Chapter 3: A Framework for Investigating Syntactic Comprehension Deficits in Parkinson's Disease

In order to investigate syntactic comprehension deficits in PD, or for that matter in any clinical population or individual brain-damaged patient, a detailed theory of the normal syntactic comprehension system is necessary, since it provides the essential frame of reference for identifying and specifying disorders. For this reason, the goal of this chapter is to delineate the architecture of the normal syntactic comprehension system at three different levels of analysis: structure, processing, and neurobiology.

Any approach to describing the organization of the normal syntactic comprehension system must begin by adopting one or another grammatical theory. At present, however, this is by no means a simple decision, since the theoretical marketplace is jammed with a panoply of alternatives to choose fromùmore than one can count on both hands, in fact. Although there is no simple procedure for selecting one theory over the others, there are several criteria that can be used to narrow down the search. First of all, one should prefer theories that can provide natural descriptions of grammatical phenomena in not only the language of interestùin my case, Englishùbut also in typologically diverse languages throughout the world. The motivation for this criterion is that the general design of the syntactic comprehension system is presumably compatible with all human languages, and therefore the basic structures that one incorporates into one's model of the system should also be compatible with all human languages. Another criterion is that one should prefer theories that strive for so-called psychological reality. Such theories attempt to accommodate evidence about how grammatical knowledge is acquired in childhood, how it is employed in on-line language processing, and how it is implemented in the brain. Taken together, these criteria are quite restrictive and elim-inate from consideration a number of grammatical theories (e.g., Generalized Phrase Structure

Grammar, Head-Driven Phrase Structure Grammar, Relational Grammar, Word Grammar, and Systemic Functional Grammar); however, they still leave a range of candidate theories in the running (e.g., Government-Binding theory, Lexical-Func-tional Grammar, Cognitive Grammar, and Role and Reference Grammar).

In recent years, the vast majority of researchers who have investigated normal and disordered syntactic comprehension have adopted some version of Government-Binding theory (GB), most likely because of the longstanding hegemony of the Chomskyan paradigm in linguistics. Many of the psycholinguistic and neurolinguistic studies of syntactic comprehension that have been anchored in GB are very impressive. For instance, the differences between three types of empty category posited by the theoryùspecifically, WH-trace, NP-trace, and PROùhave been supported by studies of the sentence processing abilities of normal subjects (Bever & McElree 1988; Fodor 1989; Nicol & Swinney 1989) as well as by studies of the patterns of sparing and loss of ability exhibited by brain-damaged patients (Caplan & Hildebrandt 1988; Grodzinsky 1989; Grodzinsky et al. 1989).

Despite the virtues of the GB-based approach to investigating normal and disordered syntactic comprehension, I have chosen not to take such an approach for the following reasons. With regard to the studies just cited which provide psycholinguistic and neurolinguistic support for the inventory of empty categories posited by GB, it is worth noting that other researchers have argued that these categories are not really necessary to account for the data (Kemmerer 1994a, 1994b; Pickering & Barry 1991; Pickering 1993; Fodor 1995; Sag & Fodor 1995). In addition, although GB is clearly concerned about achieving universal validity, it is nonetheless strongly biased toward the design features of English and other Indo-European languages and hence cannot describe in a natural, economical way the characteristics of head-marking languages, nonconfigurational languages, languages that lack traditional grammatical relations like subject, and a variety of other typological phenomena (Van Valin 1987, 1993). Finally, because GB is highly

"syntactocentric," it is unable to account adequately for a variety of phenomena that involve close interactions between syntax, semantics, and pragmaticsùe.g., extrac-tion restrictions, grammatical categories, pronominal anaphora, voice alternations, split intransitivity, etc. (Croft 1991; Givon 1995; Huang 1994; Kuno 1987; Lakoff 1987; Langacker 1987, 1991; Van Valin 1990, 1994; Kuno & Takami 1993).

Instead of grounding my investigation in GB, then, I will use an alternative theory that appears to do a better job of satisfying the criteria mentioned earlierùnamely, Role and Reference Grammar (RRG) (Foley & Van Valin 1984; Van Valin 1993; Van Valin & LaPolla, in press). Unlike GB and many other generative theories, RRG started out by considering not just English but also languages as typologically diverse as Dyirbal (Australia), Tagalog (Philippines), and Lakhota (Native American); moreover, it has continued to draw heavily on a wide range of crosslinguistic data during its develop-ment. Besides being committed to achieving genuine universality, RRG has the additional goal of capturing the interaction of syntax, semantics, and pragmatics. The theory views language as a complex form of social behavior that evolved as a solution to the adaptive problem of communicating an open-ended number of detailed propositions about the world (especially the social worldùcf. Dunbar 1993). As a result, it regards syntactic structures and rules as motivated to a large extent by semantic and pragmatic factors. Finally, RRG is concerned about psychological reality. So far, however, very little research along these lines has been conducted. Some efforts have been made to account for certain aspects of language acquisition in terms of RRG (Bowerman 1990; Braine 1992; Rispoli 1991a, 1991b, 1994; Van Valin 1991, 1994). But no work has been done to date on developing a processing model for RRG, and only one attempt has been made to characterize within RRG various types of neurolinguistic data, such as the selective deficits in syntactic comprehension exhibited by brain-damaged patients (Kemmerer 1994a). Still, the emphasis in RRG on discovering what properties of grammatical systems are universal and what properties are language-specific may give

it an advantage over alternative theories with respect to the goal of achieving psychological reality, since universal validity is a natural requirement for psychological reality. Indeed, this is the main reason why I have chosen to work within this particular theory.

As I mentioned earlier, the purpose of this chapter is to characterize the normal syntactic comprehension system at three different levels of analysis: structure, processing, and neurobiology.[1] Each of these levels of analysis is addressed in a separate section of the chapter. Thus, in section 3.1 I discuss the nature of the computational problem that the syntactic comprehension system must solve. More precisely, I describe the kind of syntactic and semantic structures that occur in various linguistic constructions, as well as the way in which the syntactic structure is linked to the semantic structure. In section 3.2 I shift to the second level, which is concerned with the processing operations and resources that are dedicated to assembling syntactic and semantic structures and linking the former to the latter. Finally, in section 3.3 I move to the third level, which focuses on the brain areas in which the syntactic comprehension system is physically realized.

3.1 Structure

In this first section, I review the RRG approach to dealing with the two fundamental aspects of grammatical structure: hierarchical structure and relational structure. Hierarchical structure involves the part-whole organization of phrases, clauses, and sentences, whereas relational structure involves the syntactic, semantic, and pragmatic relations that obtain between syntactic elements. My review will focus on those aspects of the theory

[1] These three levels correspond to the levels of computation, algorithm, and implementation that were originally proposed by Marr (1982) and that have been adopted by many cognitive neuroscientists since then (Kosslyn & Koenig 1992). See Kosslyn (1994) for an especially useful discussion and application of a revised version of Marr's metatheory.

that are most relevant to analyzing the types of English constructions that I will be concerned with in the rest of the thesis. The information presented below is drawn mainly from Van Valin (1993); further details can be found there as well as in Foley and Van Valin (1984) and Van Valin and LaPolla (in press).

3.1.1 Architecture of RRG

3.1.1.1 Hierarchical Structure

Hierarchical structure in RRG is not based on the X-bar schema familiar to most syntacticians but is instead more semantically based. The general organization of simple sentences, which is called the Layered Structure of the Clause (LSC), is shown below in Figure 7.

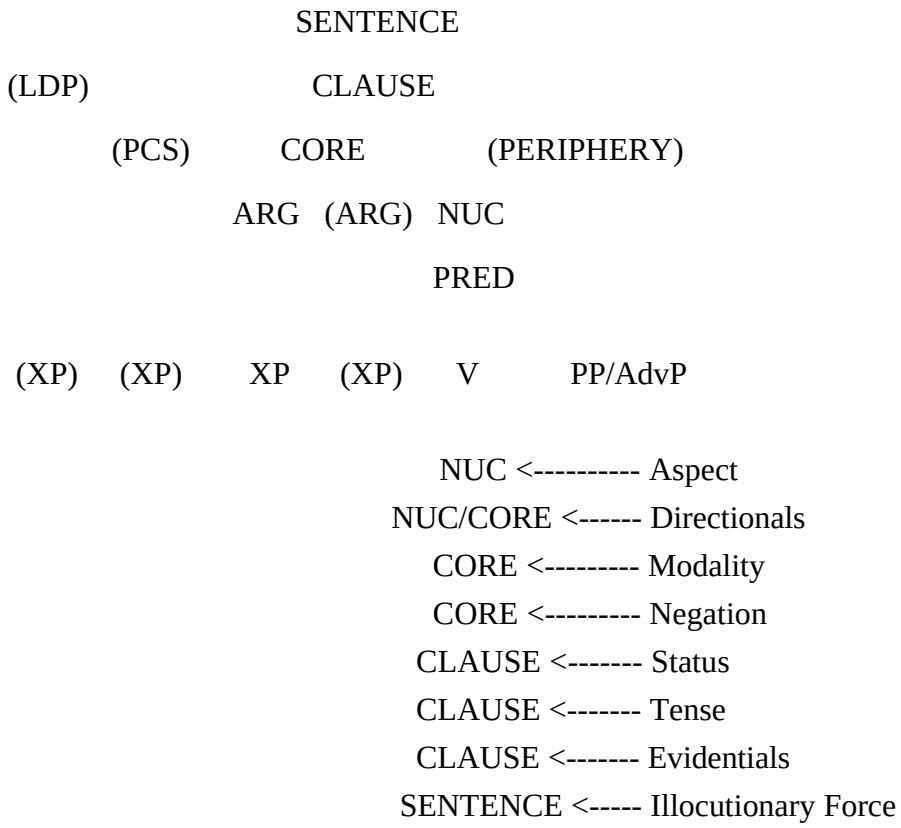


Figure 7: LSC with constituent and operator projections

Consider first the top half of the diagram. The most basic distinction expressed here is between core and periphery. A core consists of a nucleus (NUC) for the predicate, which is usually a verb, and argument positions (ARG) for the arguments of the predi-cate. Core arguments are typically those which are specified in the semantic represen-tation of the predicate, and they may be syntactically realized as either direct or oblique: a direct core argument appears without an adposition (e.g., *Sam dropped the bag*), whereas an oblique core argument appears with an adposition (e.g., *Sam put the ball in the bag*). An optional periphery is attached to the core; this is for adjuncts, i.e., expres-sions that are not specified in the semantic representation of the verb and are not sensi-tive to the major syntactic rules of the language, e.g., locative and temporal "setting" expressions such as *at the park* or *last night.*

Three points about the notions of core and periphery deserve to be mentioned before going on to describe the rest of the scheme. First, these notions are universally valid because every language distinguishes, on the one hand, between a predicate and its arguments and, on the other hand, between elements which are arguments of the predi-cate and those which are not. Second, the elements making up the core and periphery may occur in any linear order whatsoever, since the languages of the world run from one extreme of fixed word order (e.g., English) to the opposite extreme of nonconfiguration-ality (e.g., Warlpiri [Australian]). Third, the basic syntactic units are strongly motivated by basic semantic units, as shown below:

Semantic Unit(s)	Syntactic Unit
Predicate	Nucleus
Argument in semantic representation of predicate	Core argument
Predicate + Arguments	Core
Non-arguments	Periphery

It is important to recognize, however, that the units in the LSC are in fact syntactic in nature, since they do not always correspond directly to their semantic analogues. For instance, although NPs are normally associated both syntactically and semantically with a single core, there are complex sentences in which an NP is syntactically associated with one core but semantically associated with a different core (e.g., in *Bill seems to like chocolate*, the NP *Bill* is a syntactic argument of *seem* but a semantic argument of *like*). Thus, the notion of core argument is essentially syntactic.

Returning now to the top half of Figure 7, the units that dominate the coreùnamely, clause and sentenceùare universal, but the units that branch off from the clause and sentence nodesùnamely, PCS and LDPùare not. PCS stands for pre-core slot, which is a special position for WH-phrases and topicalized phrases (e.g., *What did you put on the table? This book you put on the table*). Arguments that are specified in the semantic representation of a predicate can appear in the PCS. LDP stands for left-detached position, which is reserved for phrases that are set off from the rest of the sentence by a pause or intonation break (e.g., *After the picnic, we went to the zoo*). Finally, the XPs in the figure denote any type of phrase that can appear below the immediately dominant unit; generally they are noun phrases (NPs). An example of an English sentence containing all the elements of the top half of Figure 7 is shown below in Figure 8.

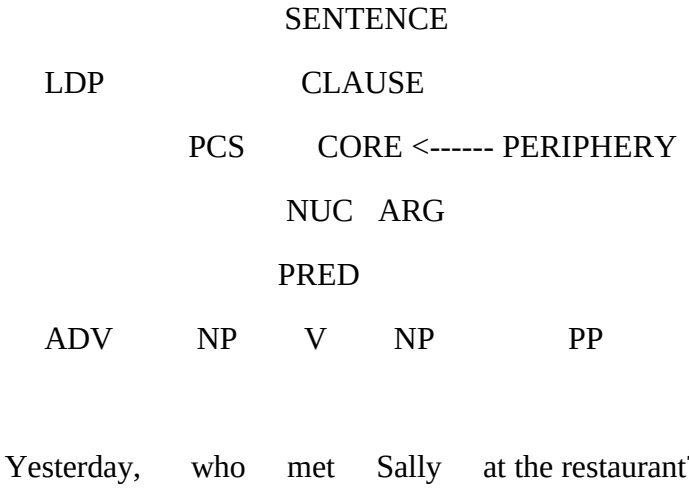


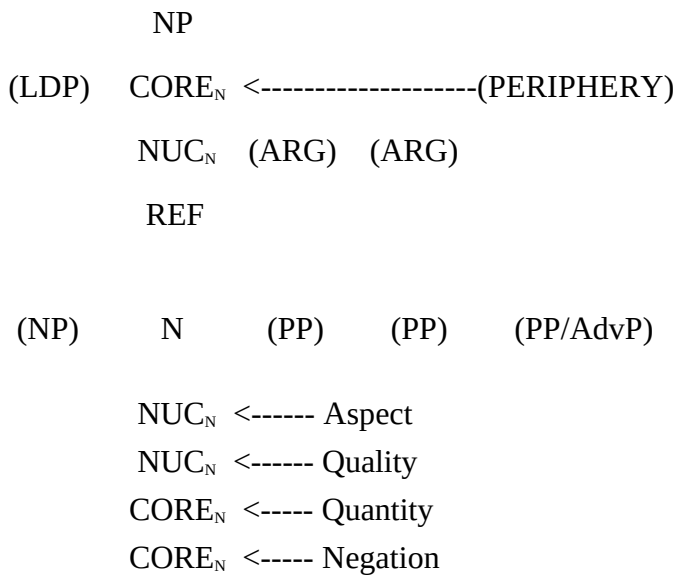
Figure 8: Constituent structure of English sentence

The bottom half of Figure 7 expresses a variety of categories which are collectively referred to as operators. They are qualitatively different from predicates and arguments insofar as they function as modifiers of the various hierarchical units of sentences. Languages code operators with auxiliary verbs, verbal affixes, and verbal clitics. As shown in the figure, each of the major layers of a simple sentenceùnucleus, core, and clauseùis modified by one or more operators. The verb is the "anchoring point" for operators, which makes sense, given that they are traditionally considered verbal categories. Operators are not relevant to the central issues of this thesis, so I will not describe them in detail here.

According to RRG, complex sentences consist of combinations of clauses, cores, and nuclei. The normal linkage pattern is for units at the same level to be combined, i.e., clauses with clauses, cores with cores, and nuclei with nuclei. Each of these combinations may be accomplished in three different ways: coordination, where the syntactic units are simply added together and neither unit depends on the other, either structurally

or for certain operators; subordination, where one syntactic unit is structurally dependent on the other; and cosubordination, where one syntactic unit depends on the other for certain operators but is not embedded in it. Since there are three levels of combination and three types of combin-ation for each level, it is theoretically possible for a language to have nine distinct patterns for complex sentences: clausal coordination, subordination, and cosubordination; core coordination, subordination, and cosubordination; and nuclear coordination, subordination, and cosubordination. Some languages have all nine patterns (e.g., Korean), but most do not (e.g., English has seven, and Nootka [Native American] has six) (Van Valin & LaPolla, in press). It is important to note that each of these abstract patterns can be instantiated in a language with several different grammatical constructions. For instance, in English both complement clauses (e.g., *Harry persuaded Sally <u>that he was sincere</u>*) and adverbial clauses (e.g., *Harry visited Sally <u>after he finished work</u>*) are cases of clausal subordination.

Many syntacticians have observed that the hierarchical structure of NPs is similar to the hierarchical structure of clauses. Within RRG the basic organization of NPs is expressed as in Figure 9:



NP <--------- Locality

Figure 9: Constituent and Operator Projections of NP

As before, consider first the top half of the diagram. Since nouns have a referential function, they are dominated by the node REF; this is analogous to the PRED node that dominates verbs and that indicates their predicating function. In addition, nouns are similar to verbs in that both can take arguments and hence can serve as the nucleus of a core (e.g., *the destruction <u>of the city by the enemy</u>*). Two further commonalities between NPs and clauses are, first, that both have a periphery in which adjunct "setting" expressions can appear (e.g., *the concert <u>in Central Park</u>*) and, second, that both have a left-detached position in which optional material can appear (e.g., *<u>Mark's</u> book*). Yet another feature that makes NPs similar to clauses is that, as the bottom half of Figure 9 shows, NPs are modified by a distinctive set of operators. However, since these operators are not relevant to the issues that I will be dealing with later, I will not discuss them in any detail. Finally, it is worth noting that complex NPs can be formed by combining syntactic units at all three levels of NP structureùNP, $core_N$, and $nucleus_N$ùand these combinations can be of all three of the types described earlierùcoordination, subordination, and cosubordination.

3.1.1.2 Semantic Relations

From the perspective of RRG, three different kinds of relational structure are important for grammatical phenomena: semantic relations, syntactic relations, and pragmatic relations. I will only be concerned with the first two, however, since the third is not central to the major topics of this thesis. Semantic relations are the focus of this subsection, and syntactic relations are the focus of the next.

The RRG approach to semantic relations is based on the following four-way classification of verbs originally proposed by Vendler (1967):[2]

States: *be shattered, be cool, be dead, be tall, be sick, know, have, believe, love*
Activities: *march, walk, roll* (intransitive versions); *swim, think, rain, read, eat*
Achievements: *shatter, cool* (intransitive versions); *die, learn, receive, realize*
Accomplishments: *shatter, cool* (transitive versions); *kill, teach, give, convince*

Although Vendler arrived at these fundamental distinctions by investigating only English verbs, subsequent research has shown that they are crosslinguistically valid; in fact, some languages code the different verb classes with explicit morphological markers (e.g., Tepehua [Totonacan, Mexico], Qiang [Tibeto-Berman], and Russian). Dowty (1979) developed a set of syntactic and semantic tests for determining which class a verb belongs to; these tests are discussed in detail by Van Valin (1993), so I will not review them here. Dowty (1979) also proposed a formal representational system for expressing the logical structure (LS) of each verb class, and this system is adopted by RRG:

Verb Class	Logical Structure (LS)
State	**predicate** (x) or (x,y)
Activity (+/- agentive)	**do** (x, [**predicate** (x) or (x,y)])
Achievement	BECOME **predicate** (x) or (x,y)
Accomplishment	å CAUSE #, where å is normally an activity predicate and # an achievement predicate

In this scheme, states and activities are both considered primitive, but activities contain the generalized activity predicate **do**. In addition, activities vary as to whether the action is controlled by the entity or not; when the action is necessarily agentive (rather than

[2] What follows is the "old" version of the RRG approach to semantic relations (Van Valin 1993); a more refined version is presented in Van Valin and LaPolla (in press). I have chosen to stick with the original version for the simple reason that it is adequate for the purposes of this thesis.

agentivity merely being an implicature), this is signaled by the operator DO, which has scope over the entire LS. Achievements are derived from states and are semantically inchoative, so they are represented as a state modified by a BECOME operator. Finally, accomplishments involve causation, typically between an activity and an achievement, so they are represented with a CAUSE operator linking two variables. Examples of some English verbs with their LS are shown below:

States:

a. *The watch is broken.* **broken** (the watch)
b. *The soup is cool.* **cool** (the soup)
c. *Sam saw the painting.* **see** (Sam, the painting)

Activities:

a. *The ball rolled.* **do** (the ball, [**roll** (the ball)])
b. *The door squeaks.* **do** (the door, [**squeak** (the door)])
c. *The man read the magazine.* DO (the man, [**do** (the man, [**read** (the man, the magazine)])])

Achievements:

a. *The watch broke.* BECOME **broken** (the watch)
b. *The soup cooled.* BECOME **cool** (the soup)
c. *Sam noticed the painting.* BECOME **see** (Sam, the painting)

Accomplishments:

a. *The baby broke the watch (accidentally).* [**do** (the baby, °)] CAUSE [BECOME **broken** (the watch)]
b. *The breeze cooled the soup.* [**do** (the breeze, [**blow-on** (the breeze, the soup)])] CAUSE [BECOME **cool** (the soup)]
c. *Mary showed the painting to Sam.* [DO (Mary, [**do** (Mary, °)])] CAUSE [BECOME **see** (Sam, the painting)]

Semantic relations can be thought of as the roles that arguments play in the LSs of verbsùe.g., in the LS "**see** (Sam, the painting)," Sam plays the role of perceiver and the

painting plays the role of target of visual perception. Since states and activities are the two primitive verb classes, all types of semantic relations are defined with reference to argument positions in the LSs of these verb classes. The following continuum of semantic relations, which is by no means exhaustive, is from Van Valin and LaPolla (in press):

<--->

Single arg of DO	1st arg of **do** (x, ...	1st arg of **pred** (x,y)	2nd arg of **pred** (x,y)	Single arg of state **pred** (x)
agent	mover	location	theme	patient
	effector	domain	entity	
	emitter	perceiver	stimulus	
	user	cognizer	content	
	consumer	wanter	desire	
	creator	judger	judgement	
	speaker	possessor	possessed	
	observer	experiencer	sensation	
	performer	emoter	target	
		attributant	attribute	
			implement	
			consumed	
			creation	
			spoken	
			locus	
			performance	

Three semantic relations which are not listed above but which are important for many grammatical phenomena are recipient, goal, and source. They are defined as follows:

recipient: first argument in LS configuration "... BECOME **have** (x,y)"
goal: first argument in LS configuration "... BECOME **be-located-at** (x,y)"
source: first argument in LS configuration "... BECOME NOT **have**/**be-located-at** (x,y)"

In addition to these specific semantic relations, RRG also posits two broader semantic relationsùnamely, actor and undergoerùwhich are generalizations across classes of argument positions in LSs. These semantic relations are refered to as macroroles, since each of them subsumes a number of specific semantic relations. For instance, the actor macrorole subsumes such narrower relations as agent and mover, and the undergoer macrorole subsumes such narrower relations as patient and theme. In short, the more agent-like an argument is, the more it qualifies as an actor, and the more patient-like an argument is, the more it qualifies as an undergoer. This is expressed in the actor-undergoer hierarchy shown below:

ACTOR UNDERGOER

---------->

<----------

Single arg of DO	1st arg of **do** (x, ...	1st arg of **pred** (x,y)	2nd arg of **pred** (x,y)	Single arg of state **pred** (x)

['----->' = increasing markedness of realization of argument as macrorole]

The motivation for positing these two macroroles is that each one captures a grouping of specific semantic relations which are treated alike for grammatical purposesùe.g., actors are typically realized as subjects of transitive clauses while undergoers are typically realized as objects of transitive clauses; undergoers can be realized as subjects in passive constructions; etc. Macroroles are important for determining the syntactic transitivity of verbs, i.e., the number of direct core arguments that a verb takes. Verbs that have two macroroles are transitive and hence take two direct core arguments (e.g. *toss, push*). Verbs that have one macrorole are intransitive and hence take only one direct core argument (e.g., *run, be sick*). For these verbs, the

nature of the macrorole is based on whether or not the verb has an activity predicate in its LS: if it does, the macrorole is actor (e.g., *run*); if it doesn't, the macrorole is undergoer (e.g., *be sick*). Finally, verbs that have no macrorole at all are atransitive (e.g., *rain, seem*). Since these verbs are exceptional, they are marked in the lexicon with the feature [MR0], which means zero macrorole. This feature has significant gramma-tical consequences, since it implies that none of the arguments in the LS of the verb can be syntactically realized as a direct core argument. Because English requires that all sentences contain a subject, atransitive verbs occur with the "dummy" subject *it* (e.g., *It is raining, It seems that Jeff is happy*). Alternatively, sentences with *seem* or *appear* can be structured in such a way that an argument which is semantically associated with the verb in the dependent core is syntactically realized as subject of the verb in the matrix core (e.g., *Jeff seems/appears to be happy*).

3.1.1.3 Syntactic Relations

With regard to the second major kind of relational structureùi.e., syntactic rela-tionsùRRG departs from traditional grammatical theory. Up to now I have referred to the common notion of syntactic subject, but this has been solely for expository purposes. RRG rejects the universality of subjects and replaces this notion with the notion of pivot. In all languages there are restrictions on which arguments can be involved in particular constructionsùe.g., verb agreement, reflexivization, relativization, control, raising, etc. The argument that plays a privileged role in a given construction is called the pivot of the construction. In some languages the role that the pivot plays is defined semantically in terms of macrorolesùe.g., in Acehnese (Austronesian, Sumatra) the omitted argu-ment in a control construction is always an actor, and the argument associated with the predicate in a resultative construction is always an undergoer. In most languages, however, the role that the pivot plays in a particular construction is defined in purely syntactic terms; in

other words, the distinction between actor and undergoer is neutral-ized for syntactic purposes.

Consider, for instance, the English raising sentences below:

a. Susan$_i$ seems ____$_i$ to be dancing.
b. Susan$_i$ seems ____$_i$ to be happy.
c. Susan$_i$ seems ____$_i$ to be winning the race.
d. *Susan$_i$ seems the man to have pushed ____$_i$.
e. Susan$_i$ seems ____$_i$ to have been pushed by the man.

In purely syntactic terms, the initial NP in the matrix core of all these sentences is coreferential with a missing argument in the embedded core, as notated by coindexation. There is a restriction, however, on what the missing argument can be. This restriction cannot be stated semantically in terms of macroroles, because in (a) and (c) the missing argument is an actor whereas in (b) and (e) it is an undergoer. The restriction can, however, be stated syntactically in terms of the positions of arguments in the embedded core, as the contrast between (d) and (e) indicates: in both sentences the missing argument is an undergoer, but in (d) the "gap" occurs in core-final position whereas in (e) it occurs in core-initial position. Thus, the pivot relationship for the English raising construction can be described as follows: the initial NP of the matrix core must correspond to the initial position of the embedded core.

It is worth noting that most languages have the same pivot for most constructions, and for this reason languages can be classified as either syntactically accusative (e.g., English) or syntactically ergative (e.g., Dyirbal): in syntactically accusative languages the default choice for pivot of a transitive clause is the actor, but in syntactically ergative languages the default choice for pivot of a transitive clause is the undergoer. These defaults can be overridden in certain marked constructionsùe.g., in syntactically accusative languages the passive construction selects the undergoer as pivot, and this is

signalled by special verb morphology; similarly, in syntactically ergative languages the antipassive construction selects the actor as pivot, and this too is signaled by special verb morphology.

A final point about syntactic relations is that grammatical phenomena that have traditionally been accounted for with reference to the notions of direct and indirect object are accounted for in RRG in terms of the notion of direct core argument. Since this point is not crucial for the issues that I will concentrate on later, I will not elaborate it further.

3.1.1.4 Linking

Before turning to the RRG approach to analyzing specific English construction types, there is one more feature of the general architecture of RRG that I must mentionùnamely, the theory of linking between syntax and semantics. This theory is shown below in Figure 10. According to this scheme, linking can be accomplished in two directions: from syntax to semantics, and from semantics to syntax. The former direction pertains to language comprehension and the latter to language production. Naturally, because the focus of this thesis is on comprehension, I will only be concerned with linking from syntax to semantics. This type of linking takes place in two stages: first, syntactic relations are linked to macroroles according to the pivot hierarchy; and second, macroroles are linked to argument positions in the LSs of specific verb classes according to the actor-undergoer hierarchy. Linking in simple as well as complex sentences is governed by a general principle called the Completeness Constraint, which states that every argument position in a verb's LS must be linked to an NP in the sen-tence containing the verb, and every NP in a sentence must be linked to an argument position in an LS.

SYNTACTIC RELATIONS: Pivot Direct Core Arguments Oblique Core Arguments

Pivot Hierarchy:
Actor > Undergoer (e.g., English)
Undergoer > Actor (e.g., Dyirbal)

SEMANTIC MACROROLES: Actor Undergoer

ACTOR UNDERGOER

---------->

<----------

Single arg of DO | 1st arg of **do** (x, ...) | 1st arg of **pred** (x,y) | 2nd arg of **pred** (x,y) | Single arg of state **pred** (x)

[increasing markedness of realization of argument as macrorole]

Transitivity = No. of Macroroles

Transitive = 2

Intransitive = 1

Atransitive = 0

Argument Positions in **LOGICAL STRUCTURE**

Verb Class	Logical Structure
State	**predicate** (x) or (x,y)
Activity (+/- agentive)	**do** (x, [**predicate** (x) or (x,y)])
Achievement	BECOME **predicate** (x) or (x,y)
Accomplishment	å CAUSE #, where å is normally an activity predicate and # an achievement predicate

Figure 10: System for Linking Syntactic and Semantic Representations

3.1.2 RRG Analyses of English Construction Types

The English construction types that I will be most concerned with in this thesis are shown in (1):

(1) a. transitive active: *Harry saw Sally.*
b. passive:
i. foregrounding: *Sally was seen.*
ii. backgrounding: *Sally was seen by Harry.*
c. relative clause:[3]
i. subject-subject relative: *The man that saw Sally knows me.*
ii. subject-object relative: *The man that Sally saw knows me.*
iii. object-subject relative: *I know the man that saw Sally.*
iv. object-object relative: *I know the man that Sally saw.*
d. cleft:

[3] Since RRG does not posit syntactic relations equivalent to the traditional notions of subject and object, the names for these constructionsù"subject-subject relative," "subject-object relative," etc.ùare technically inappropriate. I continue to use these names, however, because they are so familiar and because there aren't any replacement names in RRG. The same holds for the names of the cleft constructionsù"subject cleft" and "object cleft"ùand the raising constructionsù"subject-to-subject raising" and "object-to-subject raising."

i. subject cleft: *It was the man that saw Sally.*

ii. object cleft: *It was the man that Sally saw.*

e. raising-to-subject:

i. subject-to-subject raising:

a. canonical: *It seems to Harry that Sally is tall.*

b. noncanonical: *Sally seems to Harry to be tall.*

ii. object-to-subject raising:

a. canonical: *It's easy for Harry to see Sally.*

b. noncanonical: *Sally is easy for Harry to see.*

f. undergoer control:[4]

i. active matrix core: *Harry persuaded Sally to be nice.*

ii. passive matrix core: *Sally was persuaded by Harry to be nice.*

g. intransitive:

i. actor-intransitive: *Harry left.*

ii. undergoer-intransitive: *Harry drowned.*

3.1.2.1 Transitive Active

Consider first the transitive active construction exemplified in (1a). This construction is quite straightforward and is represented below in Figure 11:[5]

[4] Although it would seem natural to include the actor control construction as wellùe.g., *Harry promised Sally to be nice*ùI will not deal with this construction because there is only one verbùnamely, *promise*ùwhich occurs very frequently in this construction, and even when this verb is used, a *that* complement clause (e.g., *Harry promised Sally that he would be nice*) seems to be preferable to an infinitival comple-ment clause.

[5] In this and the following figures, I will suppress the nodes inside NPs (cf. Figure 3) unless there is a complex NP which requires that they be expressed. This is strictly to avoid needlessly cluttered

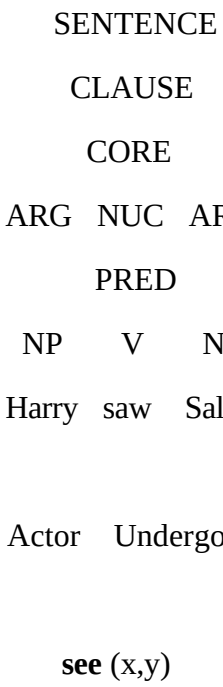


Figure 11: Representation of Transitive Active Construction

The clause consists of a single core, which in turn contains a nucleus for the verb and argument positions for the pivot NP *Harry* and for the direct core NP *Sally*. The predicate **see** has a state LS with two argument positions, one for a perceiver and another for a perceptual target. The linking between the NPs in the constituent structure and the argument positions in the LS is mediated by macroroles and takes place in two steps. First, NPs are linked to macroroles, and since the verb is in the active voice this linking follows the default pattern: the pivot NP *Harry* is linked to the actor macrorole, and the direct core NP *Sally* is linked to the undergoer macrorole. Second, macroroles are linked to argument positions in the LS of the predicate according to the actor-undergoer hierarchy: the actor macrorole is linked to the first argument position, and the undergoer macrorole is linked to the second argument position. Thus, the transitive active construction has a perfectly canonical linking pattern.

3.1.2.2 Passive

By contrast, the distinguishing feature of passive constructions in general is that they involve a noncanonical linking pattern which is signaled by special morphological markers. Two different types of passive construction are exemplified in (1b); since the construction in (b-ii) is identical to the one in (b-i) except for the addition of a *by*-phrase, only (b-ii) is illustrated below in Figure 12:

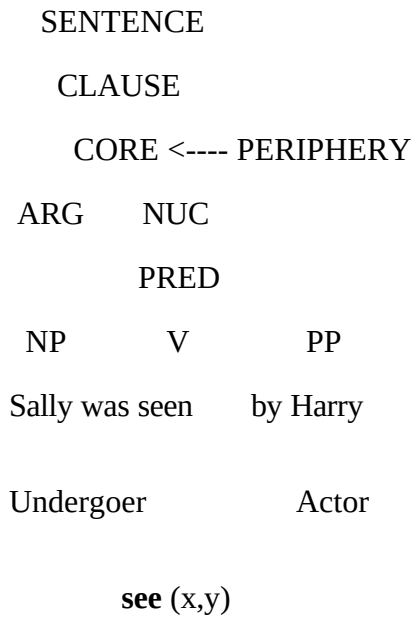


Figure 12: Representation of Backgrounding Passive Construction

The clause consists of a single core, which in turn contains a nucleus for the verb and an argument position for the pivot NP *Sally*. In addition, the core has an attached periphery for the PP *by Harry*. As in the transitive active sentence above, the predicate **see** contains a perceiver argument and a perceptual target argument, and the linking between NPs and argument positions in the LS is mediated by macroroles. Unlike in the transitive active construction, however, here the first stage of the linking processùi.e., between

NPs and macrorolesùdoes not follow the default pattern, since the verb is in the passive voice. The passive morphology signals explicitly that the pivot NP *Sally* is not linked to the actor macrorole but is instead linked to the undergoer macrorole. Furthermore, the preposition *by* in the periphery signals explicitly that the oblique NP *Harry* is linked to the actor macrorole. The second stage of the linking processùi.e., between macroroles and argument positions in the LSùis the same as in the transitive active sentence: the actor macrorole is linked to the first argument position, and the undergoer macrorole is linked to the second argument position. The construction in (b-i) is unique in that it lacks a *by*-phrase; it is called a foregrounding passive because its sole function is to promote the undergoer to pivot status. On the other hand, the distinctive feature of the construction in (b-ii) is that it includes a *by*-phrase; it is called a back-grounding passive because, in addition to promoting the undergoer to pivot status, it demotes the actor to oblique status.

3.1.2.3 Relative Clauses and Clefts

Consider now the relative clause and cleft constructions exemplified in (1c) and (1d). RRG treats relatives and clefts as being similar in some respects and different in other respects. The major difference is pragmatic in nature. On the one hand, cleft constructions involve marked narrow focus in the following sense. Narrow focus typically falls on the final argument of a core, so that in the sentence *The man saw Sally* narrow focus falls on *Sally* by default. In order to give narrow focus to *the man,* it is necessary for this NP to be realized as a core-final argument. This in turn requires that the rest of the proposition be realized in a peripheral clause and that the pivot of the matrix core be filled in by the dummy NP *it,* yielding the subject cleft sentence *It was the man that saw Sally.* By using this grammatical construction, the speaker presupposes that someone saw Sally and asserts that this individual was the man. On the other hand, the speaker

of a sentence with a relative clause like *The man that saw Sally knows me* presumably assumes that the simple NP *the man* does not provide the addressee with sufficient information to identify the man in question, so the restricting clause *that saw Sally* is added to indicate precisely which man is being referred to. Thus, with regard to pragmatics, the speaker presupposes that the man saw Sally and asserts that this man knows me.

Relative clause and cleft constructions are similar in that they contain the same kind of complex NP. This can easily be seen in the sentences in (1c) and (1d), which are reproduced below for convenience:

relative clause:

i. subject-subject relative: *[The man that saw Sally] knows me.*
ii. subject-object relative: *[The man that Sally saw] knows me.*
iii. object-subject relative: *I know [the man that saw Sally.]*
iv. object-object relative: *I know [the man that Sally saw.]*

cleft:

i. subject cleft: *It was [the man that saw Sally.]*
ii. object cleft: *It was [the man that Sally saw.]*

As the bracketings make clear, the subject-subject relative in (1c-i), object-subject relative in (1c-iii) and subject cleft in (1d-i) have in common the complex NP *the man that saw Sally*, and the subject-object relative in (1c-ii), object-object relative in (1c-iv), and object cleft in (1d-ii) have in common the complex NP *the man that Sally saw*. The constituent structures and LSs of these two complex NPs are shown below in Figure 13:

NP	NP
$CORE_N$ <----------PERIPHERY	$CORE_N$ <----------PERIPHERY
NUC_N CMPL---> CLAUSE	NUC_N CMPL---> CLAUSE

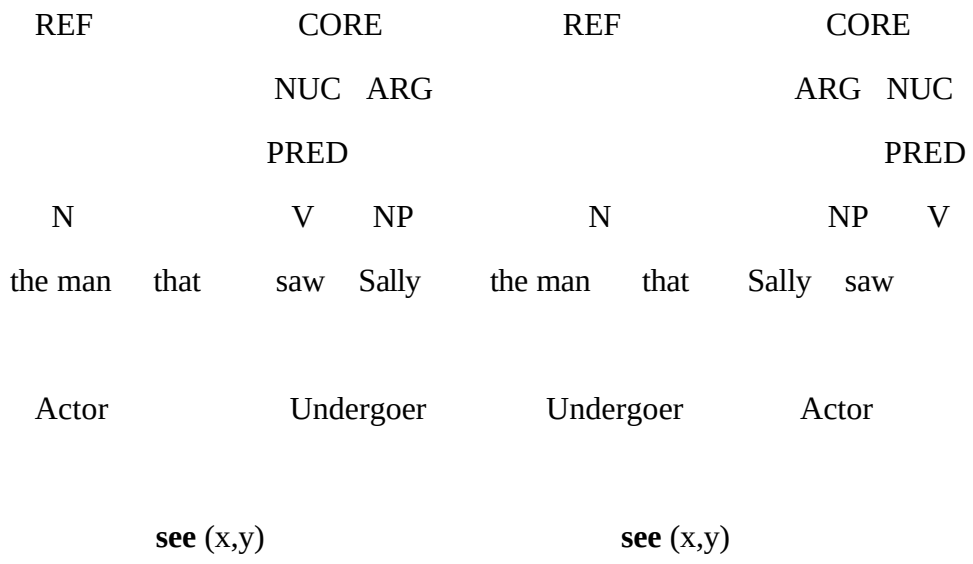


Figure 13: Representation of Complex NPs of Relative Clause and Cleft Constructions

Each of the trees in Figure 13 has the following two parts: first, the head NP *the man*, and second, a periphery which is attached to the $CORE_N$ of the head NP and which contains an embedded clause that modifies it. The embedded clause itself consists of a core with a nucleus and a single argument position. As before, the LS of **see** has two argument positions, and linking is mediated by macroroles. Within the embedded clause, linking follows the typical pattern, since the verb is in the active voice: in the left-hand figure the core-final NP is linked to the undergoer macrorole, which in turn is linked to the second argument position in the LS; and in the right-hand figure the core-initial NP is linked to the actor macrorole, which in turn is linked to the first argument position in the LS. In each complex NP, this leaves the head NP *the man* unlinked to an argument position in the LS, and an argument position in the LS unlinked to an NP. In order to prevent a violation of the Completeness Constraint, these two elements are linked together. Thus, in the left-hand figure the head NP is linked to the actor macro-role, which in turn is linked to the first argument position in the LS; and in the right-hand figure the head NP is linked to the undergoer macrorole, which in turn is linked to the

second argument position in the LS. In the left-hand complex NP the ordering of arguments in relation to the verb is like the ordering in the transitive active construc-tionùi.e., actor - predicate - undergoerùand for this reason the complex NP has a canonical linking pattern. By contrast, in the right-hand complex NP the ordering of arguments in relation to the verb is atypicalùi.e., undergoer - actor - predicateùand for this reason the complex NP has a noncanonical linking pattern.

Before moving on to the next set of constructions, a few remarks are in order about the larger syntactic contexts in which these two types of complex NP can occur. In the relative clause and cleft constructions exemplified in (1c) and (1d), the complex NP is a constituent of the matrix clause: in the subject-subject relative (1c-i) and subject-object relative (1c-ii), the head of the complex NP functions as the pivot of the matrix clause; and in the object-subject relative (1c-iii), object-object relative (1c-iv), and both clefts, the head of the complex NP functions as the direct core argument of the matrix clause. Thus, in all of these constructions the head of the complex NP is linked not only to an argument position in the LS of the predicate in the peripheral clause, but also to an argument position in the LS of the predicate in the matrix clause. The following examples should make this clear: in the sentence *The man that saw Sally knows me,* the NP *the man* is actor of both *saw* and *knows;* in the sentence *The man that Sally saw knows me,* the NP *the man* is undergoer of *saw* but actor of *knows;* in the sentence *I know the man that saw Sally,* the NP *the man* is undergoer of *know* and actor of *saw;* finally, in the sentence *I know the man that Sally saw,* the NP *the man* is undergoer of both *know* and *saw.*

3.1.2.4 Raising-to-Subject

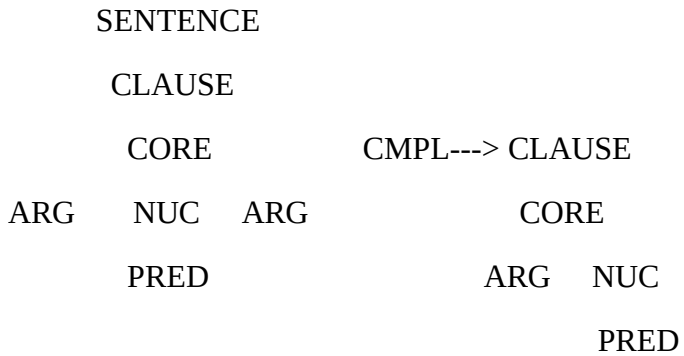
I shift now to the raising-to-subject constructions in (1e); the representative sentences are reproduced below for ease of reference:

raising-to-subject:

i. subject-to-subject raising (SS):
   a. canonical: *It seems to Harry that Sally is tall.*
   b. noncanonical: *Sally seems to Harry to be tall.*

ii. object-to-subject raising (OS):
   a. canonical: *It's easy for Harry to see Sally.*
   b. noncanonical: *Sally is easy for Harry to see.*

I will describe the structure and linking pattern of each of these constructions individually, starting with the canonical SS construction, which is shown in Figure 14. The matrix clause has two components: first, it has a core which consists of a nucleus and two argument positions; and second, it has an embedded clause which consists of a core with a nucleus and a single argument position. As I mentioned briefly in the discussion of semantic relations in section 3.1.1.2, the predicate **seem** is marked with the feature [0MR]. This feature indicates that neither of the predicate's two semantic argumentsùan experiencer and a propositionùhas macrorole status, which in turn indicates that neither of these arguments can be syntactically realized as pivot (cf. **Harry seems that Sally is nice, *That Sally is nice seems to Harry*). Thus, the pivot position in the canonical SS construction is occupied by the dummy NP *it.* The predicate's experiencer argument is then realized as the oblique core NP *Harry* (object of the preposition *to*), and the predicate's proposition argument is realized as an embedded clause. Because



NP	V	PP		NP	V
It	seems	to Harry	that	Sally	is nice

Undergoer

seem (x, [**be nice** (y)]) [0MR]

Figure 14: Representation of Canonical SS Raising Construction

seem does not have any macroroles, the linking between the oblique core NP and the experiencer argument is unmediated. However, the proposition **be nice** (y), which fills the proposition slot in the LS of **seem**, does allow its single argument to have macrorole status. Hence the linking between the NP in the embedded clause and the single argument position in the predicate **be nice** is accomplished in a straightforward manner via the undergoer macrorole.

The noncanonical SS construction is represented in Figure 15. The clause contains two coresùa matrix core which itself consists of a nucleus and two argument positions, and an embedded core which has just a nucleus. As with the canonical SS raising construction, the fact that **seem** carries the feature [0MR] means that neither of its two semantic arguments can be realized as pivot. Thus, as before, the experiencer argument is realized as an oblique core NP (object of *to*), and the linking is not mediated by a

SENTENCE

CLAUSE

CORE			CMPL---> CORE
ARG	NUC	ARG	NUC
	PRED		PRED

NP V PP V

Sally seems to Harry to be nice

Undergoer

seem (x, [**be nice** (y)]) [0MR]

Figure 15: Representation of Noncanonical SS Raising Construction

macrorole. The difference between the canonical and noncanonical constructions lies in how the pivot is treated. Here the position is not filled by the dummy NP *it* but rather by an argument of the predicate within the proposition slot of **seem**. If this predicate contains only a single argument, as with **be nice**, then this argument is realized as the pivot; but if the predicate contains two or more arguments, the one that is realized as the pivot is the one that would normally be realized in the preverbal position of the embedded core (cf. *Karen*$_i$ *seems* ____$_i$ *to like Jeff* vs. **Karen*$_i$ *seems Jeff to like* ____$_i$). In the sentence represented in Figure 15, the linking between the pivot NP *Sally* and the argument of **be nice** is mediated by the undergoer macrorole, since this predicate is not marked by the feature [0MR]. In summary, the distinguishing characteristic of the non-canonical SS raising construction is that a semantic argument that would normally be realized as an NP in the initial position of the embedded core is instead realized as the pivot NP of the matrix core; the argument metaphorically "raises up" to this higher syntactic position, and as a result the embedded core lacks an NP position for it.

Now consider the canonical and noncanonical OS constructions. The canonical construction is shown in Figure 16:

SENTENCE

CLAUSE

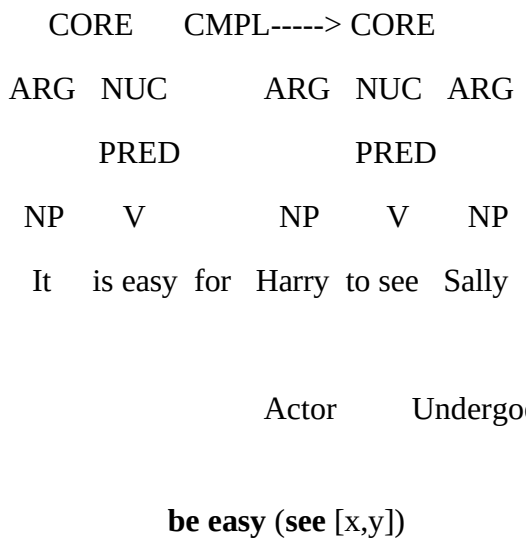


Figure 16: Representation of Canonical OS Raising Construction

The clause in this construction has two coresùa matrix core with a nucleus and one argument position, and an embedded core with a nucleus and two argument positions. The predicate **be easy** takes a proposition argument which is instantiated here by **see** (x,y). Since **be easy** is not marked with the feature [0MR], it is possible for the proposition to be realized as a complex pivot (e.g., *For Harry to see Sally is easy*). But in the OS construction in Figure 16, an alternative linking pattern is used where the proposition is realized as an embedded core and the pivot position is filled by the dummy NP *it.* Because the predicate in the embedded core is in the active voice, the linking between NPs and argument positions in the predicate's LS is accomplished in the standard fashion via macroroles. Thus, the core-initial NP *Harry* is linked to the actor macrorole, which in turn is linked to the predicate's first position; and the core-final NP *Sally* is linked to the undergoer macrorole, which in turn is linked to the predicate's second position.

The noncanonical OS construction is represented in Figure 17:

SENTENCE

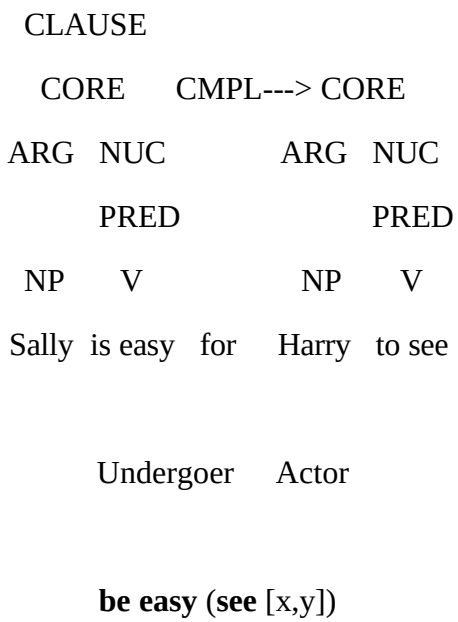


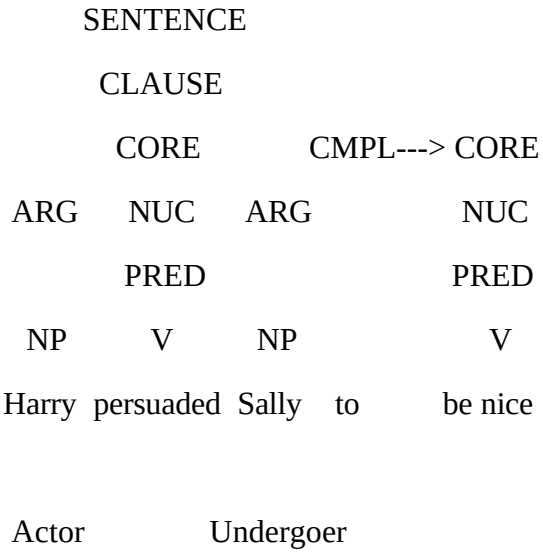
Figure 17: Representation of Noncanonical OS Raising Construction

The clause contains two cores, both of which have a nucleus and a single argument position. The matrix predicate is **be easy**, and its proposition argument is instantiated by **see** (x,y), just as in the sentence shown in Figure 16. The difference between that sentence and the one shown in Figure 17 is that here the proposition **see** (x,y) does not map completely into the embedded core. The proposition's first argument and predicate do in fact correspond to the initial NP and verb of the embedded core; in addition, because the verb is in the active voice, the linking between the semantic argument and the NP position is mediated by the actor macrorole. However, the second argument of the proposition is not realized as the final NP of the embedded core but is instead realized as the pivot NP of the matrix core and is linked to this position via the undergoer macrorole. The argument metaphorically "raises up" to this higher syntactic position, just like the first argument of the proposition in the noncanonical SS construction. Indeed, the noncanonical SS and OS constructions are quite similar, the only significant difference

having to do with which argument of the proposition "raises up" to the pivot positionùthe first argument in the SS construction, and the second argument in the OS construc-tion.

3.1.2.5 Undergoer Control

The next construction that I will consider is the undergoer control construction, which is exemplified by the sentence *Harry persuaded Sally to be nice.* This construc-tion is shown in Figure 18:



persuade': [**do** (x, [**say** (x,y)])] CAUSE [BECOME **be nice** (z)]

Figure 18: Representation of Undergoer Control Construction

The clause contains two coresùa matrix core which has a nucleus and two argument positions, and an embedded core which has just a nucleus. The LS of **persuade** has three argument positions: one for the persuader, another for the person being persuaded, and a third for the proposition expressing what the second person is persuaded to do; in the sentence represented above, this third argument position is filled by the proposition **be**

nice (z). Since the matrix verb is in the active voice, the linking between the NPs in the matrix core and the first two argument positions in the LS of **persuade** is accom-plished in a standard manner: the pivot NP *Harry* is linked to the actor macrorole, which in turn is linked to the first argument position in the LS; and the direct core NP *Sally* is linked to the undergoer macrorole, which in turn is linked to the second argu-ment position in the LS. This leaves the single argument position of **be nice** unlinked to an NP. The solution to this problem is that one of the two NPs in the matrix core is linked not only to an argument position in the LS of the matrix verb, but also to the single argument position in the LS of the embedded verb. Which macrorole serves this functionùa function referred to as "control"ùis determined by the semantic properties of the matrix verb. This is captured in the RRG "theory of control," which states that causative change-of-state verbs and directive speech-act verbs (i.e., jussives) have undergoer control, and all other verbs have actor control. Note that, according to this theory, it is the macrorole that is relevant to control, not its specific syntactic realization in the matrix core. This is shown by the fact that if the sentence represented in Figure 18 is passivized so that the undergoer NP *Sally* is associated not with the direct core position but rather with the pivot positionù*Sally was persuaded by Harry to be nice*ù it is still the undergoer NP that controls the single argument of **be nice**. Another impor-tant feature of the undergoer control construction is that when the verb in the embedded core has more than one argument in its LS, the argument that is controlled by the under-goer of the matrix core is the one that would otherwise be syntactically realized as the initial NP of the embedded core; this is true regardless of whether the argument is an actor or an undergoer with respect to the LS of the embedded verb (e.g., *Harry allowed Sally$_i$ [____$_i$ to visit Kim]; Harry allowed Sally$_i$ [____$_i$ to be visited by Kim]; *Harry allowed Sally$_i$ [Kim to visit____$_i$]*).

3.1.2.6 Intransitives

The last two constructions that I will consider are the actor and undergoer intransitive constructions, which are exemplified in (1g); these sentences are reproduced below and illustrated in Figure 19.

i. actor intransitive: Harry left.
ii. undergoer intransitive: Harry died.

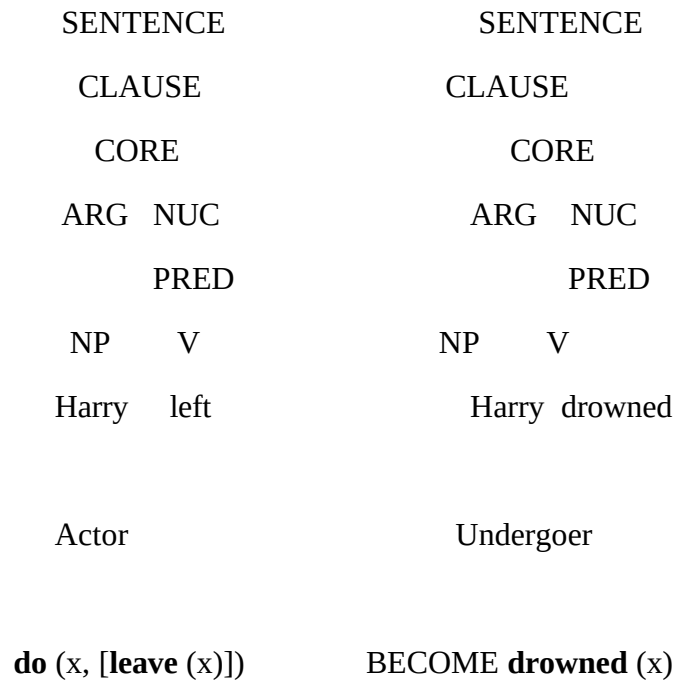


Figure 19: Representation of Actor and Undergoer Intransitive Constructions

Both clauses contain a single core which has a nucleus and a single argument position. The difference between the two constructions lies in the LSs and the nature of the macroroles that are linked to the NPs. According to the actor-undergoer hierarchy, the argument of **do**, which dominates all activity predicates regardless of whether or not they are agentive, is a prototypical case of an actor. This means that the NP of an intransitive sentence with an activity predicate will always take the actor macrorole, as shown in the

left-hand figure above. By contrast, the actor-undergoer hierarchy indi-cates that the single argument of a state predicate is a prototypical undergoer. Hence, the NP of an intransitive sentence with a state predicate (or with an achievement predicate that derives from a state predicate) will always be linked to the undergoer macrorole, as shown in the right-hand figure above. It is noteworthy that the linking pattern in the actor intransitive construction can be considered canonical, since in general the pivot NP of an English sentence usually corresponds to the actor macrorole; on the other hand, the linking pattern in the undergoer intransitive construction can be considered noncanonical, since it deviates from the normal situation.

3.2 Processing

The previous section focused on the abstract nature of the computational problem that the syntactic comprehension system must solve. The goal there was to specify in terms of a well-motivated grammatical theoryùnamely, RRGùthe syntactic and semantic structures, as well as the syntactic-semantic linking patterns, of several different types of English constructions. In this section I move on to the next level of analysis, which concerns the on-line processing operations and resources that are dedi-cated to assembling syntactic and semantic structures and to linking the former to the latter. My goal here is to provide RRG-based characterizations of the operations and