sigga bjóði séð.
   Harold says(I) that Jon comes since Sigga invites REFL

Maling suggests that a solution might lie in proposing that the adverbial modify the entire sentence, not just the verb phrase. In this case, Jón would not c-command séð. She abandons this proposal since it raises problems for the general c-command based approach to binding in GB. Furthermore it would require proposing that the s-structure for a sentence like (7.8) which contains a sentential adverbial would have to be structurally different than the s-structure for a sentence like (7.10) (Maling’s 33a) containing a phrasal adverbial which modifies a verb phrase.

(7.10) Jón kemur ekki án konu sinnar.
   Jon comes not without wife REFL(poss).
   ‘John won’t come without his wife’

The (locally bound) possessive reflexive pronoun sinnar in (7.10) can take Jón as its antecedent. According to the GB account of reflexives, Jón must c-command sinnar. In the TUG framework, Maling’s recommendation for adverbials would not cause us any
problems since we have already abandoned the general treatment of reflexives proposed in GB — we do not use s-structures.

Although one may attempt to account for the difference in the distribution of long distance reflexives in sentence pairs like (7.8) and (7.10) in terms of syntactic (or semantic) structure, there are other examples of even more closely related sentence pairs in which reflexives behave differently. There are certain verbs and verb forms for which long distance reflexivisation is blocked even if the subordinate clause is in the subjunctive mood. Consider the following pair of sentences (Sells 1987:20,21).

(7.11) *Barnað bar þess ekki merki að það hefði verið hugsað vel um sig.
child-the bore it not signs that there had(S) been thought well about REFL
'The child didn’t look as if it had been taken good care of.'

(7.12) Barnað lét ekki í ljós að það hefði verið hugsað vel um sig.
child-the put not in light that there had(S) been thought well about REFL
'The child didn’t reveal that it had been taken good care of.'

Even though both sentences possess subjunctive subordinate clauses, (7.12) is grammatical while (7.11) is not. Similar behaviour is illustrated by many passive sentences in Icelandic (Maling 1984b:37b).

(7.13) *Hönum var sagt að sig vantaði haefileika.
Him(D) was said that REFL lacked(S) ability.
'He was told that he lacked ability'

Based on the last few examples, we might be tempted to postulate that there is some other restriction in addition to the presence of a subjunctive mood that can account for the distribution of long distance reflexives. Unfortunately, there are some dialects of Icelandic where long distance reflexivisation is allowed without the presence of a subjunctive mood (Sigurdsson 1986). Moreover, in Faroese (a language which is closely related to Icelandic) there is no (overt) distinction between indicative and subjunctive yet long distance reflexivisation is allowed. A possible explanation is that both the presence of a subjunctive mood and the potential for long distance reflexivisation are both the consequence of some other phenomena.

Anderson (1986) suggests that the observed behaviour may be due to a tense agreement principle in Icelandic. It is proposed that there is "a rule of Tense Agreement, which has the effect of copying the tense marked on a verb onto a (subjunctive) verb in a complement clause which it governs" (Anderson 1986, p.76). Potential antecedents for long distance reflexives are required to be subject noun phrases from the minimal tensed sentence containing the reflexive. Consequently if a sentence like (7.3), which is repeated
here as (7.14), possesses an 'underlying' structure in which none of the subjunctive verbs are tensed, then any of the subjects in the sentence may act as antecedents are for the reflexive.

(7.14) Jón segir að Maríu telji að Haraldur vilji að Billi heimsaeki sig.
Jon says(I) that Maria believes(S) that Harold wants(S) that Billy visits(S)

The (untensed) subjunctive verbs obtain their tense due to the Tense Agreement rule. Tenses assigned by this rule do not affect the domain of possible antecedents since the set of possible antecedents is determined before application of the rule. Unfortunately, there are numerous cases of long distance reflexivisation where the verb of the subjunctive complement does not have the same tense as the main clause verb (Rognvaldsson 1986, Sigurdsson 1986). An example of one of these cases is shown in (7.15) (Sigurdsson 1986:21).

(7.15) Jón hefur sennilega haldið að Maríu aetlaði að slá sig.
Jon has probably thought that Mary intended(S) to hit

'REFL' has probably thought that Mary was going to hit him.'

In sum, although there is some type of correlation between long distance reflexivisation and the presence of a subjunctive mood, it is not direct. A purely subjunctive view of long distance reflexivisation predicts certain grammatical constructions to be ungrammatical and certain ungrammatical constructions to be grammatical. A natural explanation is that there is some factor (other than tense agreement) on which both the presence of the subjunctive mood and the potential for long distance reflexivisation are dependent. With this in mind, let us consider the role that logophoricity plays with respect to long distance reflexivisation.

7.1.2. Logophoricity

Maling (1984b), Sigurdsson (1986), Sells (1987) and Kuno (1988) all suggest that the Icelandic long distance reflexive is logophoric in nature. Recall that a logophoric pronoun is one whose antecedent is a logocentric entity corresponding to the individual whose speech, thought or belief is being reported (Clements 1975, Hyman and Comrie 1981). In this section, we shall see how the phenomena discussed in the previous section might be accounted for in terms of logophoricity.

Let us re-examine the difference in grammaticality of the sentences introduced in (7.11) and (7.12) which are repeated here as (7.16) and (7.17).
The difference can be accounted for by arguing that the intended antecedent is not the *source* (using Sells’ terminology) of the action in (7.16). The same kind of explanation can be used to account for why the subjects of passive sentences are not allowed to act as antecedents for long distance reflexives.

The logophoric nature of Icelandic long distance reflexives and their relationship to constructions in the subjunctive mood is further illustrated by the cases where the reflexive does not have a syntactic antecedent. Consider the following discourse from (Sigurdsson 1986:22).

In this discourse, the long distance reflexives introduced in the second and third sentences find their antecedent in the first sentence. The first sentence has established an individual whom the discourse is about. Sigurdsson (1986) makes a further observation that the antecedent need not even be explicitly mentioned, as long as the reflexive can be interpreted as being related to some particular individual. This is illustrated in the following discourse where the reflexive pronoun *does not* refer to *Olaf*; it can best be translated into English as a stressed *him*.

(7.19) *Maria var alltaf svo andstyggileg.*
Maria was(I) always so nasty

*þegar Ólafur kaemi segði hún sér áreiðanlega að fara.*
when Oláf came(S) told(S) she REFL, certainly to leave

‘When Oláf would come she would certainly tell *him* to leave.’
Hún var alltaf svo góð við Ólaf og þegar Ólafur kom vildi hún hann aldrei.
She was always so good with Olaf and when Olaf came she never

She was always so nice to Olaf, and when Olaf came she never wanted him.'

Já, hún segði sér áreiðanlega að fara.
Yes she told(S) REFL, certainly to leave

'Yes, she would certainly tell him to leave.'

He stresses the point that the reflexive pronoun does not act like a personal pronoun having
‘free reference’ — it is ‘referring’ to a particular individual. Notice that when the
indicative tense is used, the personal pronoun hann is used in lieu of the reflexive. So
again, even though there is no explicit antecedent, the subjunctive mood is associated with
the appearance of a long distance reflexive having a logocentric entity as its antecedent.

It is apparent that logophoricity plays some role in determining the distribution of
long distance reflexive pronouns, but it is not the only factor. As we have seen during our
discussion of the role of the subjunctive, there are some structural factors that seem to
contribute. For instance, non-subjects cannot appear as antecedents, nor can the subjects of
sentences modified by adverbials containing reflexives. One could try to avoid any
syntactic and semantic constraints by arguing that it is logophoricity that is responsible in
all of these cases. Unfortunately, this type of argument is difficult to provide since it is
not a simple matter to establish the logocentric entity that is associated with an expression.
We are now ready to outline a proposal in which logophoricity is primary factor but not
the only one in determining the distribution of long distance reflexives.

7.1.3. A Proposal

Once again, the notion of predication can be used to account for the relationship
between a long distance reflexive and its antecedent. Hellan (forthcoming) notes that
Norwegian long distance reflexives conform to his predicate command condition, and
Sigurdsson (1986) suggests that this condition can be extended to handle long distance
reflexives in Icelandic. In TUG, we will once again rely on the function argument
structure of an expression to account for the distribution of reflexives — the predication
command relation is equivalent to the R-antecedent information of a predicative functor
being dependent on the anaphoric index associated with its argument. However, we will
distinguish between long distance and local R-antecedent information. There are different
constraints on the distribution of the former as compared to the latter information. We will
also need to account for long distance reflexives whose antecedents are not in the same
sentence. The notion of logophoricity will play an important role in this respect.

In addition to the other syntactic features specified for signs, we will propose the
existence of a logophoric feature log. The use of logophoric features is discussed in
(Kameyama 1985, Kuno 1987, Sells 1987). Certain lexical entries, like those associated with what Sells (1987) calls logophoric verbs and psych verbs, can require their arguments to possess this feature. Verbs which introduce a $+\log$ on their arguments allow long distance reflexives to appear in these arguments. This is similar to Kuno's approach whereby certain verbs allow their subjects (or other arguments) to be antecedents for reflexives contained in embedded complements. The presence of this feature on a finite complement also results in the complement possessing a subjunctive mood; in Icelandic, verbs in a $+\log$ environment are required to be subjunctive. Thus it is not the subjunctive that permits long distance reflexivisation, but rather another feature related to logophoricity that permits subjunctive mood and long distance reflexivisation. Arguments which are marked as $-\log$ do not allow long distance reflexivisation. This does not mean though that complements possessing a $-\log$ feature are required to be indicative; a subjunctive mood can be introduced for other reasons which are independent of logophoricity. For our needs, we can restrict the $\log$ feature to take either the value of plus or minus although there are arguments for allowing a more complex set of values in order to account for grammatical preferences (Kuno 1988).

In the analyses provided in earlier chapters, the reflexive attribute contained information responsible for locally bound reflexivisation. Now, we are introducing long distance R-antecedent information which is subject to different restrictions than the locally bound R-antecedent information. To distinguish between these two forms of information in a sign, a separate store will be introduced. The reflexive attribute will consist of two lists, one for local R-antecedent information and another for long distance R-antecedent information (henceforth LDR-antecedent information). These two lists will be separated by commas as illustrated in the lexical entries for long distance reflexives shown in Figure 7.1. The lexical entry for a long distance reflexive closely resembles the one for a locally bound reflexive, except that it selects its antecedent $x$ from a different store. Separate lexical entries are not required for masculine and feminine antecedent reflexives, but there is a separate entry for each case of the reflexive; the Icelandic reflexive does not possess a nominative form. All of these lexical entries could be defined in terms of a template describing the information shared by the different entries.

The value of the $\log$ feature determines the distribution of LDR-antecedent information in an FA structure. This is illustrated by the templates shown in Figure 7.2. For generalised predicative functors in a $+\log$ environment, the last element $x$ (the subject) from the local reflexive store of the root-sign will be merged with the information $B$ contained in the long distance store of the root-sign to form the information contained in the long distance stores of the functor and argument signs (as illustrated in template $R-LG$).
Figure 7.1. Lexical Entries for Long Distance Reflexives

Figure 7.2. Templates for Long Distance R-Antecedent Information
If the log feature of a generalised predicative has a negative value, the information is blocked as shown in template R-NLG. For constructions where the functor-sign does not correspond to a generalised predicative, both the functor and argument signs inherit the LDR-antecedent information from the root-sign (template R-L).

The log feature is treated like the syntactic features for category and form — for any subtree of an FA structure, the value of the log feature for the root-sign and functor-sign will be the same. A functor-sign inherits its log value from its root-sign. The value of this feature for argument-signs in an FA structure is determined by the lexical entries that introduce the argument-signs. We will propose two different ways in which these values are determined. A lexical entry can specify an argument to be +log, or it can require the log value of an argument to be the same as that of its functor. Let us now introduce some lexical entries that illustrate these different relationships.

Consider a verb like says which takes a finite complement. It is logophoric since its subject is the entity whose speech or belief is being reported in the complement. The lexical entry for a logophoric verb like says introduces a +log feature on its complement regardless of the value of the log feature on the functor over the complement. This is illustrated in our initial formulation of a TUG lexical entry for the Icelandic verb segir (says) in Figure 7.3. Segir is a finite-indicative form of the verb, as represented by the appearance of fini as its verb form, and possesses the syntactic feature -log. It introduces the feature +log on the root-sign of a as shown in bold in Figure 7.3. Logophoric or psych verbs introduce +log features on their complements regardless of the values of their own log features. The +log feature appears on the sign associated with the complementiser að (that) because the log feature is passed on from root-sign to functor sign. The lexical entry for the complementiser would be responsible for passing this feature onto its argument (as shown in italic in Figure 7.3). Since the finite complement possesses a +log feature, it must be a subjunctive complement as reflected by the specification fins. In Icelandic, we are requiring all +log verbs to be subjunctive. The verb forms fini and fins are actually subtypes of the finite verb form fin; both fini and fins will unify with fin but they will not unify with each other. Since the verb form and logophoric features are passed on from root-sign to functor-sign in FA specifications, this means that the verb of the sentential complement will possess the features +log and fins. Observe that the LDR-antecedent information B of the root-sign of the FA specification is not included in that of the functor and arguments signs. This is due to the generalised predicative functor possessing the feature -log.
Figure 7.3. Logophoric Feature introduced by a Logophoric Verb

Figure 7.4. Logophoric Features in a Domino Effect Verb
Verbs which are not logophoric or psych verbs cannot 'introduce' the $+\log$ feature onto their arguments and must merely 'propagate' onto an argument-sign the value of the $\log$ feature associated with its functor-sign. In this way, we get the 'domino effect' of subjunctive mood that was described in the previous section. A slightly abbreviated version of an FA specification for the verb veit (knows) is introduced in Figure 7.4. The $-\log$ feature associated with the arguments is the same as that associated with the sign for the verb (shown in bold). If the verb possessed the feature $+\log$, then its arguments would possess this feature as well and the verb would be in its subjunctive form. It is not only verbs that illustrate this type of propagation of the $\log$ feature. We have already mentioned that the complementiser $\alpha\delta$ passes on the value of its $\log$ feature onto the sign of its argument.

What we have so far proposed will handle cases where there is an explicit syntactic antecedent for the reflexive, but what about the cases where there is no such antecedent. One possibility would involve associating a particular discourse marker with the logocentric entity of a sentence (Sells 1986). This marker would correspond to the individual whose thoughts or beliefs are being discussed. Since such a marker is associated with logophoric contexts, we will propose associating a discourse marker with those lexical entries that introduce (as opposed to propagate) $+\log$ features onto their arguments. Whenever a $+\log$ feature is introduced onto an argument sign, a marker corresponding to the logocentric entity is introduced into the long distance reflexive store. This is reflected in our revised lexical entry for the logophoric verb segir (says) which is shown in Figure 7.5. For verbs like these, the marker $x$ introduced into the long distance reflexive store corresponds to the subject. We will propose that the FA specifications associated with logophoric and psych verbs are not the only ones in which logophoric features and logocentric markers can be introduced. Furthermore, there is no requirement for the logocentric marker to be associated with some syntactic constituent as we shall see in the next section.

7.2. A TUG Analysis

Now that we have outlined the constraints on long distance reflexivisation and seen how they can be incorporated into the TUG framework, let us examine the distribution of long distance reflexives in constructions like those introduced in the previous section. As was the case for locally bound reflexives, the distribution of long distance reflexives can be described in terms of the distribution of LDR-antecedent information. In this section, we shall see how the distribution of this information is dependent on the tree structure associated with the various lexical entries, the presence of the logophoric feature $+\log$ on
Figure 7.5. Lexical Entry for a Logophoric Verb

Figure 7.6. Lexical Entry for "elski"
generalised predicatives, and on restrictions associated with particular lexical entries.

7.2.1. Finite Complements

We shall start by looking at a sentence in which a long distance reflexive has several potential antecedents (Maling 1984b:23b).

(7.20) Jón segir að Haraldur viti að Sigga elski sig.
Jon, says(I) that Harold knows(S) that Sigga loves(S) REFLiIJ/*k

A lexical entry for the subjunctive verb *elski* (loves) used in this sentence is introduced in Figure 7.6. Observe that the +log feature associated with the functor-signs of the FA specification for the verb is propagated onto all of the argument-signs as highlighted in italic — love is not a logophoric or psych verb. Since the generalised predicative’s functor-sign possesses a +log feature, LDR-antecedent information is not blocked; the LDR-antecedent information of the functor and argument signs consists of the discourse marker *z* corresponding to the subject from the local reflexive store of the root-sign merged with the LDR-antecedent information *B* of the root-sign.

A section of an FA structure for the reading of (7.20) where Haraldur is chosen as the antecedent for the reflexive is introduced in Figure 7.7. The sign associated with the reflexive pronoun *sig* contains two markers (*m2* and *m1*) in its long distance store (which is shown in italic). Although *m2* is chosen as the antecedent, both of these markers are potential antecedents. The marker *m2* first appears in the local pronoun store of the sign for *viti að Sigga elski sig*. Then, since the generalised predicative associated with *elski sig* is +log (as shown in italic), this marker is merged into the long distance store of the generalised predicate (as shown in bold) according to the relation embodied in template R-LG. In this way, *m2* becomes available to the sign associated with the reflexive pronoun. The +log feature is introduced by the main clause verb *segir* onto its sentential argument as is the logocentric entity *m1*. This is highlighted in bold in Figure 7.7. It is distributed throughout the subtree associated with the subordinate clause because the other lexical entries simply propagate the log values from functor to argument as was illustrated in the lexical entry for *elski* from Figure 7.6.

The long distance reflexive in our example does not have the marker corresponding to Sigga as a potential antecedent, but this marker (*fl*) is present in the local reflexive store. This means that some form of the locally bound reflexive would be required in order to get the reading where Sigga loves herself. Although an analysis of local reflexivisation in Icelandic will not be provided here, the treatment would be similar to our proposal for local reflexives in English. A distinction between the two forms of locally bound
Figure 7.7. Long Distance Reflexive in Subordinate Clause
reflexives (e.g. between *sig* and *sjdlfan sig*) would need to be incorporated into the grammar.

The FA structure in Figure 7.7 corresponds to an analysis where the antecedent of a long distance reflexive is *not* a logocentric entity. Under our analysis, the antecedent for a long distance reflexive can either be a logocentric entity or the subject of some intermediate clause as illustrated in Figure 7.7. In some dialects of Icelandic, only logocentric entities are allowed to act as antecedents for long distance reflexives. For these dialects, the template $R-LG$ would have to be altered so that the the marker corresponding to the subject of the upstairs clause ($x$ in Figure 7.2) is *not* merged into the long distance store; discourse markers would be introduced into the long distance store only by logophoric and psych verbs.

### 7.2.2. Relative Clauses

Just as the generalised predicative functors associated with verb phrases do not block LDR-antecedent information when they possess a $+\text{log}$ feature, generalised predicatives associated with relative clauses do not block it either. Consider (7.6) which is repeated below as (7.21).

(7.21) Jón segir að Ólafur hafi ekki enn fundið vinnu, sem sér líki.

Jon says(I) that Olaf has(S) not yet found a-job, that REFL$_{ij}$ pleases(S)

Part of the FA structure for this sentence is shown in Figure 7.8. In this structure, foot feature information has not been displayed. The long distance reflexive *sér*, which is the (dative) subject of the relative clause, has markers for both Jón and Ólafur in its reflexive attribute. In this example, $m2$ is chosen as the antecedent. Once again, the presence of the $+\text{log}$ feature causes LDR-antecedent information to be propagated by generalised predicatives and causes the verb contained in the relative clause to take on the subjunctive form. The relative pronoun *sem* is semantically vacuous, as discussed in §5.3, which is denoted by the semantic formula $[[n1]]\text{and}([\text{true}])$. Semantically vacuous noun phrase arguments do not contribute to the R-antecedent information of their functors, so the local reflexive store of the functor *sér líki* is empty. It is an open question as to whether the long distance reflexive is semantically vacuous like locally bound reflexives, or whether it possesses an anaphoric index like *PRO* and personal pronouns do. In our examples we are grouping them in the second class, thus they introduce anaphoric indices into the local reflexive stores of their functors.

Since relative clauses modify nouns phrases in Icelandic, entities introduced within the head noun phrase cannot generally act as antecedents to reflexives contained in relative
Figure 7.8. Long Distance Reflexive in Relative Clause

Figure 7.9. Relative Clause Modifying Complex Noun Phrase
clauses. The head noun phrase is a functor in the FA structure, and the reflexive information of its argument (the relative clause) does not contain any antecedent information introduced by the functor. This means that sentences like (7.22) (Maling 1984b:fn20) where Olafs is the intended antecedent for the reflexive will be disallowed; the marker associated with Olafs will not be contained in the reflexive attribute of the reflexive as illustrated in an excerpt of an FA specification for this sentence in Figure 7.9.

(7.22) *Sigga segir að þýki trú Olafs, sem sé sér huggun, barnaleg.
Sigga says that to-you seems(S) belief Olaf's, which is(S) REFL a-comfort, childish
‘Sigga says that you consider Olaf's belief, which is to him a comfort, childish'

The LDR-antecedent information B associated with the relative clause comes directly from the root-sign and does not contain any information introduced by the modified noun phrase.

7.2.3. Sentential Modifiers

In all of the cases we have so far examined, the distribution of LDR-antecedent information has followed entirely from the tree structure and the presence of the +log feature. This is also the case for constructions involving sentential modifiers. No special treatment is required to explain the distribution of reflexive pronouns in constructions like (7.23) (Maling 1984b:24c,25).

(7.23) Haraldur segir að Jón komi fyrst Sigga bjóði sér.
Harold says(I) that Jon comes(S) since Sigga invites(S) REFL, J
‘Harold says that Jon is coming because Sigga invited him.’

The lexical entry for fyrst (since) as it is used in this sentence is introduced in Figure 7.10. Observe that this lexical entry combines two sentences of the same form F to produce a complex sentence with the same form feature — a more general lexical entry could allow the component sentences to possess different forms. The log features of the component and resulting sentences are specified to be the same as reflected by the appearance of L in the signs for each of these sentences. There would be similar lexical entries for words like nema (unless) and ef (if). The antecedent information of each of the component sentences is the same as that of the complex sentence. Consequently, any discourse markers introduced in α are not directly available in the reflexive attributes of β (and vice versa).

So for a sentence like (7.23), only the marker corresponding to the main clause subject is available to a long distance reflexive in either subordinate sentence. This is illustrated in an excerpt of an FA specification for (7.23) shown in Figure 7.11. The logophoric verb segir (says) introduces the +log feature onto its argument sign and introduces the marker ml associated with the logocentric entity Haraldur into the long distance store (as shown
Figure 7.10. Lexical Entry for "fyrst"

Haraldur-segir-Jón-komi-fyrst-Sigga-bjöð-sér
[sent,fini,-log]
[s1][harry(m1),say(s1,m1,a),[a]S] 
[ ],[ ]

Figure 7.11 Long Distance Reflexive in Sentential Modifier
in bold). This is the only marker contained in the long distance store of the sign for the subordinate sentence Sigga bjöði sér. Consequently, ml is the only marker that can serve as an antecedent for sér.

7.2.4. ‘Opinion’ Sentences

At first glance, a sentence like (7.7) (repeated as (7.24)) appears to be troublesome for our proposal.

(7.24) Skoðun Siggu er að sig vanti haefileika. 
opinion Sigga’s is that REFL lacks(S) talent

One possible analysis for this sentence is outlined in Figure 7.12. A logophoric feature is introduced on the subordinate clause and the discourse marker associated with the subject noun phrase is introduced as the logocentric marker (as shown in bold). Unfortunately, this means that the LDR-antecedent information of the subordinate clause will not contain the discourse marker fl corresponding to Sigga — only the marker associated with opinion will be available to the long distance reflexive. Consequently, we cannot obtain an analysis for the sentence introduced in (7.24).

The problem lies in introducing nl as the logocentric marker. We should actually be introducing the marker corresponding to Sigga into the long distance store of the subordinate clause since she is the entity whose thought is being reported! Instead of using the anaphoric index of the subject noun phrase as the marker corresponding to the logocentric entity, we need to use some other marker present in the semantic information of the subject. Currently, our semantic formulae do not explicitly describe the individual from whose perspective the linguistic expression is viewed. Sells (1987) proposes the incorporation of this type of information explicitly in a discourse representation structure. We could propose a similar extension to our semantic notation by introducing a perspective index into an InL formula. So, an InL formula would be of the form shown in (7.25) where a is its index, p is the perspective index, and S is a condition.

(7.25) \[ a / p \] S

While the InL formula associated with most noun phrases would have the same index and perspective index, those associated with noun phrases like Sigga’s opinion would not (as illustrated in (7.26)).

(7.26) Mary [f1/f1] and(mary(f1))
Sigga’s opinion [n1/f1] and( [n1][opinion(n1), poss(f1,n1), sigga(f1)] )
Figure 7.12. Troublesome FA Specification

Figure 7.13. FA Specification Containing Perspective Index
It appears that nouns corresponding to propositional attitudes (i.e. the nominalised forms of verbs like *believe*) license noun phrases which have a perspective index that is different than the index of the entire formula. In cases where the index and perspective index are the same, only one of them will be displayed. There are other issues concerning perspective indices (like how they are assigned and what exactly they mean) that need to be addressed, but which will not be discussed here (see Kameyama 1985, Sells 1987).

Let us now return to our analysis of (7.24). If we introduce perspective indices into our semantic notation, then we can propose an FA specification like the one outlined in Figure 7.13. The perspective index of the noun phrase *(fl)* is introduced into the long distance store of the complement clause (as shown in bold). In this way, the discourse marker associated with *Sigga* can act as an antecedent for the long distance reflexive.

In our examples we have been ignoring the descriptive indices of noun phrases (which were discussed in conjunction with sloppy/strict readings of reflexives in § 5.5). If these indices were also treated as potential antecedents as well, then we would have a treatment for sloppy and strict readings of long distance reflexives similar to the one for locally bound reflexives. Thrainsson (1987) discusses the sloppy/strict distinction with respect to long distance reflexives and argues against Sells’ (1987) view that long distance reflexives can only have sloppy and not strict readings.

7.2.5. Non-logophoric Subjunctives

Recall that we proposed that +log implies the presence of the subjunctive mood for Icelandic. However, we have not claimed that the presence of the subjunctive implies the presence of the +log feature. Verbs can have lexical entries that introduce subjunctive complements which do not possess a +log feature and thus do not allow long distance reflexivisation.

We have stated that a logophoric verb whose subject corresponds to the logocentric entity introduces a +log feature on its complement clause, and places a discourse marker corresponding to the logocentric entity into the long distance reflexive store of the complement. For a verb or verb form whose subject does not correspond to the logocentric entity, a +log feature is not introduced on the complement nor is a logocentric marker introduced into the complement’s long distance reflexive store. However, such a verb can still specify its complement to be of the subjunctive mood.

An instance in which a subjunctive complement clause can be -log is illustrated by the passive form of logophoric verbs. The subjects of passive logophoric verbs do not generally correspond to the entity whose speech or belief is being reported. This is
illustrated in (7.13) which is repeated below as (7.27).

(7.27) *Honum var sagt að sig vantaði haefileika.
Him(D) was said that REFL lacked(S) ability.
‘He was told that he lacked ability’

Since the subject is not the logocentric entity, a +log feature is not introduced on the complement clause — the main clause passive verb specifies its complement to be both -log and fins (finite subjunctive). This is illustrated in an excerpt from the FA specification for (7.27) shown in Figure 7.14. Since the generalised predicative functor possesses a -log feature (which it inherits from its parent sign), the reflexive attributes of its argument are required to be empty (as was outlined in template L-NLG). But the reflexive attribute of the sign associated with the long distance reflexive sig cannot be empty; it must contain at least one potential antecedent in a valid FA specification. So, by proposing that certain constituents may be subjunctive but not logophoric, one can avoid analyses for sentences like (7.27).

7.2.6. Discourse Antecedents

So far, we have assumed that each sentence in a discourse is in a null context. Instead of having a null context for long distance reflexivisation, we shall allow a logocentric marker to be introduced into the long distance reflexive store of the root-sign of each sentence in a discourse. This marker corresponds to the logocentric entity of the sentence. Again, the introduction of such a marker will be accompanied by the introduction of a +log feature.

Logophoric sentences can be introduced by lexical entries which are associated with the punctuation marks that terminate sentences, as shown in Figure 7.15. The first lexical entry forms a multi-sentence discourse from the FA specification β associated with a sentence, and another α associated with a sub-discourse. It introduces a +log feature onto both of its arguments and introduces a discourse marker for the same logocentric entity into their long distance stores. This entity need not be associated with some syntactic constituent. Lexical entries like the one provided in Figure 7.16 are responsible for propagating the LDR-antecedent information onto individual sentences. There would be additional lexical entries like the one in Figure 7.15 which would propagate LDR-antecedent information throughout multi-sentence discourses instead of introducing new +log features. We can also provide analyses for discourses in which the first sentence establishes a logophoric entity for the use of subsequent sentences. Such a lexical entry is introduced in Figure 7.17. The perspective index \(x\) of the first sentence is introduced as the logocentric marker for the logophoric discourse \(\alpha\) as shown in bold.
Figure 7.14. Subjunctive Non-Logophoric Complements

Figure 7.15. Lexical Entry for Multi-Sentence Logophoric Discourse

Figure 7.16. Lexical Entry for Single Sentence Discourse
Figure 7.17. Additional Lexical Entry for Multi-Sentence Discourse

Figure 7.18. Logocentric Markers in a Discourse
By having lexical entries for discourses which introduce logophoric contexts and their associated logocentric entities, we can provide analyses for discourses like those introduced in (7.18) and (7.19). In Figure 7.18 we outline the FA structure for the section of the discourse introduced in (7.18) which is repeated here as (7.28).

(7.28) Formaðurinn varð óskaplega reiður.
    chairman-the_i became furiously angry
    ‘The chairman became furiously angry.’
Sér vaæri reyndar sama ...
REFL_i was(S) in-fact indifferent ...
    ‘In fact, he did not care ...’

Observe that the discourse marker associated with the chairman is introduced into the long distance store of the second sentence as shown in bold. Due to the presence of the \(+\text{log}\) feature on the second sentence, the LDR-antecedent information is propagated to the sign associated with the reflexive pronoun; the LDR-antecedent information is not blocked. In this way, the marker \(ml\) is available as a potential antecedent for the reflexive pronoun (as shown in italic). The presence of a \(+\text{log}\) requires the second sentence to be subjunctive (as reflected in the feature specification \(fins\)).

7.3. Summary

The treatment of long distance reflexives in TUG can account for the distribution of reflexives in a wide range of constructions including deeply embedded complement clauses, relative clauses and sentential modifiers. Furthermore, the same general principles are responsible for describing the behaviour of reflexives regardless of whether or not they are c-commanded by their antecedents or even in the same sentences as their antecedents.

The distribution of LDR-antecedent information is dependent on the actual tree structure assigned to linguistic expressions and on the distribution of a logophoric feature. The distribution of this logophoric feature is determined by the various lexical entries. There are two broad classes of lexical entries with respect to logophoricity. Members from one class introduce logophoric features \(+\text{log}\) on their arguments and introduce logocentric markers into their long distance reflexive stores while the lexical items from the other class merely propagate the logophoric feature from functor to argument. In Icelandic, if a verb possesses a \(+\text{log}\) feature then it must take on its subjunctive form. However, there may be verbs which are subjunctive but which do not possess the logophoric feature. Long distance reflexivisation and the presence of the subjunctive are both consequences of the presence of a logophoric environment.
The treatment of long distance reflexives is very similar to that of locally bound reflexives. LDR-antecedent information is environmental just as R-antecedent information is — the LDR-antecedent information of a sign is determined from information contained in its sister and parent signs in an FA specification. The ultimate source of this information is the anaphoric and perspective indices of argument-signs. For most noun phrases, these two indices are the same. The various principles responsible for establishing and changing perspective indices need further investigation. Potential antecedents can either be introduced into a long distance store directly (as a logocentric entity) or they can incorporated indirectly by virtue of being the subject of a predicate in a logophoric environment (as embodied in template $R-LG$). In this way we can account for long distance reflexives whose antecedents are logocentric entities as well as those whose antecedents are not.
Chapter 8
Conclusions

Tree Unification Grammar is a declarative unification-based linguistic framework in which the distribution of locally bound and long distance reflexive pronouns can be elegantly accounted for. It is a highly lexical framework that requires only a single grammar rule operating over tree structures which contain the phonological, syntactic, semantic and antecedent information associated with a linguistic expression. We will briefly summarise the important points of TUG and reflexive anaphora before looking at some possible directions for further research.

8.1. A Summary

The basic grammar structures of our framework have much in common with the 'predication structures' used by various formalisms (Williams 1980, Hellan forthcoming, Chierchia 1988). Unlike predication structures, the FA structures of TUG have highly structured signs labelling their nodes. Signs are organised in a hierarchical fashion in the FA structure with each sign describing the phonological, syntactic, semantic and antecedent information associated with some sub-expression of the complete linguistic expression. It is partial specifications of FA structures that are used as lexical entries in TUG. A single grammar rule is used to combine these specifications to produce more detailed (FA) specifications. By using FA specifications as lexical entries, many local relationships between linguistic expressions can be stated directly in the lexicon in the information contained in their respective signs. Since a lexical entry can specify a relationship between any two signs in its FA specification, it can impose restrictions on the phonology, syntax, semantics and potential antecedents associated with neighbouring expressions. Unlike other formalisms, the explicit relations specified in lexical entries are not limited to local dependencies of a functor on its argument. The relations responsible for determining the distribution of reflexive pronouns can be concisely and transparently stated in the lexicon.

By proposing a monostratal formalism we allow different forms of information to interact. In particular, antecedent information is given the potential to constrain possible analyses. Sorted variables are associated with the discourse markers of reflexives and their antecedents, with the agreement between anaphor and antecedent being mediated through the sort of their unified discourse markers. The failure to establish an anaphoric relationship between two expressions (ie. the failure of the unification of their discourse markers) can be used to disallow analyses.
Our examination of reflexivisation has shown this phenomenon to be responsible for local anaphoric dependencies and for long distance logophoric-anaphoric relationships. Semantic-based constraints on locally bound reflexivisation can be stated in terms of the FA structures associated with linguistic expressions. Lexical items can also impose individual restrictions on the distribution of reflexive pronouns within their arguments. These lexical restrictions are usually associated with some aspect of the meaning of the individual lexical entries. The constraints on long distance reflexivisation can also be stated in terms of FA structures, but this time the notion of logophoricity plays a major role in determining the distribution of the reflexive pronouns. Essentially the same general approach is applicable to both long distance and locally bound reflexives.

Our constraints on reflexivisation affect the distribution of R-antecedent information. For any sign in an FA structure, its R-antecedent information consists of a set of discourse markers corresponding to potential antecedents. In this way, the possible antecedents for a reflexive pronoun are always locally available. The predicate-command constraint on reflexivisation is equivalent to the requirement for the R-antecedent information of a functor to contain the R-antecedent information of its parent-sign in addition to the anaphoric index of its argument. Our locality constraint involves blocking the inheritance of R-antecedent information from a root-sign to a generalised predicative functor-sign.

The treatment of Icelandic long distance reflexivisation is very similar to that of locally bound reflexivisation in English — it is just that different constraints are relevant. A separate attribute is used for LDR-antecedent information. The LDR-antecedent information contained in this attribute originates from the anaphoric and perspective indices of linguistic expressions. Like R-antecedent information it is *environmental*; a sign in an FA structure obtains its antecedent information from its parent and sister signs. The distribution of LDR-antecedent information is highly dependent on the kind of verbs contained in the environment.

The general constraints on reflexivisation allow a uniform treatment of English reflexive pronouns regardless of whether they take subject or object antecedents, whether they are bound by or coreferential with their antecedents, or whether they have sloppy or strict readings. Furthermore, the same constraints are applicable whether or not reflexives are involved in unbounded dependencies, contained in picture-noun or possessive constructions, involved in controlled constructions, or contained in prepositional phrases. With respect to the long distance reflexivisation observed in Icelandic, there is a uniform treatment of long distance reflexives regardless of whether or not they have linguistic antecedents in the same sentence.
Since TUG possesses but a single grammar rule, all linguistic generalisations must be captured in the lexicon through the use of templates and lexical rules. The lexicon itself is hierarchical — lexical entries and templates can be defined in terms of templates, and lexical rules can be defined in terms of templates thus avoiding duplication of information. It is not surprising that capturing all linguistic generalisations in the lexicon results in an increase in the size of the lexicon. This tradeoff between the size of lexicon and the number of grammar rules merits further study, particularly in relation the development of a parser for TUG (§ 8.2.3).

The presence of signs possessing a null phonology ε is an integral part of our treatment of control, unbounded dependencies and reflexivisation. Lexical entries for null phonological items are not required though. Null phonology signs are present to mediate many syntactic, semantic and anaphoric relationships.

Our treatment of unbounded dependencies has involved treating them as more than just syntactic phenomena. A storage mechanism is used to pass all the different forms of information contained in a sign. This allows the semantic information associated with a trace to be dependent on that of the unbounded dependency constituent and allows the antecedent information of this constituent to be dependent on that of the trace. Within our framework, we have been able to account for the syntactic, semantic and anaphoric properties of relative clauses, topicalised constructions and cleft constructions.

8.2. Further Research

As with any major research project, in the process of pursuing our primary goals we have encountered numerous other interesting problems into which further investigation would be appropriate. There are two main directions in which further research can be directed — one being the further investigation of anaphora in the TUG framework and the other concerning a more detailed investigation of the TUG framework itself.

8.2.1. Anaphora

8.2.1.1. Choosing Amongst Antecedents

Our approach to reflexivisation has been concerned with determining the possible antecedents for reflexives, not chosing amongst the possible antecedents. In order to reflect the relative preference of antecedents, the elements in the reflexive store could be ordered, say with the first element of the store corresponding to the preferred antecedent. It is not a trivial problem to determine the factors responsible for establishing these preferences. Furthermore, preferences may differ from individual to individual. A detailed account
concerning the relative acceptability of different antecedents for reflexives is provided by Kuno (1987). He notes how factors such as grammatical function, thematic role, kind of antecedent, and perspective all contribute to the relative acceptability of certain readings of reflexive pronouns. Such factors could be incorporated into the lexical entries for expressions like verbs in TUG and would be reflected in the ordering of the elements in the reflexive stores of a verb's arguments.

8.2.1.2. Other Reflexives

During the course of our study, we have been concentrating on third person singular reflexives. We have only very briefly touched on the issue of plural reflexives (§ 6.1.1). Since our treatment of reflexives has been based on the DRT treatment of pronouns, it is natural to expect that our approach to plural reflexives would be dependent on the DRT treatment of plurals. This is an area that is still very much under investigation. Some issues concerning plurals in DRT are discussed in (van Eijck 1985).

As for first person and second person reflexives, they seem to behave in a much different manner than third person reflexives. Some languages only have an explicitly marked reflexive form for the third person. Even in English first and second person reflexive pronouns seem to behave differently than their third person counterparts. Consider the following examples.

(8.1) I voted for me / myself, not you!
(8.2) He voted for him / himself, not you!

The second sentence does not have a reading where he is the antecedent for him. In (8.1), either me or myself can be used with the subject I as the antecedent. To incorporate a treatment of first and second person reflexivisation into TUG we would first need to determine the constraints on this form of reflexivisation. These constraints would then be used to account for the distribution of first-second person R-antecedent information in an FA specification. Based on data like (8.1-8.2) it appears that different information is relevant for first and second person reflexivisation as compared to third person reflexivisation.

8.2.1.3. Control

In § 5.1.2, we briefly outlined an account of local control phenomena associated with infinitival complements of equi verbs like promise and want. A more general treatment of control could rely on the use of a separate store for control information which would behave much in the same way as the R-antecedent and LDR-antecedent stores. The lexical
entries for verbs would determine the markers that could be introduced into the store and would also be responsible for blocking the information from entering certain constituents. For instance, verbs introducing object controlled complements would introduce the discourse marker associated with the object into the control-store of the complement. The sign associated with PRO would require its discourse marker to be a member of the control-store. This is reflected in the FA specification for the sentence (8.3) which is shown in Figure 8.1.

(8.3) John believes that PRO killing himself would solve all of his problems.

Much of the information in this FA specification has been removed in order to highlight the relevant relationships. The fourth attribute of the sign is a pair of lists separated by commas where the first list contains R-antecedent information and the second (shown in italic) contains control information. Observe that the sign with a null phonology, which corresponds to PRO, obtains its controller from the control store associated with the sign (as shown in bold). Details concerning the constraints on control information would have to be examined before a general treatment of control could be specified. Nevertheless, this information based treatment of control would allow super-equi constructions to be treated in the same way as other control constructions; the PRO would simply select the discourse marker corresponding to its controller from its own control store.

8.2.1.4. Pronominal Anaphora

One of the reasons for adopting a variation of the DRT approach to anaphora for our treatment of reflexivisation is that it allows our proposal to be naturally extended to include pronominal anaphora. Furthermore, by adopting the DRT treatment of personal pronouns we are not restricted to cases where an anaphor and its antecedent are in the same sentence. The same approach that is used for reflexive anaphora in TUG can be adapted for use with pronominal anaphora; a personal pronoun store containing possible antecedents can be introduced.

The treatment of pronominal anaphora involves different problems than those which we encountered with reflexive anaphora. For reflexives, new discourse markers were introduced from anaphoric indices of argument-signs. With respect to pronominal anaphora, we need more than just this index of the argument sign. Recall from § 5.2 and § 5.3 that for sentences like (8.4) and (8.5), the anaphoric index of the subject noun phrase is a discourse marker corresponding to the mother and the woman respectively.
John believes that killing himself W
[sent,fin]

that-killing-himself-W believes
[sent,comp]

killing-himself-W
[sent,prp]

killing-himself
[np,nom]

Figure 8.1. FA Specification with Control Information

Figure 8.2. Template for Pronominal Anaphora

Figure 8.3. Lexical Entry for Personal Pronoun
The pronoun antecedent (P-antecedent) information of a functor needs to contain information obtained from inside the subject noun phrase. In the following two sentences, the personal pronoun takes an antecedent which is contained within the complex subject; John is the antecedent for the pronoun.

Essentially, we need to incorporate the restriction that any discourse marker from the same DRS as the pronoun can act as the antecedent for the pronoun. This means that ungrammatical sentences like the following need to be disallowed.

Instead of the simple relationship captured by the templates for R-antecedent information, we would need something like the one shown in Figure 8.2 for describing the distribution of P-antecedent information. We are assuming that the information in the fourth attribute of a sign is a pair of lists corresponding to R-antecedent and P-antecedent information.

The relation $acc([a]S)$ used in Figure 8.2 describes an accessibility relation stating which discourse markers in $[a]S$ are accessible to a personal pronoun. This information is then merged with the other P-antecedent information $A$ as specified by the description $acc([a]S)++A$. $Acc$ can be defined for different kinds of arguments so as to incorporate the restrictions contained in traditional DRT. An outline of such a definition is shown in (8.9) and (8.10).

This definition would need to be extended for other semantic connectives. Essentially, it states that discourse markers introduced within sub-DRSs connected by the DRS implies relation are not available as antecedents to pronouns outside of the sub-DRSs. However
proper names introduced in such sub-DRSs are accessible, as reflected in the need for the relation acc'.

In general, the P-antecedent information will contain all of the discourse markers contained in the reflexive store plus additional markers. The main exception to this rule concerns locative PPs which we shall be discussing shortly. The lexical entry for a personal pronoun will require its antecedent to be a member of the personal pronoun store but not a member of the reflexive store. This will require the addition of a primitive relation to the TUG framework for specifying non-membership of an element relative to a set. Such a restriction is shown in (8.11), and is present in the lexical entry for the personal pronoun shown in Figure 8.3.

(8.11)  ~[...fl_]

This captures the fact that personal pronouns are generally in complementary distribution to locally bound reflexive pronouns.

Recall that in § 5.4 we noted that both personal pronouns and reflexive pronouns can appear in certain prepositional phrases. However, in instances when either one can appear each one is associated with a different meaning of the expression containing the pronoun or the reflexive; a different FA structure will be associated with each meaning. So with respect to a particular meaning (or FA structure), the reflexive and the personal pronoun are in complementary distribution.

There are still many details to be examined concerning a treatment of pronominal anaphora. We have only scratched the surface of many of the issues. Not only do we have to determine all the constraints relevant to pronominal anaphora, but we must also examine the feasibility of maintaining the potentially large set of possible antecedents within a store, and examine issues associated with the interpretation of the non-membership restriction found in the lexical entry for the personal pronoun.

8.2.2. Trees and Unification

In our discussion of the TUG framework, we have been restricting our attention to phenomena that are closely tied to the distribution of R-antecedent information. While doing this, we have encountered other interesting phenomena for which a detailed analysis could prove interesting. Here, we will briefly examine how problems concerning quantifier scope and coordination might be approached from within TUG. We will then outline some issues that are relevant for a computer implementation of this framework.
8.2.2.1. Quantifier Scope

In most of the lexical entries that we have introduced throughout this thesis the lexical entry for the verb determines the scoping of its noun phrase arguments, although the actual semantic connective is supplied by the noun phrase. Normally, the noun phrase is given narrow scope. As was illustrated in our discussion of possessive constructions (§ 5.2) and in template $S$-POS, a noun phrase can be given wider scope according to information contained in the primary tree in which it is combined. Applying this approach to a wider range of constructions, the lexical entries for verbs could specify one of their arguments to have widest scope. Different scoping possibilities would be reflected by different lexical entries for the primary trees which take noun phrase specifications as auxiliary trees.

This is by no means the only way in which scoping phenomena could be incorporated into TUG. Lexical entries for noun phrases could be structured so that they would determine their own scope, or a variation of the storage technique used for anaphora could instead be adopted (Cooper 1983). It would be premature to decide in favour of one of these alternatives at this point of time.

8.2.2.2. Coordination

FA specifications can be grouped into two broad classes based on whether or not they have an empty auxiliary list. The FA specifications for nouns, noun phrases and sentences generally have empty auxiliary lists while those for verbs, verb phrases and adjectives do not. Coordination of elements from this first class, as illustrated in expressions like John or Mary and John walks and Mary runs can be treated in a straightforward manner by proposing a lexical entry for a coordinator that takes two syntactically identical constituents as its auxiliary trees. Glossing over several details, such a coordinator would have a lexical entry like the one illustrated in Figure 8.4. It would coordinate auxiliary trees having root-signs with syntax C. Unfortunately, complications arise when proposing a lexical entry that will also coordinate constructions whose FA specifications do not have empty auxiliary lists; the TUG grammar rule requires auxiliary trees to possess empty auxiliary lists.

In order to allow constituents with non-empty auxiliary lists to act as auxiliary trees, we have already introduced additional lexical entries which possess constituents with null phonologies and vacuous semantics; this is a major factor contributing to the large size of the lexicon in our grammar fragment. This was done in § 5.1.2 to allow FA specifications for verb phrases to be used as auxiliary trees in controlled complements. Verb phrase coordination could operate over these verb phrases possessing null subjects as illustrated in
Figure 8.4. Lexical Entry for a Conjunction

Figure 8.5. Lexical Entry for Verb Phrase Conjunction
the lexical entry introduced in Figure 8.5. Unfortunately, this does not lend itself to a particularly elegant treatment of coordination since a different lexical entry for the coordinator is required depending on the type of constituents it is coordinating. Furthermore, the lexical rule introduced in Figure 5.9 for removing the subject from an auxiliary list would need to be generalised to remove other elements from auxiliary lists.

Could we avoid the complications of this proposed lexical rule by introducing an additional grammar rule to handle coordination? Could this grammar rule also handle non-constituent coordination? Is there motivation for proposing that different lexical entries for coordinators are required depending on the type of constituents that they are coordinating — do they behave differently semantically? These are just a few of the questions that need to be addressed in the development of a TUG treatment of coordination.

8.2.3. Parsing TUG

One of the aims in the development of TUG was the provision of a framework which could be implemented on a computer. In chapter four we have already seen how FA specifications could be translated into a PATR-II style description. There are programming environments which can directly execute similar specifications (Karttunen 1986, Bouma, Koenig and Uszkoreit 1988). Since our FA structures possess a fixed structure (ie. they are always binary trees with nodes containing exactly four attributes), TUG is also amenable to implementation in terms of term unification. Primitives for operations like arbitrary selection of an element from a list along with list merging would be beneficial, but these operations could easily be defined in the low level language.

One of the problems with any of these forms of implementation concerns the actual parsing strategy. Due to the highly declarative nature of the formalism, there may be problems when trying to work with 'uninstantiated information.' For instance, what if we are trying to evaluate the restriction on the R-antecedent information of a reflexive pronoun (ie. selecting an arbitrary element from a list) when that information is not yet available? There are many other issues concerning parsing that need to be addressed, but which will not be discussed here.

8.3. In Closing

We have seen that a straightforward account of reflexivisation can be provided within the Tree Unification Grammar framework. The account can be extended to handle other anaphoric phenomena in multi-sentence discourses. TUG provides a framework in which the interaction of different forms of information relevant to anaphora (and other
phenomena) can be examined. There is still much to be learned about the role of different forms of information in natural language processing and anaphora resolution. The analyses presented in this thesis are by no means the only ones possible within TUG, and the development of an implementation for processing the grammars of the framework would facilitate the selection of the optimal analyses.
Appendix A
Templates

A.1. R-Antecedent Templates

Generalised Predicatives

Non-Generalised Predicatives

Non Predicatives

A.2. Semantic Templates

Semantic Type Raising

Semantic Conjunction

Semantic Composition

A.3. Phonological Templates

Post

Pre

Wrap
A.4. Syntactic Templates

Phrasal Category

Head Functor

Foot Feature

A.5. LDR-Antecedent Templates

Generalised Predicative (+log)

Generalised Predicative (-log)

Other Functors
A.6. Noun Phrase Templates

Subject Noun Phrase

Object Noun Phrase
References


