# Grammatical Relations, Thematic Roles and Verb Semantics

Antonio Sanfilippo

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**Abstract**

Grammatical relations have always constituted a primary focus of attention in the study of language. Within the last three decades, the topicality of this trend has increasingly been determined by the quest for a universal characterization of the language faculty which has shaped the goals and directives of most current works in theoretical linguistics. Although the realization patterns and syntactic functionality of grammatical relations are subject to cross-linguistic variation, studies in comparative grammar have provided suggestive evidence that the range of variation found can often be contained within the limits fixed by a discrete set of parameters. The investigation of these parameters has broached the possibility of a universal specification of the nature of grammatical relations. This thesis proposes that such a specification should be achieved by establishing regularities in the syntax-semantics interface within a constraint-based approach to linguistic analysis that integrates a precise computational interpretation. In keeping with this objective, a unification-based categorial grammar framework is developed which incorporates the semantic insights of a Neo-Davidsonian approach to verb semantics and predicate-argument combination, where thematic roles are defined as clusters of entailments of verb meanings. This framework is extended with an integrated approach to argument selection and selection change. Properties of the resulting system are demonstrated with respect to a variety of natural language phenomena concerning grammatical function changing, unaccusativity and clitic dislocation.

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# Contents

# Chapter 1

# Introduction

Grammatical relations have always constituted a primary focus of attention in the study of language. Within the last three decades, the topicality of this trend has increasingly been determined by the quest for a universal characterization of the language faculty which has shaped the goals and directives of most current works in theoretical linguistics. Although the realization patterns and syntactic functionality of grammatical relations are subject to cross-linguistic variation, studies in comparative grammar have provided suggestive evidence that the range of variation found can often be contained within the limits fixed by a discrete set of parameters. The investigation of these parameters has broached the possibility of a universal specification of the nature of grammatical relations. This thesis proposes that such a specification should be achieved by establishing regularities in the syntax-semantics interface within a constraint-based approach to linguistic analysis which has a precise computational interpretation.

The basic motivation for adopting a semantic perspective is that grammatical relations express, in the form of syntactic dependencies, combinatory relations which form the basis for semantic compositionality. Moreover, these syntactic dependencies are in co-variation with semantic properties which characterize the argument roles of lexical predicates. The interpretation of the sentence "John loves Mary madly", for example, involves the identification of "John" and "Mary" as the *lover* and *loved* arguments of the predicate "love", and the individuation of "madly" as a modifier of the eventuality denoted by "love". The verification of these semantic relations proceeds according to the recognition of syntactic dependencies such as *subject*, *object* and *adjunct* which are established on the basis of word order and/or inflectional and derivational morphology.

From this vantage point, the major concern of the thesis is to build an approach to verb semantics and category specification where these correspondences can be given a clear interpretation. This approach is developed within the context of a unification-based categorial grammar which integrates an event system of semantic interpretation where verbs are treated as predicates of eventualities. The arguments of a verb are represented as thematic restrictions on the eventuality denoted by the verb, and expressed through relations between eventualities and individuals which are entailed by the meaning of the verb. Grammatical relations such as subject, direct object, and indirect/oblique object are induced by argument selection constraints which express cross-linguistic generalizations about the syntactic realization of thematic entailments of verbs. These generalizations are implemented in the form of linking conventions which relate the thematic and subcategorization structures of predicates. This approach makes it possible to capture the correspondence between syntactic and semantic dependencies which relate grammatical relations to compositionality in a direct way. For example, the syntactic distinction between adjuncts and arguments is related to the contrasts between adverbial modification, where no reference to the thematic entailments of a verb is made, and a mode of semantic combination where the satisfaction of thematic entailments is a prerequisite to compositionality. The co-variation between grammatical relations and lexical properties of predicates is also expressed in terms of thematic entailments, by establishing a relation between the hierarchy of roles — expressed in terms of agentivity — and the ordering of syntactic arguments in the subcategorization frame of verbs.

The concern for a constraint-based approach to linguistic analysis constitutes another major theme of this thesis. This concern is essentially motivated by the need to introduce an explanatory perspective and to endow such a perspective with a sound logical foundation. Within the constraint-based model of grammar envisaged in this thesis, these goals are achieved by restricting grammar rules to those operations which can be expressed in terms of *unification*. A unification-based approach confines grammar rules to information-preserving operations. This restriction makes it possible to develop an integrated model of grammar where the process of assembling linguistic information into structured representations of form and content is characterized as the merger of partial information structures which mutually constrain the range of representations attainable. Because unification is information-preserving, the regime of constraint-interaction it induces is purely declarative and therefore devoid of any arbitrariness, once the content of rules is specified. By contrasts, an approach where grammar rules are allowed to operate in a destructive fashion is hard to constrain and thus unsuitable to provide an explanatory account. Consider, for example, an approach to grammatical function changing which is not information-preserving. A first element of arbitrariness derives from the fact that the initial assignment of grammatical relations is defeasible. Within an approach of this type, for example, passive might be formulated as a rule which makes the initial subject into an oblique object and the initial object into a subject. Consequently, constraints on grammatical function changing have to be stated independently of argument selection principles which govern the initial assignment of grammatical relations. A second element of arbitrariness is induced by the possibility of serializing relation changes, as in the case of morphosyntactic interactions. Because a priori any assignment of grammatical relations is defeasible, whether emerging from argument selection or through grammatical function changing, a characterization of the range of possible relation changing operations can only be attained through arbitrary stipulations. Within a unification-based approach, relation changing operations are instead most naturally expressed as operations which add constraints on argument selection in a declarative fashion. The approach to relation changing developed in this thesis proposes to realize such a treatment by underspecifying the initial assignment of grammatical relations, and encoding argument selection constraints which encode restrictions on role realization as filters on the output of (sequences of) lexical rules. The range of admissible relation changing operations can thus be defined as the set of functional instantiations which are compatible with the restrictions imposed by argument selection constraints.

Alongside with its potential for explanatory power, a constraint-based approach to linguistic analysis which uses unification provides a formalism for grammar development which has a clear semantics and is computationally tractable. These properties make it possible to build grammars which have a solid logical foundation and which can be efficiently tested through implementation.

The thesis is organized in two major parts. The first two chapters contain an overview of current works in theoretical linguistics and logical semantics which address issues germane to the topics discussed in the thesis. In chapter 2, a critical review is provided of the theories of grammatical relation and relation changing developed in Government and Binding, Lexical-Functional Grammar and Categorial Grammar with specific reference to the approaches proposed by [Williams 80], [Chomsky 81], [Williams 81a], [Zubizarreta 85], [Di Sciullo & Williams 87], [Baker 88], [Bresnan & Kanerva 88], [Dowty 82a] and [Dowty 82b]. The chapter includes a discussion of data from Chichewa, Chimwiini, English, French, Italian, Japanese, Turkish and Welsh which provide topical examples of the issues at stake and which exemplify the strengths and weaknesses of these approaches. In chapter 3, questions concerning the encoding of thematic information are examined in light of the model-theoretic accounts proposed by [Parsons 80], [Carlson 84], and [Dowty 89]. The chapter concludes with a proposal concerning the definition of role content within the event-based system of semantic interpretation of [Parsons 80] which integrates Dowty's characterization of thematic roles as semantic defaults ([Dowty 87]).

In the last four chapters, a grammar framework is developed which combines a categorial treatment of grammatical relations and relation changing with a constraint-based approach to linguistic analysis; various properties of this system are demonstrated with respect a number of natural language phenomena, including those discussed in chapter 2. Chapter 4 opens with a preliminary discussion of unification and categorial grammar. In §4.2, a detailed description of the Unification Categorial Grammar framework of [Zeevat *et al.* 87] is given. In §4.3, this grammar framework is combined with a system of semantic interpretation modelled after the neo-Davidsonian framework of [Parsons 80]. Parson's treatment of verb semantics is augmented with the definition of role content developed in chapter 3 and a specification of lexical meaning according to which the participant roles entailed by a verb are represented as restrictions on event quantification. The resulting approach is shown to provide adequate ways to express thematic and subcategorization properties of verbs across languages. The chapter concludes with a detailed description of how the approach to argument selection and grammatical relations developed in [Dowty 82a], [Dowty 82b] and [Dowty 87] is implemented within the Unification Categorial Grammar framework in question. Chapter 5 presents an integrated approach to argument selection and relation changing. The chapter provides an account of several relation changing phenomena including passive, inchoative and complex predicate formation, and a detailed treatment of rule interactions involving causative formation; sample rules and derivations are provided for Chichewa, Chimwiini, English, Eskimo, and Italian. Questions concerning the syntax-lexicon interface are also dealt with in light of both cross-linguistic and language-specific issues. Chapter 6 explores the interface of thematic and aspectual information in verb semantics with reference to the approaches developed by [Verkuyl 89] and [Krifka 87]. A characterization of unaccusativity is provided where the partial object functionality attributed to the subject of some verbs under the Unaccusative Hypothesis ([Perlmutter 78]) is derived by establishing appropriate transfer relations between nominal and event reference. The subject of an unaccusative verb is characterized as an argument linked to a participant role which allows the reference properties of the subject nominal to contribute to the internal temporal constitution of the event denoted by the verb. The consequences of this approach are explored with specific reference to auxiliary selection in Dutch and Italian. Finally in chapter 7, the approach to verb semantics and predicate-argument combination developed in the thesis is shown to provide a natural account of discontinuous and long distance dependencies which are recalcitrant to an extraction analysis. The chapter presents a treatment of clitic doubling and clitic dislocation for Italian which can be profitably applied to null-subject phenomena and which can be easily parametrized to account for analogous phenomena in other languages. The extensions introduced to account for cross-linguistic differences regarding sensitivity to island constraints provide a functional classification of phrasal types where the traditional contrast between arguments and adjuncts is enriched with a linguistically motivated range of intermediate types of dependencies.

# Chapter 2

# Grammatical Relations and Relation Changing: An Overview

The goal of this chapter is to present a review of trends and issues in theoretical linguistics which have characterized the development of current approaches to Grammatical Relations and Relation Changing (henceforth GRs and GR-changing). From a pre-theoretical viewpoint, the general goal of these approaches has been to establish a systematic link between the syntactic realization of arguments and their encoding in lexical structure. In most cases, if not all, this enterprise has relied on the assumption that there is a strong correlation between the lexical properties of predicates (e.g. selectional restrictions), and the ways in which argument selection and selection changing proceed. This correlation has been captured by generalizing argument types across predicates in terms of thematic relations. From a theoretical perspective, a considerable amount of effort has been devoted to relating generalizations about argument selection and selection changing to specific grammar frameworks. Three main orientations have emerged according to whether GRs are:

- reduced to constituency relations between phrase markers;
- defined as primitive elements of the grammar, or
- derived from the semantic constituency of predicates.

In giving an overview of the theories of GRs emerging from these three orientations, I will concentrate on the approaches to GRs and GR-changing recently developed within Government and Binding (GB), Lexical Functional Grammar (LFG), and Categorial Grammar (CG). The structure of the chapter is as follows. In §2.1, the phrase structure-based approach to GRs and GR-changing developed in GB is discussed with reference to Williams' work on argument structure and predication, and Baker's theory of incorporation. In §2.2, a review of the *Lexical Mapping Theory* recently developed within LFG by Bresnan and her associates is presented. The chapter concludes with a discussion of Dowty's characterization of GR and GR-changing in CG in the light of his later treatment of argument selection based on a default treatment of thematic information.

## 2.1 Phrase Structure-Based Approaches to Grammatical Relations and Relation Changing

The practice of reducing GRs to constituency relations between phrase markers dates back to Chomsky's dissertation ([Chomsky 55]), and was described in some detail in *Aspects* ([Chomsky 65]). There Chomsky proposed that information about grammatical relations should be given directly by the system of rewriting rules generating D(eep)-structure phrase markers. Categorial rules of the form "S → VP NP" and "VP → V NP" were associated with relational expressions of dominance such as "[NP,S]" and "[NP,VP]" indicating that the NP most immediately dominated by S bears the *subject-of* relation with respect to S, and that the NP most immediately dominated by VP bears the *object-of* relation within the VP. In the GB framework this approach to GRs was incorporated into the notion of *θ-marking* ([Chomsky 81]). According to this later formulation, the syntactic realization of arguments at D-structure is characterized in terms of assignment of thematic roles (θ-roles). Such assignment is essentially determined by dominance relations expressing basic grammatical functions, and intrinsic lexical properties of lexical items which are heads of phrasal categories. For example the assignment of θ-roles to *John* and *Bill* in a sentence like *John chased Bill* is seen as arising from the fact that at D-structure *John* is "[NP,S]", *Bill* "[NP,VP]", and the verb *chase* — the head of the VP — assigns its agent role to the NP which bears the "subject-of" relation, and its patient role to the NP which bears the "object-of" relation.

In addition to the configurational structure which determines GRs at D-structure, new constituency relations may be established at S-structure through movement which create the structural conditions for the emergence of secondary GRs. Consider the case of a passive sentence as in (2-1).

(2-1) Bill was chased

On the assumption that passive has the properties stated in (2-2) ([Chomsky 81], p. 124), the D-structure of (2-1) will be as in (2-3).

(2-2) a [NP,S] does not receive a $\theta$-role
b [NP,VP] does not receive Case within VP

(2-3) $[_S[_{NP}$ e] INFL $[_{VP}$ be chase Bill]]

In (2-3) the NP most immediately dominated by S is assigned case, but is not in a position of $\theta$-assignment. According to the *$\theta$-criterion* this NP must be a non-argument (i.e. empty) in D-structure:[1]

(2-4) *$\theta$-criterion*
Each argument bears one and only one $\theta$-role, and each $\theta$-role is assigned to one and only one argument. ([Chomsky 81], p. 36)

Since a passivized verb may not assign case to its object (cf. (2-2b)) the D-structure object in (2-3b) must move into a position of case assignment to satisfy the requirements of the *case filter*:

(2-5) *Case Filter*
Every lexical NP must be assigned case

By the $\theta$-criterion, this caseless NP may only move into a non-thematic position since it has already received a $\theta$-role. The empty NP in (2-3) provides a suitable landing site for the caseless object phase: it is a case-marked position,[2] but does not have a $\theta$-role of its own. After movement of the caseless object into subject position the passive sentence in (2-1) will be as in (2-6).

(2-6) $[_S[_{NP}$ Bill$_i$] INFL $[_{VP}$ be chase $t_i$]]

In (2-6) the "[NP,VP]" relation which determines the correct $\theta$-role assignment for *Bill*

[1]The structural encoding of a non-argument subject NP in D-structure would be a consequence of the *Extended Projection Principle* ([Chomsky 82], [Chomsky 86a]) which requires every clause to have a subject, whether the subject is thematic or not.

[2]INFL[+tense] assigns case to its governing NP.

at D-structure is still recoverable from the indexing relation between the moved NP and the trace inside the VP. In addition, NP movement in (2-6) creates a new configuration where the D-structure object NP *Bill* is an immediate constituent of S (i.e. "[NP,S]"). Can this newly established configuration be regarded as giving rise to a secondary (e.g. non-thematic) GR?

[Chomsky 81] argues that both thematic and non-thematic GRs (GF-$\theta$s and GF-$\bar{\theta}$s) are needed. For example, non-thematic GRs such as the "[NP,S]" relation in (2-6) appear to play a determinant role in the assignment of a proper antecedent to reflexive anaphors. Consider the following example. In GB, the two sentences in (2-7) are usually assigned the same basic D-structure source schematically shown in (2-8).

(2-7) a They seem to each other to be happy
b *It seems to each other thay they are happy

(2-8) $[_{S_1}[_{NP}$ e] INFL $[_{VP}$ seem $[_{PP}$ to each other] $[_{S_2}[_{NP}$ they] INFL $[_{VP}$ be happy]]]]

Yet only in (2-7a) can the complement subject NP *they* serve as a proper antecedent for the anaphoric expression *each other*. Chomsky suggests that the contrast between the two sentences is due to the ability of the antecedent pronoun in (2-7a) to function as a (non-thematic) subject; such option is not available in (2-7b) where the intended pronoun antecedent (i.e. *they*) is an object both at deep and surface structure. As in the passive case, the NP most immediately dominated by $S_1$ in (2-8) is a non-argument position which receives case but is not assigned a $\theta$-role (e.g. raising verbs may only assign a $\theta$-role to their D-structure objects). This NP may thus serve as a landing site for a $\theta$-marked NP which needs case to satisfy the requirements of the *case-filter*. If the sentential complement of *seem* is tensed, no movement of the complement subject into the matrix subject position is necessary to satisfy the *case-filter* (the complement verb may assign case to its subject when tensed). In this case the non-thematic matrix subject position is filled with the pleonastic element *it* as in (2-9a).

(2-9) It seems to Bill that they are happy

If the sentential complement of *seem* is untensed as in (2-6a), the embedded subject does not receive case *in situ*[3] and must move to the matrix subject position to satisfy the *case filter* as indicated in (2-12). In this case, the moved NP (i.e. *they*) counts

[3] INFL[-tense] does not assign case to its governing NP.

as a subject for the matrix S-node containing the anaphoric expression, e.g. the NP in question bears the "[NP,S]" relation in (2-12). This newly aquired secondary GR establishes a structural configuration — i.e. *c-command*[4] — which allows the NP to function as an antecedent for the anaphor. Secondary GRs are therefore essential in the treatment of reflexive binding.

(2-10) [$_{S_1}$[$_{NP}$ They$_i$] INFL [$_{VP}$ seem [$_{PP}$ to each other] [$_{S_2}$[$_{NP}$ t$_i$] INFL [$_{VP}$ be happy]]]]

Summarizing, Chomsky's account of GRs consists in identifying structural relations of dominance such as "[NP,S]" and "[NP,VP]" which define thematic GRs at D-structure, and secondary (i.e. non-thematic) GRs at S-structure. Secondary GRs result from movement operations at S-structure induced by the *case filter*. Thematic GRs are derived from the categorial rules which generate D-structure phrase markers and specify the structural environment in which an argument is assigned a particular role by a predicate, according to the predicate's inherent lexical properties. The realization of lexical properties is secured through the *Projection Principle*:

(2-11) *Projection Principle*
Representations at each syntactic level (i.e. LF, and D- and S-structure) are projected from the lexicon, in that they observe the subcategorization properties of lexical items. ([Chomsky 81], p. 29)

What remains to be established is precisely how the projection of lexical information into syntactic representations is realized, and in which ways it can be modified. In the remainder of this section we will provide a critical overview of how these two questions have been tackled within GB.

### 2.1.1 Argument Structure and Syntactic Predication

One of the problems to solve in relating lexical and structural information is to specify how the association between thematic roles and grammatical functions is realized. As was already pointed out, the association of argument roles and grammatical functions is lexically governed. For example, it is a lexical property of the verb *chase* that leads to the assignment of the agent role to the NP which bears the "[NP,S]" relation, and assignment of the patient role to the NP bearing the "[NP,VP]" relation. Similarly, it is

[4] A node A c-commands a node B iff A does not dominate B and the first branching node dominating A also dominates B.

a property of subject raising verbs that they may only assign a $\theta$-role to their objects, but not to their subjects. A phrase structure-based approach to GRs must provide a mechanism which correctly establishes the projection of thematic information from the lexical structure of predicates onto syntactic structures.

Williams ([Williams 80], [Williams 81a]) present a system — further developed by [Zubizarreta 85] and [Di Sciullo & Williams 87] — in which the task of relating structural and lexical information can be attained by enriching GB $\theta$-theory, and introducing a new theory of syntactic predication to formalize the subject-predicate relation. Williams' theory of predication consists of a number of conditions which define ***predicate structure***, a level of syntactic representation where the subject-predicate relation is indicated in terms of index sharing. Predication rules are stated as coindexing procedures which relate a predicative phrase with a c-commanding NP at S-structure.

(2-12) a Coindex NP and X [where X is a predicative phrase]
b If NP and X are coindexed, NP must c-command X or a variable bound to X. ([Williams 80], p. 206)

For example, where X in (2-12a) is VP the rules of predication will consist of the following coindexing conventions:

1. $NP\ VP_i \rightarrow NP_i\ VP_i$

2. $NP_i\ VP \rightarrow NP_i\ VP_i$

3. $NP\ VP \rightarrow NP_i\ VP_i$

The subject-predicate relation between an NP and a VP in a sentence like (2-13a) is encoded by coindexing the VP with its c-commanding NP at S-structure as indicated in (2-13b).

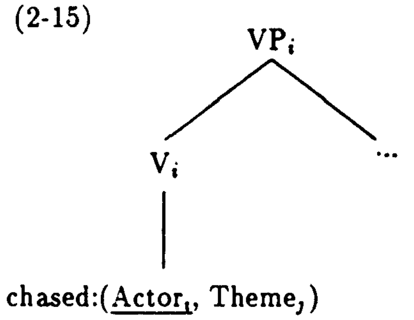
(2-13) a John chased Bill
b $[_S[_{NP_i}$ John$]\ [_{VP_i}$ chased Bill$]]$

Williams' enrichment of GB $\theta$-theory consists in structuring the arguments of a predicate into an unordered list called "argument structure" where each element corresponds to an indexed $\theta$-role as shown in (2-14).

(2-14) chased:(Actor$_i$, Theme$_j$)

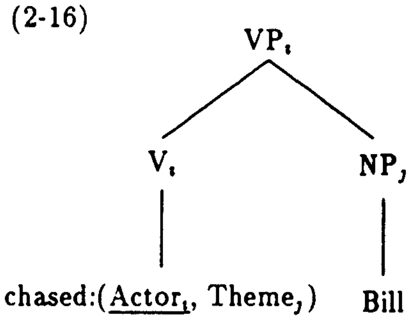
Within the argument structure of a predicate there can be a distinguished position which functions as the "head $\theta$-role" of the argument structure as a whole ([Di Sciullo & Williams 87]). This $\theta$-role is referred to as the "external argument" as it can only be assigned outside the maximal projection of its predicate (see below). Given standard conventions about feature percolation ([Lieber 80])[5] and the notion "head-of-a-word" ([Williams 81b]; [Di Sciullo & Wil pp. 23-28), Di Sciullo & Williams assume that the index of the external $\theta$-role is passed on to the maximal projection of its predicate as indicated (2-15) where the external argument is underlined following Williams' notation.

(2-15)




Information about the remaining $\theta$-roles — the "internal arguments" — is available only within the first projection of the predicate. As shown in (2-16) the $\theta$-index of an internal argument does not percolate to the VP node, but is assigned within the first projection of the predicate. Such assignment is realized under government.[6]

(2-16)



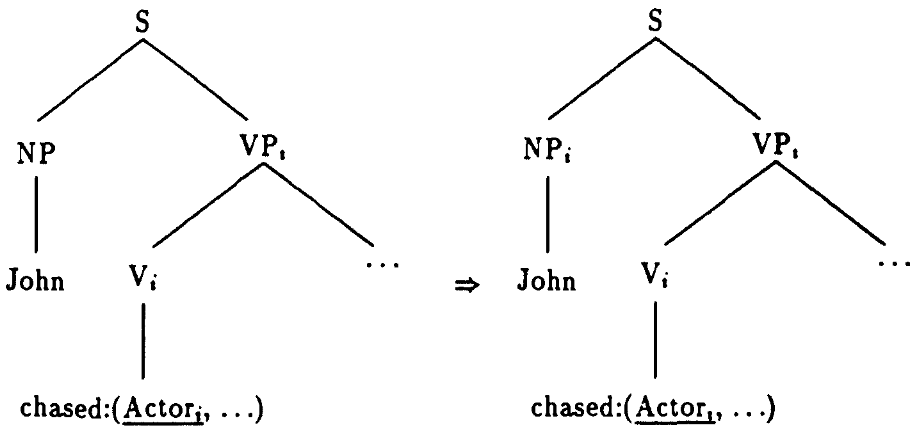

The external $\theta$-role is instead assigned outside of the maximal projection of the predicate through predication. Recall that the rules of predication relate a predicate phrase and its c-commanding NP by coindexation. As shown in (2-15), the index of the external $\theta$-role of a predicate percolates up to the maximal projection of the predicate. Under

[5] *Percolation Convention*
1. If the head of a word is specified for a feature $\alpha$, then $\alpha$ percolates up to the mother-node.
2. If the sister of the head of a word is specified for features $\beta$ and the head is not, then $\beta$ percolates up to the mother-node (unless the head specifies otherwise). ([Zubizarreta 85], p. 275, adapted from [Lieber 80])

[6] For the present purpose, it will suffice to say that government obtains under mutual *c-command*. See [Aoun & Sportiche 82] and [Chomsky 86b] for further details.

predication, the $\theta$-role index of the predicate will be assigned its c-commanding NP as indicated in (2-17).

(2-17)




[Williams 80] assumes that the indexes assigned through predication are referential indexes. Since no more than one such index can be assigned to a maximal projection ([Chomsky 80]), it follows that there cannot be more than one external argument for any given predicate. Insofar as external arguments correspond to lexically designated subjects, this conclusion ensures that there may not be more than one thematic subject within a minimal clause. No such requirement is needed with respect to internal arguments since within a sentence there may be more than one thematic object.

In William's system, GRs are still defined as constituency relations between phrase markers. The assignment of internal and external $\theta$-roles to argument positions is in fact carried out on the basis of notions such as government and predication which relate category nodes within a tree structure. The same observation holds of secondary, non-thematic GRs. To see this, one needs only to reflect on the fact that syntactic predication is established independently of thematic contrasts emerging from the distinction between external and internal arguments. An NP can thus be the subject of a VP whose head V does not have an external $\theta$-role in its argument structure. Passive sentences provide a clear example of this case.

According to Williams, the generalization that passivized verbs do not assign a thematic role to their subject is expressed by assuming that the argument structure of passive verbs lacks an external $\theta$-role. For example, Di Sciullo & Williams treat passivization as a lexical operation which suppresses the external argument of a verb. This result is achieved by encoding the passive morpheme as a *head functor* whose argument structure contains an internal argument which *controls* the external $\theta$-role of the argument predicate, e.g. "X" in (2-18); this internal argument may be syntactically realized as a subcategorized by-phrase.

(2-18)

$$\begin{array}{c} \text{ed} \\ \text{(functor)} \\ \text{(X)} \\ | \\ PP_{by} \end{array}$$

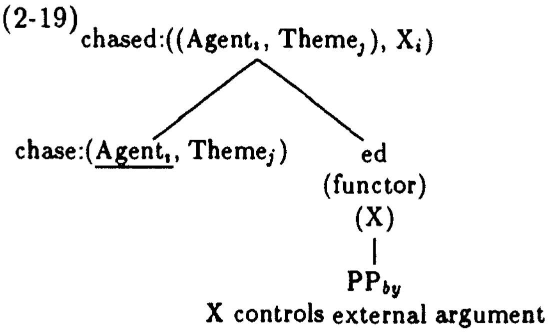
X controls the external argument of the argument predicate

Passive formation involves two distinct operations:

- *control*, and
- *function composition.*

Control is a binding operation which expresses coreference between two argument roles at the level of argument structure, and which satisfies the controlled argument so that it cannot be expressed in syntax independently of its controller ([Di Sciullo & Williams 87]). With respect to passive formation, control can be used to establish the relation between the by-phrase introduced by the passive morpheme and the external argument of the verb undergoing passivization as indicated in (2-18). Function composition occurs when a head functor combines with a non-head argument to form a word, an occurrence which distinguishes affixation from compounding where the non-head satisfies a $\theta$-role of the head ([Di Sciullo & Williams 87], pp. 29-45). Di Sciullo & Williams assume that the argument structure of a derived word (e.g. a passive verb) resulting through composition of a head functor (the passive morpheme) and a argument predicate includes the arguments of the head (the verb undergoing passivization) as well as the argument structure of the non-head as shown in (2-19).

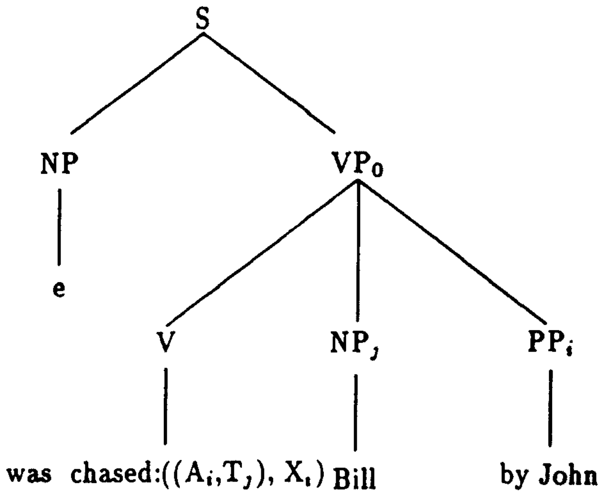
(2-19)




In (2-19), the external argument of the non-head (the verb *chase*) does not become the external argument of the word as a whole as the relation of control prevents the realization of this role independently of the syntactic realization of its controller, i.e. the internal argument of the passive morpheme. Consequently the argument structure of the passive verb will lack an external $\theta$-role. The $\theta$-roles of the passivized verb will then all be assigned within the first projection. The D-structure for the sentence in (2-20a) will be as in (2-20b) where the 0-subscript indicates that the head of the VP does not have an external argument.

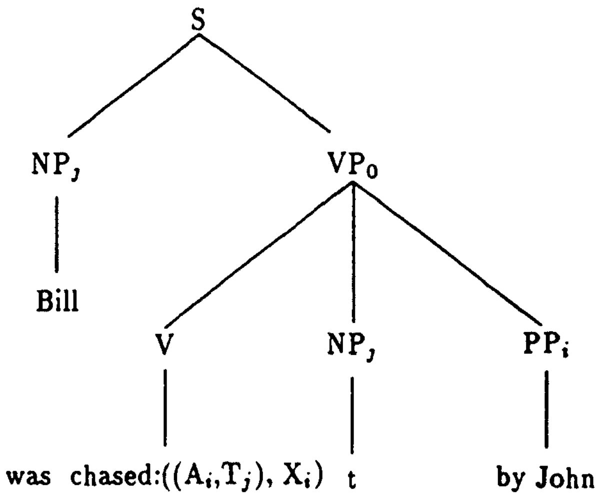
(2-20) a Bill was chased by John

b



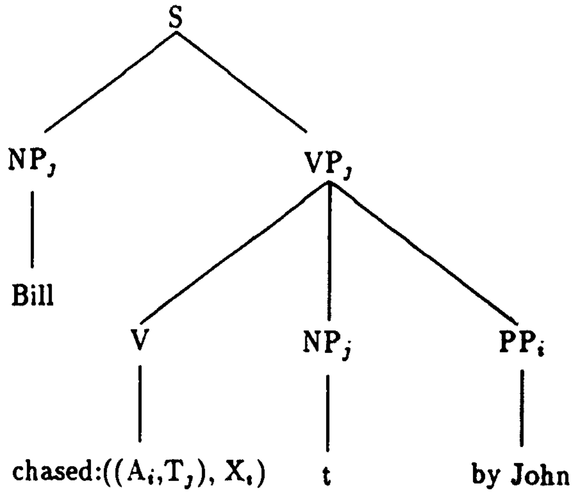

At S-structure, the object NP in (2-20) does not receive case within the VP since the passive morpheme absorbs objective case; movement into the empty subject position is thus needed to satisfy the case filter as shown in (2-21).

(2-21)




Through predication the VP is assigned the index of its c-commanding NP — the D-structure object — as indicated in (2-22). This NP will have subject status, even though its predicate does not have an external $\theta$-role to assign.

(2-22)




### 2.1.2 Argument Structure and GR-Changing

As the passive example above indicates, morphosyntactic rules in Williams' framework are viewed as lexical operations which modify the argument structure of predicate stems. GR-changing morphemes are head functors which combine with a non-head predicate giving rise to a new argument structure. The new argument structure may differ from the argument structure of the non-head in several ways. In the case of passive formation, the external argument of the non-head is controlled by the internal argument of the head functor, and the resulting argument structure has no external $\theta$-role. The head functor may also introduce:

- an external argument which controls the external $\theta$-role of the non-head predicate (e.g. causative formation);
- an internal argument which controls one of the internal $\theta$-roles of the non-head (e.g. antipassive), or
- an internal argument which does not control any of the arguments of the non-head and which simply adds a $\theta$-role to the argument structure of the non-head (e.g. applicatives). (see [Di Sciullo & Williams 87])

Certain operations are nevertheless disallowed. For example, no head functor morpheme may introduce an external argument and inherit the external argument of the non-head without controlling it. An operation of this kind would give rise to a lexical item with two external arguments, and subsequently to a doubly-indexed predicative phrase since the external $\theta$-index of lexical item is by convention passed to the maximal projection of that item. However, as we have seen there can only be one index per maximal projection.

The treatment of GR-changing which emerges from Williams' theory of argument structure is crucially dependent on the following two assumptions:

- GR-changing can be characterized in terms of operations which modify the argument structure of predicates through control of designated role values — i.e. external and internal roles — and function composition
- GR-changing rules are word-formation operations which apply within the lexicon, where affixal functor heads combine with non-head predicate stems.

Both assumptions raise a number of questions. For example, one may wonder whether the classification of argument roles into external and internal roles is sufficiently rich to capture restrictions on GR-changing processes, and to which extent the claim that GR-changing is restricted to word formation rules provides an natural account of morphosyntactic phenomena.

It is well known that there are severe restrictions on the range of morphosyntactic interactions allowed cross-linguistically. For example, Turkish, Chichewa and many other languages with affixal causatives do not allow causative formation with passive verbs (SP stands for "subject agreement prefix").

(2-23) a *Turkish*

| | | |
|---|---|---|
| *Hasan | bavulu | ac-ıl-dır-dı |
| Hasan | suitcase | open-PASS-CAUSE-PAST |

"Hasan had the suitcase (be) open" [Aissen 74]

b *Chichewa*

| | | | |
|---|---|---|---|
| *Kalulu | a-na-meny-edw-ets-a | anyamata | (ndi anyani) |
| hare | SP-PAST-hit-PASS-CAUSE-ASP | boys | (by baboons) |

"The hare made the boys be hit by the baboons" [Baker 88]

Note also that restrictions on morphosyntactic interactions are not limited to word-internal operations. The above restriction on causativization is found in many other languages where the causative morpheme is not an affix, such as Italian:

(2-24)

| | | | |
|---|---|---|---|
| *Mario | fece essere compra-to | il giornale | (da Giorgio) |
| Mario | made to be buy-PASS | the newspaper | (by Giorgio) |

"Mario had the newspaper bought (by Giorgio)"

If the restriction on causative-passive interactions is to be uniformly characterized in terms of operations on the argument structure of lexical items, the causative morpheme and its argument verb stem in languages like Italian must be viewed as forming a single lexical category (i.e. $[_V$ CAUSE+V$]$) rather than inducing a syntactic string with internal phrase structure (...$[_V$ CAUSE $[_{VP}$ V ...$]]$...). This is simply because GR-changing in Williams' theory of argument structure is realized in terms of word-formation operations within the lexicon which take as input affixes and stems to form $X^0$ (lexical) categories, and because the $\overline{X}$ rules of the categorial component are not accessible in the lexicon. Were we to assign internal phrase structure to causative verbal complexes as in (2-24), the possibility of characterizing restrictions on causativization in terms of GR-changing rules would effectively be preempted. Williams is well aware of this problem, and in fact he allows independent words to be treated as affixes and stems in the lexicon. As shown in (2-25), Di Sciullo & Williams analyze the causative morpheme as an affixal functor head whose external argument controls the external $\theta$-role of its argument verb.

(2-25) *Verb* : ($\underline{X_i}$,...)

CAUSE
(functor)
($\underline{\text{Agent}}$)

$\underline{\text{Agent}}$ controls external argument
of non-head predicate

$\Downarrow$

Verb+CAUSE:(($X_i$, ...), Agent$_i$)

Verb:($\underline{X_i}$, ...)

CAUSE
(functor)
($\underline{\text{Agent}}$)

$\underline{\text{Agent}}$ controls external argument
of non-head predicate

Insofar as independent words may be specified as having affixal properties, the word formation rule in (2-25) can be employed to generate Italian complex causative predicates as shown in (2-26) even though the causative verb in Italian is a free morpheme.

(2-26) a Mario fece comprare il giornale a Giorgio
Mario made to buy the newspaper to Giorgio
"Mario made Giorgio buy the newspaper"

b fece comprare:(Agent$_i$ (Agent$_i$, Theme))

CAUSE comprare:($\underline{\text{Agent}_i}$, Theme)
(functor)
($\underline{\text{Agent}}$)

$\underline{\text{Agent}}$ controls external argument
of non-head predicate

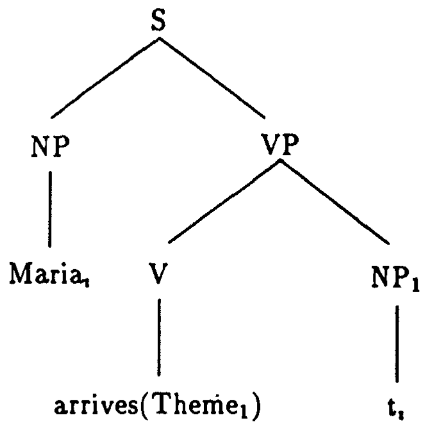
Since the external argument of the causative affix must control an external argument, it follows that only verbs whose argument structure encodes an external argument are amenable to causative formation in the lexicon (e.g. the word formation rule in (2-25)). The impossibility of causativizing passives in Turkish and Chichewa as well as in Italian can thus be attributed to the fact that the argument structure of passive verbs does not encode an external role.

However, this restriction invites the incorrect prediction that sentences such as (2-27), where the causative verb takes as argument an *unaccusative* verb, should be ungrammatical. This is because unaccusatives, like passive and raising verbs, do not have an external argument: their S-structure subject corresponds to an internal argument role (i.e. a D-structure object) as indicated in (2-28b) (cf. [Burzio 86]). In GB, this characterization is needed to capture the partial object functionality which distinguishes unaccusative subjects from *unergative* intransitive and transitive subjects with respect to a number of morpholexical and syntactic phenomena (see chapter 6 for details).

(2-27) Carlo fece arrivare Maria in ritardo
Carlo made to arrive Maria late
"Carlo made Maria arrive late"

(2-28) a Maria arriva
"Maria arrives"

b




The possibility of causativizing unaccusative verbs in languages where causative formation is carried out within the lexicon poses a serious problem for Williams' classification of argument roles. What is needed here is some intermediate term between external and internal roles which may allow causativization to go through, while still capturing Perlmutter's and Burzio's insight that the subject of unaccusatives corresponds to a deep object ([Perlmutter 78], [Burzio 86]). Yet it is rather difficult to see what the theoretical status of this intermediate term should be. Williams' classification of roles into external and internal arguments is essentially characterized in syntactic terms. The external role of a predicate is assigned outside of the maximal projection of the predicate through predication, while internal roles are assigned within the first projection of the predicate under government; i.e. the contrast between internal and external roles corresponds to the distinction between D-structure subjects and objects. But from a syntactic vantage point the surface subject of unaccusatives, raising verbs, and passives have the same properties: they all correspond to D-structure objects. The possibility of defining a "partial" internal (external) argument role is preempted by the non-existence of a "partial" D-structure object (subject).

### Morphosyntactic Interactions and the Syntax/Lexicon Interface

A further restriction on causativization in Italian regards causative-inchoative interactions. As shown in (2-29) a verb which has combined with the inchoative affix *si* cannot enter into a causative complex predicate.

| | | | | |
|---|---|---|---|---|
| (2-29) | *Il sole | fece | scioglier-si | la neve |
| | The sun | made | to melt-INCH | the snow |
| | "The sun made the snow melt" | | | |

[Zubizarreta 85] attributes this constraint to the nature of inchoative formation, and the requirements that the passive affix imposes on the argument structure of its argument verb stem. The inchoative morpheme suppresses the external argument of the verb to which it attaches; since the causative morpheme may not apply to a verb that has had its external argument suppressed, an inchoative verb may not be made causative.

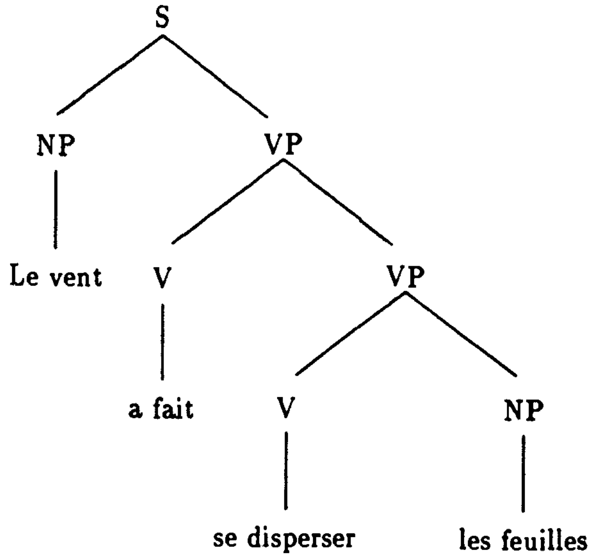
Unlike Italian and standard French, some dialects of French ([Zubizarreta 85]) do allow for causative-inchoative interactions.

| | | | | | |
|---|---|---|---|---|---|
| (2-30) | Le vent | a fait | se | disperser | les feuilles |
| | the wind | made | INCH | scatter | the leaves |
| | "The wind made the leaves scatter" | | | | |

Zubizarreta suggests that this would follow if causative constructions in these dialects were given a syntactic (e.g. biclausal) analysis as indicated in (2-31) where the causative morpheme and the inchoative verb are attached to distinct V-nodes rather than forming a single predicate as in the Italian example in (2-26).[7]

[7]The same suggestion is made in Di Sciullo & Williams. In keeping with their approach I will represent the clausal complement of the causative verb as a VP rather than an S as suggested by Zubizarreta.

(2-31)



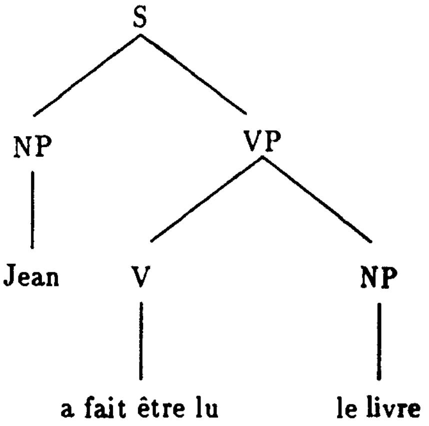

In (2-31), the causative verb no longer functions as a morphosyntactic affix. Consequently, causative formation cannot involve operations such as control and function composition on the argument structure of the causative verb and its complement. Such operations are only possible at the level of word formation. The causative structure in (2-31) will thus be immune to the restrictions which are inherent to these operations. In particular, the requirement that the argument role introduced by the causative morpheme must control an external argument is not operative in (2-31).

However, just as in Italian, these dialects do not allow for causative-passive interactions:

| | | | | | | |
|---|---|---|---|---|---|---|
| | *Jean | a fait | être | lu | le livre | (par Pierre) |
| (2-32) | Jean | made | to be | read-PASS | the book | (by Pierre) |
| | "Jean made the book be read (by Pierre)" | | | | | |

In this case, Zubizarreta proposes to attribute affixal properties to the causative verb. That is, a sentence like (2-32) should be analyzed as in (2-33) where the causative and passive verb form a single lexical category. Since the causative verb in this case functions as an affix, causativization can be formulated as a word formation rule. Consequently, the ungrammaticality of the sentence would follow from the fact that the argument verb of the causative affix (i.e. a passive verb) does not have an external role in its argument structure; such restriction will be operative in the context of word formation as in the Turkish, Chichewa and Italian cases discussed above.

(2-33)




In short, Zubizarreta's suggestion is that the causative verb in the French dialects in question has affixal properties, but may also function as an independent word. Causativization can thus be characterized both as a lexical process and a syntactic operation. The possibility of causative-inchoative interactions arises under the syntactic analysis, while causative-passive interactions are ruled out under the lexicalist analysis. The question arises then as to what determines whether *faire* functions as an affix or as a main verb. Notice that nothing prevents us from assigning an alternative structure to (2-30) where the causative morpheme functions as an affix, and an alternative structure to (2-32) where *faire* function as a main verb. In both cases we would obtain exactly the opposite results: causativized passives would be ruled in and causativized inchoatives would be ruled out. Clearly we should not allow such degree of freedom. I shall return to this problem after a brief discussion of coanalysis.

**Coanalysis** According to Williams, Zubizarreta and Di Sciullo & Williams, morphophonologically independent morphemes may function as affixes. It is natural to ask at this point whether bound morphemes can function as independent words. Di Sciullo & Williams discuss some Japanese data where they claim such occurrence arises. Japanese causative complex predicates are formed by adding the suffix *-sase* to a verb stem as shown in (2-34).

| | | | | |
|---|---|---|---|---|
| (2-34) | Tanaka-ga | John-ni | hon-o | yomi-sase-masu |
| | Tanaka | John | book | read-CAUSE-PAST |
| | "Tanaka made John read the book" | | | |

Since *-sase* is an affix it is natural to regard causative formation as the result of a word-formation rule in the lexicon. The affix *-sase* and its argument stem will then form a single lexical category. However, this analysis will fail to account for the fact that the reflexive *zibun* in a sentence structure such as (2-35) can be bound by the prepositional object:

(2-35) Tanaka-ga [$_{VP}$ [$_{PP}$ John-ni] [$_{NP}$ zibun-o] [$_{V}$ VERB-sase-masu]]
Tanaka John SELF VERB-CAUSE-PAST
"Tanaka made John$_i$ VERB himself$_i$"

Di Sciullo & Williams argue that in Japanese the reflexive *zibun* must be controlled by a subject. Consequently, the possibility of binding *zibun* to the PP *John-ni* in (2-35) provide evidence that the PP may function as a subject. This is a problem for the representation in (2-35) since the PP may not be related to the VP containing the reflexive anaphor through predication, i.e. the PP does not c-command the VP. Di Sciullo & Williams suggest that this problem can be solved if the causative morpheme *-sase* is allowed to function simultaneously as an affix and a main verb. A sentence such as (2-35) will receive a dual-tree representation where both options are simultaneously represented as indicated in (2-36).

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| (2-36) | NP | [$_{VP}$ | PP | [$_{VP}$ | NP | V] | V] |
| | Tanaka-ga | | John-ni | | zibun-o | verb | -sase |
| | NP | [$_{VP}$ | PP | | NP | V | ] |

In the tophalf of the *coanalyzed* structure in (2-36) the correct structural conditions for *zibun-o* to be bound to *John-ni* obtain, since the reflexive is contained in a VP for which the PP *John-ni* functions as a subject. In the bottomhalf *-sase* forms a single lexical category with the verb stem, thus giving a natural account of the affixal status of the causative morpheme in Japanese. Here the PP *John-ni* may not function as an antecedent for the reflexive anaphor as it does not have subject status. The sentence structure is nevertheless well-formed since at least in one of the two analyses (i.e. the top-half representation) the appropriate binding conditions are met.

Let us consider what the consequences of allowing the same sentence to receive two simultaneous syntactic representations are for the French sentences in (2-30) and (2-32). Since *faire* may function both as an affix and a main verb, a sentence like (2-30) will be analyzed as in (2-37) ([Zubizarreta 85], p. 283).

(2-37) $[_S$ NP $[_{VP}$ V $[_{VP}$ V NP $]]]$

| | | | | | | |
|---|---|---|---|---|---|---|
| $[_S$ | NP | $[_{VP}$ | V | $[_{VP}$ V | NP | $]]]$ |
| | le vent | | a fait | se disperser | les feuilles | |
| $[_S$ | NP | $[_{VP}$ | | V | NP | $]]$ |

Although the bottom description is not well-formed (*faire* combines with a verb stem which has no external argument to form a single word) the sentence as a whole is grammatical since the tophalf of the coanalyzed structure is well-formed, as in the Japanese case above. However when we apply the same criterion to (2-32), we are no longer in a position to rule out causative-passive interactions. In (2-38) the bottomhalf of the coanalyzed structure is ungrammatical since the *faire* combines with a passive verb — a predicate whose argument structure does not encode an external argument — to form a single predicate in the lexicon. Word formation rules are in fact sensitive to the restrictions which lexical causativization imposes on the argument structure of the argument predicate; i.e. presence of an external role. The tophalf of the description in (2-38), where *faire* functions as a main verb, will nevertheless be well-formed. Recall that when *faire* occurs as a main verb there are no restrictions on the thematic make-up of the complement verb. Clearly, what is needed here is to rule out the sentence as a whole because at least one of the two simultaneous descriptions assigned to it is not well-formed. But having settled for exactly the opposite requirement with respect to the Japanese structure in (2-36) and causative-middle interactions in French (cf. (2-37)) this option is unavailable.

(2-38)

| | | | | | | |
|---|---|---|---|---|---|---|
| $[_S$ | NP | $[_{VP}$ | V | $[_{VP}$ V | NP | $]]]$ |
| | Jean | | a fait | être lu | le livre | |
| $[_S$ | NP | $[_{VP}$ | | V | NP | $]]$ |

Di Sciullo & Williams are not unaware of this problem. Here are their comments on the Japanese case.

> The one troublesome feature of this analysis is that the reflexive will be correctly bound in only one of the two analyses—(the syntactic one, in (36) [e.g. top-level structure in (2-36)]; in the morphological analysis the reflexive is not contained in a VP that takes *John ni* as its subject
>
> (38) Tanaka ga [John ni zibun o Vsase]
>
> Because (37) [my (2-35)] is grammatical, the reflexive *need not be properly bound in both analyses* of a coanalysis—one will do. This is especially

worrisome because it was necessary earlier to apply the $\theta$-criterion to both analyses. Why both for the $\theta$-criterion but either one for the binding theory? This question must be answered. ([Di Sciullo & Williams 87], p. 95)

To the best of my knowledge, this problem has not been solved yet.

### 2.1.3 GR-changing and Syntactic Affixation

Within GB, the seemingly irrelevance of morphophonological representation in classifying levels of grammatical description has been often interpreted as suggesting that the contrast between word and phrase formation processes does not correspond to distinct domains of the rule system of grammar, i.e. the lexicon and syntax subcomponents . The boundary between word and phrase formation can thus be further weakened so that in those instances where a morpheme appears to function both as an affix and a word of its own — as in the Japanese and French examples discussed above — we are not obliged to conclude that there is parallel emergence of syntactic and lexical structure as in the dual-tree representation resulting under the coanalysis hypothesis. Morphological and syntactic processes can be viewed as two aspects of the same derivation. This enterprise has recently been developed into some detail by Baker ([Baker 88]).[8]

In Baker's view, the syntax/morphology isomorphy is the result of the requirements which the *Mirror Principle* imposes on Universal Grammar:

(2-39) *The Mirror Principle*
Morphological derivations must directly reflect syntactic derivations (and vice versa). [Baker 88]

Baker develops a treatment of GR-changing within a GB framework where the Mirror Principle can be made to follow by treating affixation as a syntactic operation. The basic idea which underlies Baker's proposal is to establish a correspondence between lexical properties of lexical items and their syntactic representation in D-structure which transcends morphophonological factors. This idea is expressed through the *Uniformity of Theta Assignment Hypothesis* (UTAH), a principle of *universal grammar* which characterizes the level of D-structure.

[8]See also [Fabb 84] and [Marantz 84].

(2-40) *Uniformity of Theta Assignment Hypothesis*
Identical thematic relationships between items are represented by identical structural relationships between those items at the level of D-Structure. ([Baker 88], p. 46)

The following example provides a concrete illustration of how the syntax/morphology isomorphy obtains under the UTAH.

Unlike English, causative formation in Chichewa involves affixation as shown in (2-41).[9]

| | | | | |
|---|---|---|---|---|
| (2-41) | Anyani | a-na-meny-ets-a | ana | kwa buluzi |
| | baboons | SBJP-AGR-hit-CAUSE-ASP | children | to lizard |
| | "The baboons made the lizard hit the children" | | | |

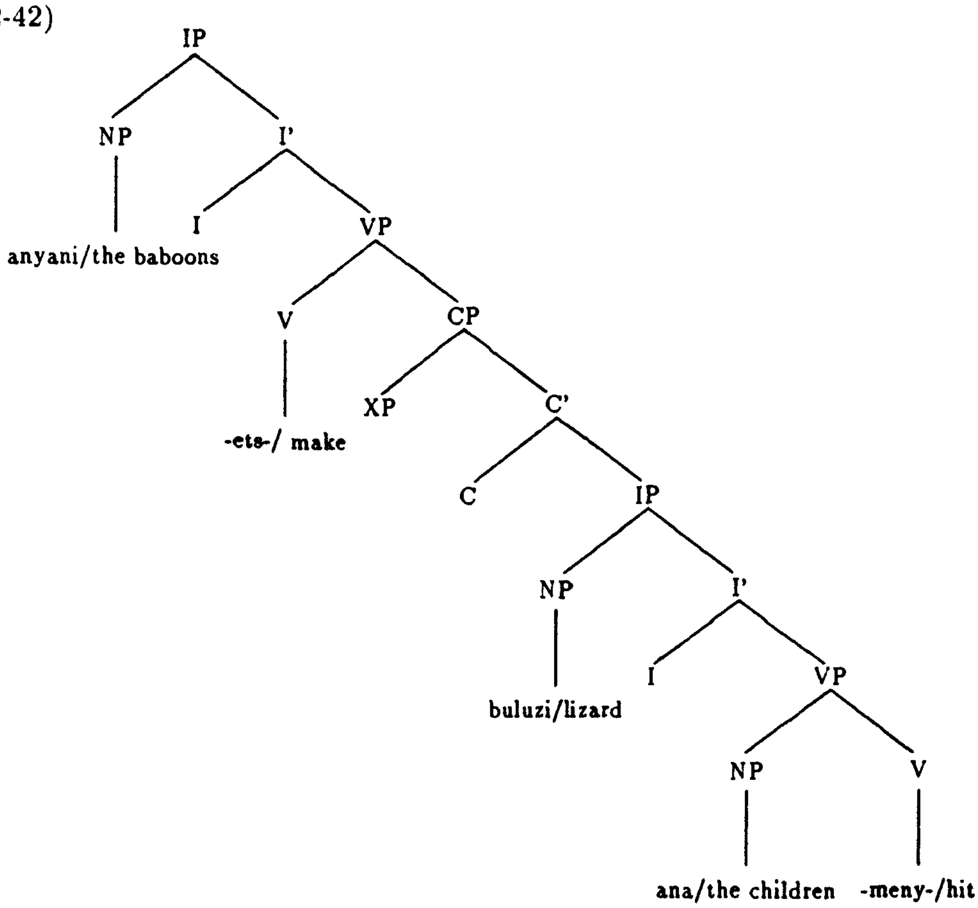
According to the UTAH, the Chichewa sentence above and its English translation will be represented alike at D-structure, as shown in (2-42), since in both sentences the same thematic relations are involved.[10]

[9] Chichewa and Chimwiini examples are taken from [Baker 88].

[10] Baker assumes the $\overline{\mathrm{X}}$ model presented in [Chomsky 86b], where functional categories like INFL and COMP are heads and form projections according to the schema below.

- X' = X XP*
- XP = X' XP*

(2-42)




Baker assumes that affixes and free morphemes have the same features and properties, differing only in the presence/absence of a *morphological subcategorization frame* ([Lieber 80]) which specifies what type of stem the morpheme in question must have as sister in S-structure. The lexical entry for free and affixal causative verbs will contain the same theta marking and subcategorization properties; only affixal causatives will have morphological subcategorization.

(2-43)

| | free causative morpheme | affixal causative |
|---|---|---|
| Syntactic Subcategorization<br>Theta Marking | V:[_ proposition]<br>external theta role :"agent" | |
| Morphological<br>Subcategorization | nil | $\ldots]_V\_$ or $\_[\ldots]_V$ |

Satisfaction of the morphological subcategorization of a lexical item at S-structure is ensured through the Stray Affix Filter.

(2-44) *Stray Affix Filter*
*X if X is a lexical item whose morphological subcategorization frame is not satisfied at S-structure. ([Baker 88], p. 140)

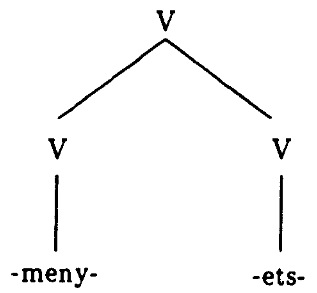
The different surface realization of the causative and the embedded verbs in Chichewa and English can thus be attributed to the different lexical properties of the causative verb in those two languages with respect to morphological subcategorization. Because the causative morpheme in Chichewa is an affix, it must merge with the embedded verb at S-structure in order to satisfy the *Stray Affix Filter.* No such requirement is enforced in English where the causative verb is a free morpheme.

Morphological merger at S-structure is realized through head-movement. Following [Travis 84], Baker assumes that head-movement obeys the following constraint:

(2-45) *Head Movement Constraint*
An $X^o$ may only move into a $Y^o$ which properly governs it.

The *Head Movement Constraint* is just a special case of the *Empty Category Principle* which requires each trace to be properly governed (i.e. governed by a lexical head or a coindexed phrase). Since government involves c-command, the causative affix in (2-42) may not move down the tree to join its complement verb. If it did, the trace left behind would not be c-commanded by its filler, violating (2-45). Hence the lower verb must move upward and adjoin to the matrix V-node creating a structure as in (2-46).

(2-46)




Baker refers to this process as *incorporation.*

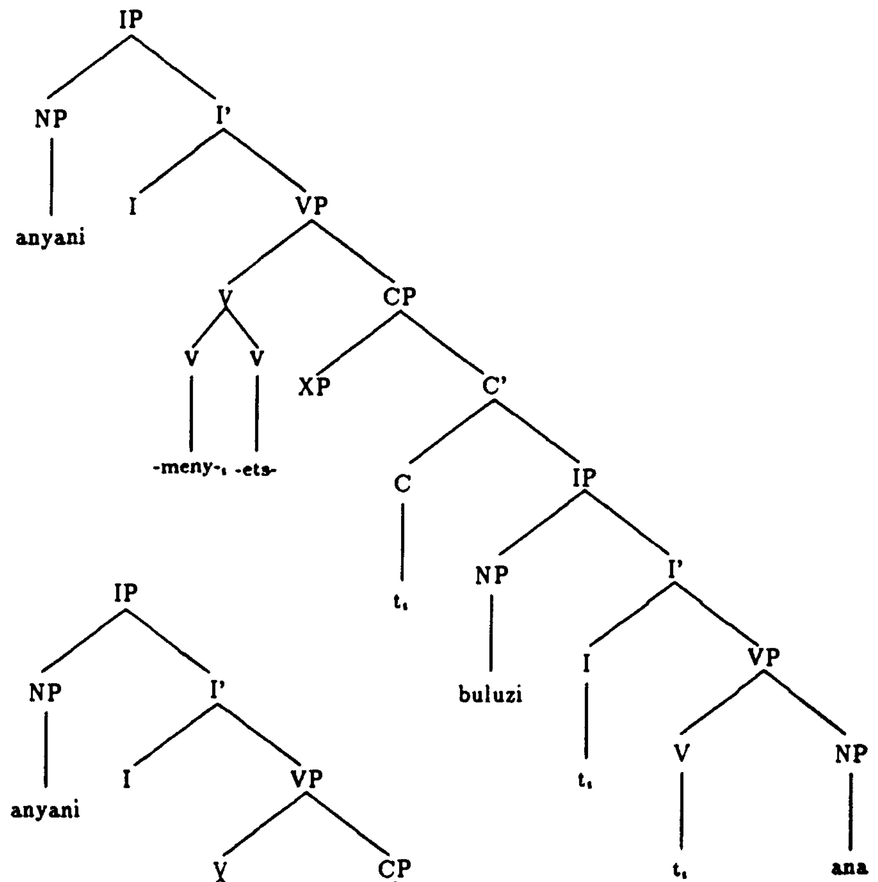
Given the D-structure in (2-42) there are two possible derivations through which the embedded verb may incorporate into the matrix V-node:

1. the embedded verb moves from its initial position, passing through the head of IP and the head of CP on its journey to the matrix V-node;

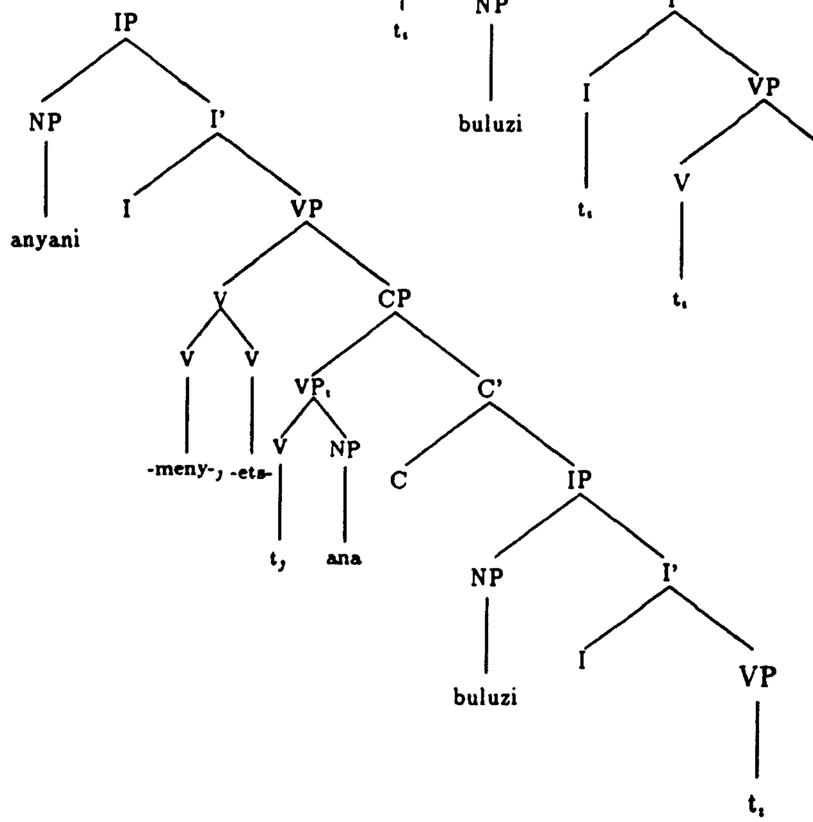
2. the embedded VP moves to XP, the specifier of C', from where the verb incorporates into the matrix V through another movement step.

The two resulting S-structures are shown in (2-47) and (2-48).

(2-47)




(2-48)




In either case, each trace is properly governed, hence no violations of the *Head Movement Constraint* arise. However, in (2-47) the stranded NP *ana* is caseless since a V-trace may not assign case in Baker's system. The structure in (2-47), where incorporation involves V-movement from the VP *in situ*, thus gives rise to a violation of the case filter. In (2-48), the entire embedded VP moves into the specifier of C', and from there the verb incorporates into the matrix verb. Baker argues that although here too the NP *ana* is stranded, no violation of the case filter arises: from its incorporated position *meny* together with the causative verb governs, and therefore case-marks[11], its object NP *ana* through the *Government Transparency Corollary.*

(2-49) *Government Transparency Corollary*
A lexical category which has an item incorporated into it governs everything which the incorporated item governed in its original structural position.

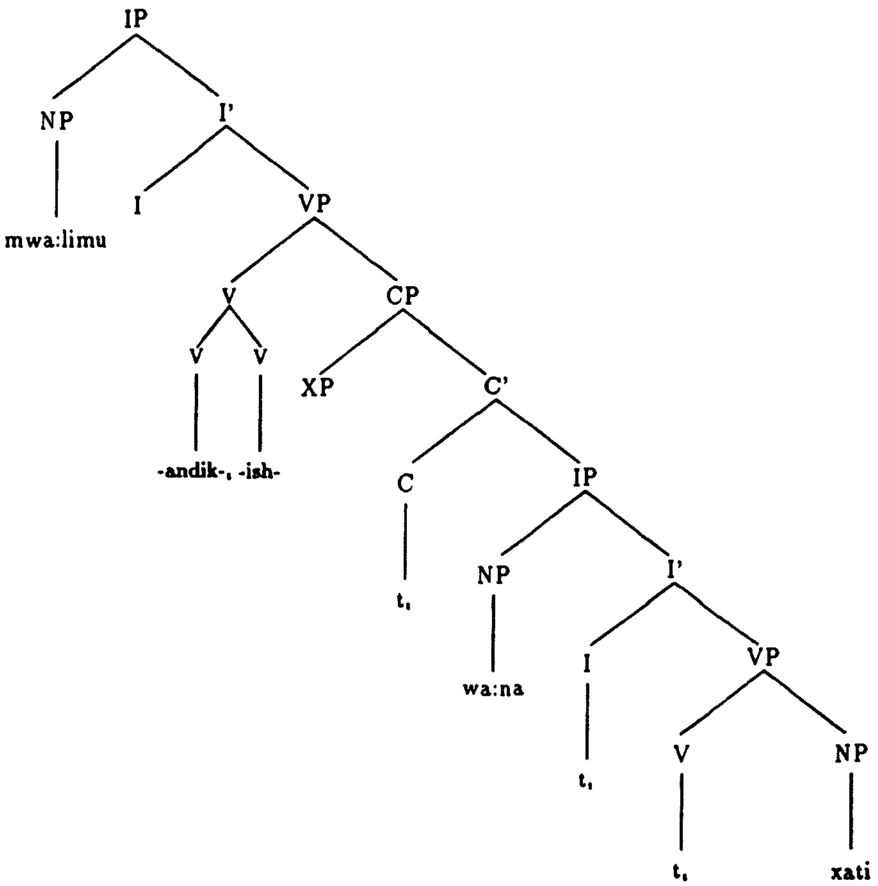
The hypothesis that causative formation in Chichewa involves VP-movement is corroborated by the fact that object of the embedded verb in a sentence like (2-41) always precedes its subject. Note that the *Government Transparency Corollary* would also allow the stranded object in (2-47) to be governed by the incorporated verb. Baker claims that the sentence would still constitute a violation of the case filter because the incorporated verb is not adjacent to the stranded object, and adjacency is a *sine qua non* condition for case-assignment ([Stowell 81], [Chomsky 86a]).

The situation appears to be different in Chimwiini. As (2-50) seems to suggest, here causativization is more likely to involve a derivation like (2-47), i.e. V-movement as indicated in (2-51), since the order of subject and object NPs in the complement clause is not affected by verb incorporation: the subject NP *wa:na* still precedes the object NP *xati*.

| | | | | |
|---|---|---|---|---|
| (2-50) | Mwa:limu | Ø-wa-andik-ish-ize | wa:na | xati |
| | teacher | SBJP-OBJP-write-CAUSE-ASP | children | letter |
| | "The teacher made the children write a letter" [Abasheik 79] | | | |

[11]Case assignment takes place under government.

(2-51)




The question arises then as to why the stranded lower object (*xati* in (2-51)) can be left stranded *in situ* in Chimwiini but not in Chichewa.

Baker observes that in Chimwiini only the goal object NP of a dative shifted construction like (2-52a) can become subject following passivization (OP stands for "object agreement prefix).

(2-52) a Ni-m-pele Jama kuja
1sS-OP-gave Jama food
"I gave Jama food"

b Jama Ø-pel-a: kuja na: mi
Jama SP-gave-PASS food by me
"Jama was given food by me"

c *Kuja i-pel-a Jama na: mi
food SP-gave-PASS Jama by me
"Food was given Jama by me"

On the assumption that only a structural object can become subject following passivization, Baker concludes that after dative shift the goal NP becomes the new structural object, while the theme NP is assigned *inherent case*. Inherently case-marked NPs need not be governed at S-structure to satisfy the case filter, since they receive case at

D-structure:

(2-53) *Inherent Case*
If $\alpha$ assigns inherent case, then $\beta$ receives a $\theta$-role from $\alpha$ iff $\beta$ receives case from $\alpha$. [Chomsky 86a]

The theme NP of dative shifted constructions is thus case-marked at D-structure by an "abstract" $\theta$-assigner. Baker argues that it is the availability of such an abstract case- and $\theta$-marker which rescues the stranded object in (2-51). In Chimwiini, a causative verb that has incorporated its complement verb behaves somewhat like a dative shifted ditransitive: it assigns structural case to the embedded subject, while the embedded object receives inherent case at D-structure by an abstract $\theta$-assigner. Baker substantiates his claim by showing that the lack of abstract inherent case in many languages is coextensive with the occurrence of VP movement in the derivation of causatives. For example in Chichewa no dative shift is allowed:

| | | | | | |
|---|---|---|---|---|---|
| (2-54) | a | Amayi | a-na-perek-a | mtsuko | kwa ana |
| | | woman | SP-PAST-hand-ASP | waterpot | to children |
| | | "The woman handed the waterpot to the children" | | | |
| | b | *Amayi | a-na-perek-a | ana | mtsuko |
| | | woman | SP-PAST-hand-ASP | children | waterpot |
| | | "The woman handed the children the waterpot" | | | |

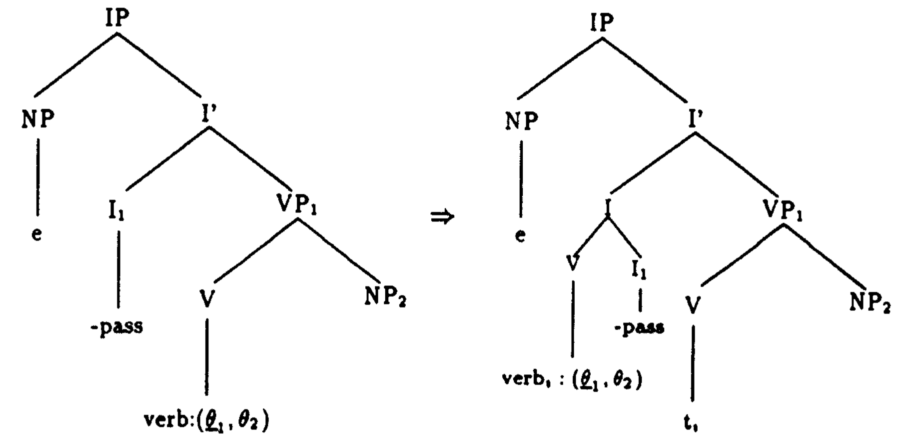
Consider next causative-passive interactions. In Chichewa the causative verb may not take a passive complement as shown earlier in (2-23b) here repeated as (2-55).

| | | | | |
|---|---|---|---|---|
| (2-55) | *Kalulu | a-na-meny-edw-ets-a | anyamata | (ndi anyani) |
| | hare | SP-PAST-hit-PASS-CAUSE-ASP | boys | (by baboons) |
| | "The hare made the boys be hit by the baboons" | | | |

In Baker's analysis, the passive morpheme is generated under INFL and the verb moves to incorporate into it as shown in (2-56).[12] In addition, Baker assumes that the passive morpheme functions as an argument which is assigned the external role encoded in the VP containing the incorporating verb through predication as indicated in (2-56) with the numeral subscript "1".

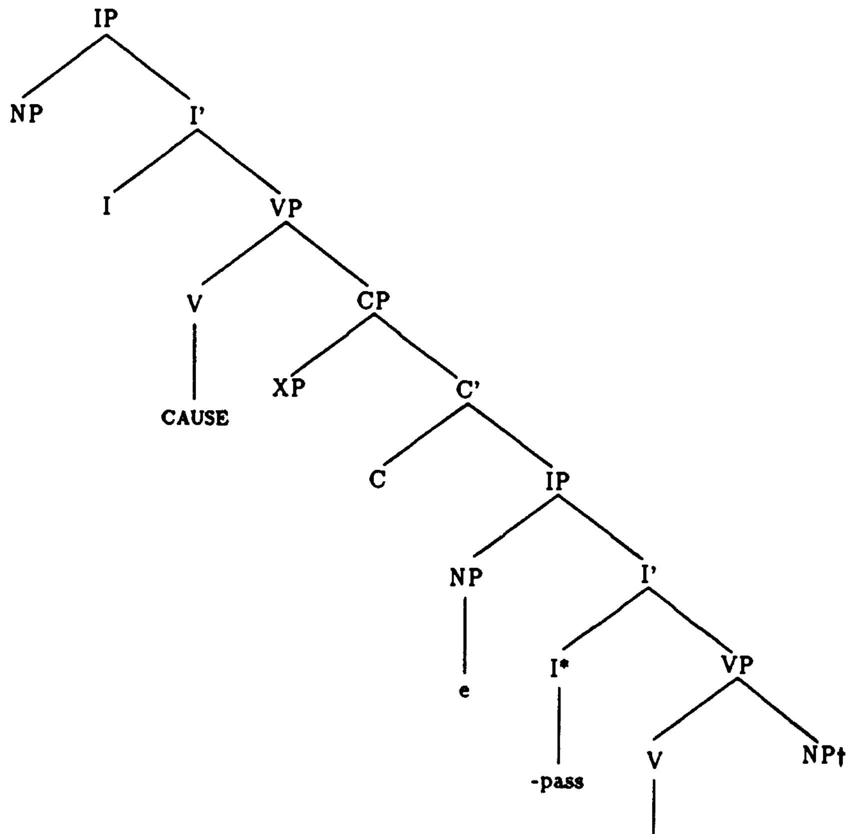
[12]This analysis of passive is not intended to cover languages like Lithuanian where unaccusative verbs can form impersonal passives. Baker argues that in these languages the passive morpheme is categorially a noun which can be generated in any base NP position (e.g. "[NP,S]", "[NP,VP]") and whose morphological subcategorization frame requires that it be affixed to INFL at S-structure ([Baker 88], pp. 329-32).

(2-56)

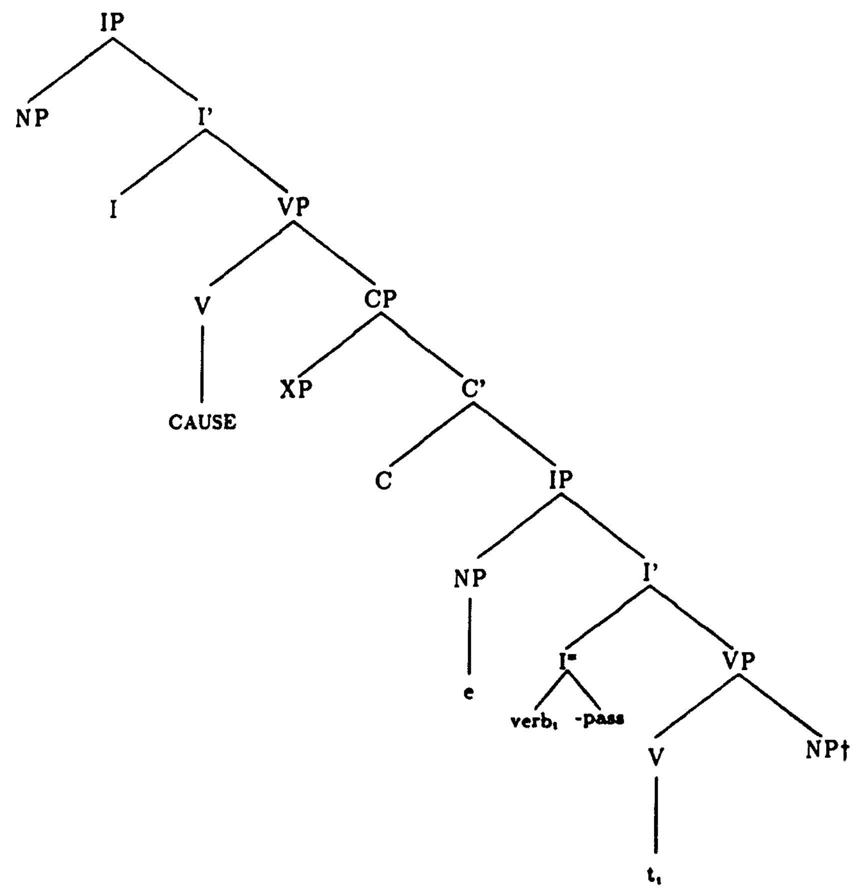



According to this treatment of passive, the D-structure of the Chichewa causative sentence in (2-55) will be as in (2-57), omitting details. At S-structure the lower verb has to move to I* to incorporate with the passive morpheme as shown in (2-58).

(2-57)



(2-58)




In the next derivational step, the passivized verb should move to XP from where it can subsequently incorporate into the causative verb. Recall that in Chichewa causatives, a violation of the case-filter arises if the complement object is left stranded. The passivized verb under the I* node in (2-58) must therefore move together with NP†. The only way to do this is by moving the entire lower I' projection, since the complement verb is no longer inside the lower VP. However, since X' projections are not amenable to movement ([Chomsky 86b]), such a step is not feasible. Causative-passive interaction are thus ruled out in Chichewa.

### Some Problems for Baker's Theory of Incorporation

According to Baker's account, causative-passive interactions are possible in languages where verb incorporation in causative formation does not involve VP-movement. In these languages, the embedded verb can first raise to INFL to amalgamate with the passive morpheme and then incorporate into the causative verb, leaving behind an ungoverned object. No case-filter violation will arise since that object receives inherent case. Yet, as Baker himself points out, there are several languages where verb incorporation in causatives involves V-movement and yet passives may not be causativized (Swahili, [Vitale 81]). Baker suggest that this unexpected fact might be due to "morphological gaps". However, on second inspection, Baker's idea that the option of causative-passive interaction can be cross-linguistically determined by distinct movement strategies in causative incorporation appears to be questionable on more substantial grounds. For example, the conclusion that the ban on X'-movement is responsible for the impossibility of causative-passive interactions is at odds with the occurrence of an inflected complement verb in Romance causative constructions. As was mentioned earlier in this section, Italian does not allow causative constructions to be formed with passive complements:

| | | | | | | |
|---|---|---|---|---|---|---|
| (2-59) | *Mario | fece | essere | compra-to | il giornale | (da Giorgio) |
| | Mario | made | to be | buy-PASS | the newspaper | (by Giorgio) |
| | "Mario had the newspaper bought (by Giorgio)" | | | | | |

According to Baker, causativization in Italian is thus to be characterized in terms of VP-movement, as in Chichewa. This conclusion is corroborated by the fact that dative shift is not allowed in Italian, as shown in (2-60).

(2-60) a Carlo da un libro a Maria
"Carlo gives a book to Maria"
b *Carlo da Maria un libro
"Carlo gives Maria a book"

Recall that, according to Baker, the occurrence of dative shift follows from the possibility of assigning inherent case to the theme object NP of a ditransitive. In the context of a causative construction, the availability of inherent case allows a complement transitive to move upwards and incorporate into the matrix causative verb leaving its D-structure object stranded. However, causative complements in Italian are always inflected in the infinitive:

| | | |
|---|---|---|
| (2-61) | fece | compra-re |
| | made | buy-INFINITIVE |

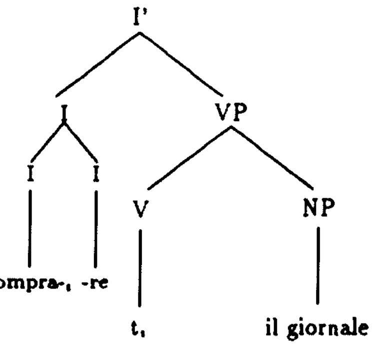
If infinitive inflection is base-generated in INFL as all other verbal inflectional morphemes,[13] the VP-movement hypothesis cannot be right for Italian. The complement verb of a causative sentence such as (2-62a) must pass through the head of INFL to amalgamate

[13] Evidence in favour of verb-movement to INFL in infinitivals for Italian is provided by [Belletti 88].

with the infinitive morpheme before it can move next to the causative verb as indicated in (2-62b).

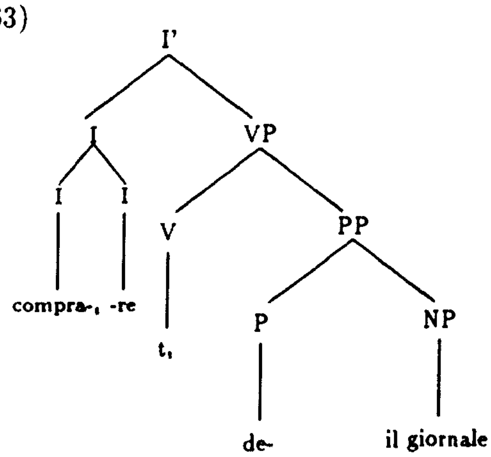
| | | | | | | |
|---|---|---|---|---|---|---|
| (2-62) | a | Mario | fece | comprare | il giornale | a Giorgio |
| | | Mario | made | to buy | the newspaper | to Giorgio |
| | | "Mario made Giorgio buy the newspaper" | | | | |

b




Moreover, Baker's hypothesis that cross-linguistic differences in causativization patterns can be explained in terms of V vs. VP movement from the complement clause appears to be problematic also with respect to the assumption that a verb trace does not assign case. In Baker's approach, such assumption is effectively the only reason which motivates the existence of distinct movement strategies in causative constructions. However, it is not clear that this assumption is independently motivated, if indeed motivated at all. First, the alleged lack "abstract inherent case' does not ensure that the complement verb of a causative construction must be adjacent to its D-structure object. The insertion of a preposition adjacent to the stranded object as shown in (2-63) would in fact suffice to satisfy the requirements of the case filter; consequently movement of the complement verb should be potentially available in Chichewa and Italian causative constructions.

(2-63)

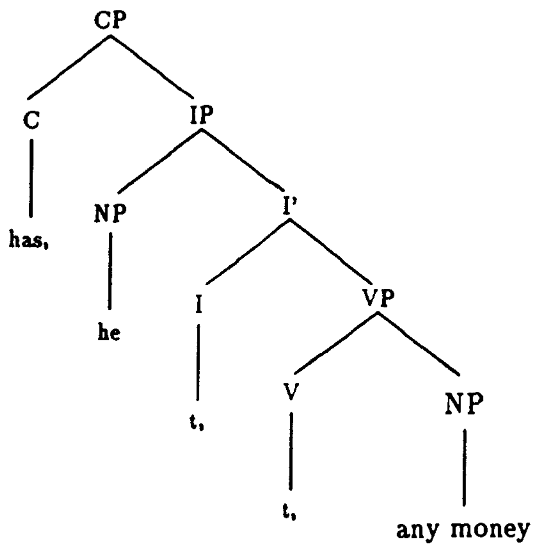


Second, there appear to be a number of constructions in which a verb trace must be granted the possibility of functioning as a case assigner. Consider the following case.

(2-64) Has he any money?

Within a *barrier* framework — the framework which Baker assumes — the S-structure of a sentence as in (2-64) is (2-65) ([Chomsky 86b]).

(2-65)

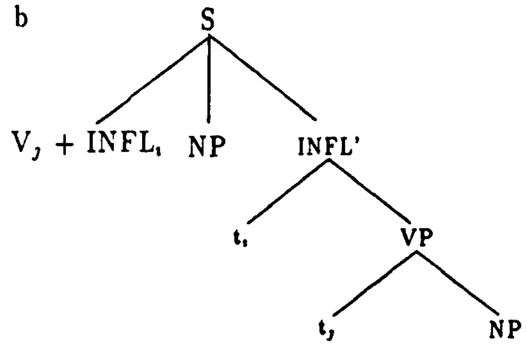



In (2-65), the verb *have* has first raised to INFL to incorporate into tense and agreement, and then moved into the head of CP. Since the sentence is grammatical, all NPs must have case. The subject NP is case-marked by INFL in COMP, as case-marking by INFL in English is bidirectional ([Koopman 84]). What about the object NP? It seems to me that, on the assumption that a verb trace may not assign (or transmit) case, the NP *any money* should be caseless. Note, incidentally, that to invoke the *Government Transparency Corollary* so as to allow the verb in COMP to govern the stranded object NP would not do. For even though government obtained, the verb is not adjacent to the stranded object and therefore cannot case-mark it. Similar remarks hold with respect to the VSO constructions of many languages which in the work of Stump, Sproat, Travis and Koopman ([Stump 84], [Travis 84], [Sproat 85], [Koopman 84]) have been analyzed as involving movement of V to INFL and movement of INFL into sentence initial position as shown in (2-66) for Welsh.[14]

[14] The VSO analysis proposed in these works could be made to be isomorphic to the analysis of inverted English constructions such as the sentence in (2-64) by assuming that after amalgamating with INFL the verb moves into the head of CP as suggested in [Sanfilippo 87]:

[$_{CP}$ [$_{C}$ gwelodd$_i$] [$_{IP}$ [$_{NP}$ Siôn] [$_{I'}$ [$_{I}$ $t_i$] [$_{VP}$ [$_{V}$ $t_i$] [$_{NP}$ ddraig]]]]]

(2-66) a Gwelodd Siôn ddraig
saw-3,SING,PAST dragon
"John saw a dragon"

b



([Sproat 85], p.202)

In short, the assumption that a verb trace does not assign/transmit case is highly questionable at best.

Appealing as it might seem, Baker's attempt to reduce (morphosyntactic) affixation to syntactic movement cannot be regarded as a viable approach to morphosyntactic explanation until problems such as those pointed out above are provided with an appropriate answer. Note also that a model of natural language understanding which adopted incorporation as a processing strategy would assume that speakers/hearers compute word-formation operations on-line alongside phrase formation processes. Such an assumption seems implausible both with respect to productivity (e.g. morphological processes are generally less regular than syntactic processes) and efficiency in parsing strategies. From this perspective, a lexicalist approach — where all word-formation processes are (partially) compiled — is undoubtly more motivated.

### 2.1.4 Conclusions

Chomsky's original proposal to derive GRs from syntactic structure, Williams' work on argument structure and predication and Baker's efforts to reduce morphosyntactic affixation to head-movement have contributed enormously to the debate on the nature of GRs and GR-changing. However, as a whole, the practice of reducing GRs to structural relations between phrase markers does not seems to provide a suitable framework in which to develop a natural account of the relation between syntactic structure, morphological structure, and lexical information. This may well be because notions such as c-command and government are ill-suited to represent lexical information and characterize word-internal processes. Because GRs and GR-changing is so intimately related to lexical properties and word-bound processes it would seem more appropriate to assign less relevance to configurational notions and maximize the role of lexical information. Note also that a theory where GRs are defined in terms of dominance and precedence relations makes rather strong claims about phrasal constituency. While these claims may be appropriate with respect to languages like English, it is less clear how successfully they could be adapted to nonconfigurational languages where surface word order does not encode subject object asymmetries. Certainly, nonconfigurational sentence structures would have to be mapped into abstract configurational structures either by means of movement or by stipulation (Chomsky's "assume a GF" rule, [Chomsky 81]). The legacy of either one of these practices remains highly controversial.

## 2.2 GRs as Primitives

Within a transformational theory of grammar, the option of deriving GRs from syntactic constituency is provided by mapping a non-configurational surface ordering into an abstract configurational structure. Clearly, no such option is available within a monostratal grammar where constituency relations between phrases are directly derived from surface word order. In monostratal theories of grammar, GRs have either been derived from the (semantic) predicative structure of lexical items, or assumed as primitives. The latter program has been independently pursued in both multistratal and monostratal frameworks, most notably in Relational Grammar (RG) and Lexical Functional Grammar. Our choice of concentrating on LFG is mainly motivated by the fact that this theory establishes an explicit connection between thematic relations and GRs, and therefore provides topics of discussion which are more germane to the goals of this thesis.

### 2.2.1 GRs and GR-Changing in LFG

In LFG, a basic distinction is made between grammatical relations and grammatical functions. In [Bresnan 82], grammatical functions were defined as universal syntactic primitives of the grammar, and classified according two main parameters: *subcategorizability* and *semantic restrictedness*. Subjects, objects and sentential/VP-complements are subcategorizable functions in that they can be assigned to the arguments of lexical items. Nonsubcategorizable functions correspond to adjunct phrases, and — as the term suggests — may not be associated with the arguments of lexical items. The subcategorizability of grammatical functions such as *Topic* and *Focus* is subject to parametric variation and distinguishes between "subject-oriented" and "topic-oriented" languages.

Subcategorized functions may differ with respect to the range of argument types with which they can be associated. Grammatical functions which are not inherently tied to specific selectional restrictions are *semantically unrestricted*, while those which can only be paired with arguments of specific semantic types are *semantically restricted*. For example, the subject function can be linked to any thematic role and can also occur as a non-thematic function when encoding the subject-subcategorization of raising verbs such as "seem" and "appear", while oblique functions are always thematic (i.e. they are never associated with pleonastic elements), and are generally more sensitive to selectional restrictions (they are inherently tied to a thematic role ([Rappaport 83])).

In addition, complements and adjuncts may occur as *closed* or *open* functions. Closed complement and closed adjunct functions (XCOMP, XADJ) are assigned to clausal expressions which have a controller of their own, e.g. the underlined NPs in (2-67a) and (2-67b).

(2-67) a John believes [*that* <u>*Bill*</u> *is a genius* ]$_{XCOMP}$
b [<u>*John*</u> *being angry*]$_{XADJ}$ , Mary left

Clausal expressions which are assigned the open complement and open adjunct functions (COMP, ADJ) are instead controlled from without, e.g.

(2-68) a <u>John</u> wants [*to be a genius* ]$_{COMP}$
b [*Being angry at John*]$_{ADJ}$, <u>Mary</u> left

A schematic picture of the grammatical functions adopted in LFG is given below.

(2-69)

| GRAMMATICAL FUNCTIONS | | |
|---|---|---|
| Subcategorizable | | Nonsubcategorizable |
| Unrestricted | Restricted | ADJ (selfcontained controller) |
| SUBJ | OBL$_\theta$ | XADJ (controller is outside) |
| OBJ | COMP (finite complement clause) | |
| OBJ2 | XCOMP (non-finite verb phrase) | |
| TOPIC | | |
| FOCUS | | |

In LFG, grammatical relations are associations of grammatical functions with thematic roles or with non-thematic values. These associations are encoded in the lexicon, where each verb is represented as a *lexical form* consisting of a *predicate argument structure* and a *grammatical function assignment.* The predicate argument structure of a lexical form is a list of the arguments for which there are selectional restrictions. The grammatical function assignment of a lexical form is a list of its syntactically subcategorized functions.

(2-70)

a. predicate argument structure: break⟨agent, theme⟩

b. grammatical function assignment: ((SUBJ), (OBJ))

c. lexical form:

$$\begin{array}{cccc} \text{`break}\langle & \text{agent} & \text{theme} & \rangle\text{'} \\ & | & | & \\ & \text{SUBJ} & \text{OBJ} & \end{array}$$

The assignment of functions is subject to a number of universal conditions. For example all monadic predicates are assigned a SUBJ, and all dyadic predicates are assigned a SUBJ and an OBJ. A very important condition on grammatical function assignment is the *Biuniqueness of Function-Argument Assignments* which establishes a one-to-one relation between grammatical functions and arguments within the predicate-argument structure of a lexical form.

(2-71) *Biuniqueness of Function-Argument Assignments*
$G = g_1, ..., g_n$ is a possible grammatical function assignment to $P(1, ..., m)$ if and only if the mapping from $1, ..., m$ to $G$ defined by $i \mapsto g_i$ is injective (one-to-one and into). ([Bresnan 82], p. 163)

Grammatical function assignment lists serve as subcategorization frames. Subcategorization is checked in *Functional Structure* for *Completeness* and *Coherence* ([Kaplan & Bresnan 8

*Completeness* ensures that all subcategorized arguments are present in functional structure (e.g. it rules out sentences like **John devours,*eats a cookie*), while *Coherence* restricts the occurrence of subcategorizable grammatical functions to those listed in the verb's lexical form (e.g. it rules out sentences like **John arrives Bill*).

### Lexical Mapping Theory

In LFG, GR-changing rules are formulated as lexical redundancy rules relating lexical forms. In early LFG, these rules were allowed to perform destructive operations on grammatical function lists. For example the passive rule would substitute the SUBJ of a lexical form with either the null function $\phi$ or OBL, and the OBJ of the lexical form with the function SUBJ.

(2-72) *Effect of Passivization on a Lexical Form*

| | | | | | |
|---|---|---|---|---|---|
| a. | L( | (SUBJ), | (OBJ) | ) | → |
| | | agent | theme | | |
| b. | L( | (OBL/$\phi$), | (SUBJ) | ) | |
| | | agent | theme | | ([Bresnan 82], p. 9) |

More recently, it was felt that if the range of operations on lexical forms were restricted to *monotonic* operations as much as possible then a more elegant system would result. Intuitively, an operation is monotonic if it is information-preserving: it may add new information if such addition is consistent with the information of the input, but may neither subtract nor change any information present in the input. Rules such as (2-72), for example, are not monotonic because they delete and change functional values. Bresnan & Kanerva, Bresnan & Moshi and Alsina & Mchombo ([Bresnan & Kanerva 88], [Bresnan & Moshi 89], [Alsina & Mchombo 88]) have recently developed a new theory of GRs and GR-changing within LFG where monotonicity can be made to follow by underspecifying grammatical relations in lexical forms (see also [Levin 87]). Grammatical functions such as SUBJ, OBJ etc. are no longer viewed as atomic specifications, but are defined in terms of more primitive functional features. The process of function realization and function change can thus be more easily implemented as an incremental accretion of functional information leading to fully specified grammatical relations. The emerging theory, *Lexical Mapping Theory*, consists of four basic components:

- A Hierarchy of Lexical Roles

- Decomposition of Syntactic Functions
- Lexical Mapping Principles
- Well-formedness Conditions

**Hierarchy of Lexical Roles** Bresnan & Kanerva and Bresnan & Moshi assume a universal hierarchy of thematic roles which provides a classification for argument positions in lexical forms. The hierarchy includes the following roles in descending order: agent, beneficiary and maleficiary, recipient and experiencer, instrumental, patient and theme, locative, motive:

(2-73) *Universal Thematic Hierarchy*

$$ag > ben/mal > recip/exp > ins > pt/th > loc > mot$$

In addition to the roles in (2-73), the symbol $\hat{\theta}$ is used to designate the highest thematic role of a predicate, and the symbol $\theta_{th \gg \theta}$ as a cover term for roles lower than theme. Thematic roles can also merge to form complex roles. In Bresnan & Kanerva for example, the predicate-argument structure of verbs like *run* (in Chichewa) is represented as in (2-74), where *ag+th* is meant to indicate that the first argument in the predicate-argument structure of the verb is both an agent and a patient.

(2-74) *thamánga*: $\langle ag + th \quad loc \rangle$ 'run'

**Decomposition of Syntactic Functions** Syntactic functions are decomposed according to the features $[\pm r]$ (thematically restricted or unrestricted) and $[\pm o]$ (objective or not) as follows:

(2-75)
$$\begin{bmatrix} -r \\ -o \end{bmatrix} \text{SUBJ} \qquad \begin{bmatrix} +r \\ -o \end{bmatrix} \text{OBL}_\theta$$

$$\begin{bmatrix} -r \\ +o \end{bmatrix} \text{OBJ} \qquad \begin{bmatrix} +r \\ +o \end{bmatrix} \text{OBJ}_\theta$$

There is a clear sense in which this classification follows from general insights already present in previous versions of the theory. The feature $[\pm r]$ was already used to characterize functions — albeit somewhat implicitly — as we noted above. The additional feature $[\pm o]$ distinguishes functions which cannot occur as complements of intransitive categories such as Adjective and Noun from those which can. This subclassification corresponds to the difference between primary/secondary objects (OBJ, $\text{OBJ}_\theta$) and oblique functions ($\text{OBL}_\theta$) in (2-69). Individually, each value for the two features $[\pm r]$ and $[\pm o]$ defines a partial grammatical function as indicated below.

| | | |
|---|---|---|
| (2-76) | $[-r]$ | SUBJ/OBJ |
| | $[+r]$ | $\text{OBJ}_\theta/\text{OBL}_\theta$ |
| | $[-o]$ | $\text{SUBJ}/\text{OBL}_\theta$ |
| | $[+o]$ | $\text{OBJ}/\text{OBJ}_\theta$ |

**Lexical Mapping Principles** While in early LFG semantic roles were associated with fully specified grammatical functions, in Lexical Mapping Theory this association involves partially specified grammatical functions. The association of semantic roles and partially specified grammatical functions is governed by three kinds of *Lexical Mapping Principles*:

1. Intrinsic Role Classifications

2. Morpholexical Role classifications

3. Default Role Classifications

Bresnan & Kanerva restrict Lexical Mapping Principles to monotonic operations:

> A constraint on all lexical mapping principles is the preservation of information: they can only *add* features, and not delete or change them. This monotonicity is allowed by underspecification. ([Bresnan & Kanerva 88], p. 12).

**(1) Intrinsic Role Classifications** Intrinsic role classifications establish a link between underspecified syntactic functions and inherent semantic properties of thematic roles. In Bresnan & Kanerva the following encoding principles are included among the set of intrinsic role classifications.

(2-77) a agent encoding: $\begin{array}{c} ag \\ | \\ [-o] \end{array}$

b theme encoding: $\begin{array}{c} th/pt \\ | \\ [-r] \end{array}$

c locative encoding: $\begin{array}{c} loc \\ | \\ [-o] \end{array}$

Bresnan & Kanerva consider these encoding principles as providing some sort of substantive universals. However, they point out that both the theme and locative intrinsic classifications may be preempted by encodings which are specific to particular lexical subclasses. For example, the locative role introduced by the applicative morpheme in Chichewa can be associated with the functional specification [$+o$] (Alsina & Mchombo (in preparation)). In Bresnan & Moshi this possibility is stated more explicitly by introducing disjunctive specifications in intrinsic classifications, as shown in (2-78) where the values [$+o$], [$-r$] are alternative classifications for instrumental, patient, theme, locative and motive roles.

(2-78) $\underbrace{ben/mal > recip/exp > \underbrace{ins > pt/th > loc > mot}_{[+o]}}_{[-r]}$

**(2) Morpholexical Role Classifications** Morpholexical role classifications arise from the application of GR-changing rules to lexical forms. In addition to augmenting or reducing the valency of predicate-argument structures, morpholexical rules may establish new associations between thematic roles and syntactic functions. For example, the passive rule in (2-79a) introduces a thematically restricted functional specification for the highest role of a lexical form, and the rule of *locative inversion* in (2-79b) links the locative role to [$-r$] within a predicate-argument structure whose highest role is a theme.

(2-79) a passive: $\begin{array}{c} \hat{\theta} \\ | \\ [+r] \end{array}$

b locative inversion: $\langle th \ldots \begin{array}{c} loc \\ | \\ [-r] \end{array} \rangle$

**(3) Default Role Classifications** Default role classifications establish a link between the thematic and grammatical function hierarchies. As the term suggests, these classifications apply only if the specifications which they introduce are consistent with specifications assigned through other types of classification. The two default classification in (2-80) express the generalizations that roles lower than theme ($\theta_{th \gg \theta}$ in Bresnan's & Kanerva's notation) are restricted, and restricted roles ( $\underset{[+r]}{\theta}$ ) are non-objective.

(2-80) a $\begin{array}{c} \theta_{th \gg \theta} \\ | \\ [+r] \end{array}$

b $\begin{array}{c} \theta \\ [+r] \\ | \\ [-o] \end{array}$

The default classifications in (2-81) associate the highest role with $[-r]$, next highest with $[+o]$, and the third highest with $[+r]$.

$$\text{(2-81)} \quad \left( \begin{array}{c} top\ \theta \\ | \\ [-r] \end{array} \left( \begin{array}{c} next\ \theta \\ | \\ [+o] \end{array} \left( \begin{array}{c} next\ \theta \\ | \\ [+r] \end{array} \right)\right)\right)$$

The grammatical function hierarchy obtained through these default classifications is as shown below.

(2-82) SUBJ/OBJ> OBJ/OBJ$_\theta$ > OBJ$_\theta$/OBL$_\theta$

**Well-formedness Conditions** After mapping principles have applied, any remaining underspecified grammatical function is fully instantiated. This instantiation is free as long as *Biuniqueness* (cf. (2-71)) and the *Subject Condition* in (2-83) are observed.

(2-83) *The Subject Condition*
Every lexical form must have a subject

Once well-formedness conditions have applied, lexical forms are entered in feature structures as values for the attribute PRED ([Kaplan & Bresnan 82]). The following examples taken from Bresnan's & Kanerva's paper on locative inversion in Chichewa provide a concrete example of the types of lexical derivations which arise from the Lexical Mapping Theory.

### Lexical Mapping Theory at Work: Locative Inversion in Chichewa

Chichewa has a rule of inversion which preposes the locative phrase of an intransitive sentence, and postposes its subject.

| | | | | | |
|---|---|---|---|---|---|
| (2-84) | a | Nkhalambá | zókha | a-a-khalá | kú-mu-dzi |
| | | 10elder | 10-only | 10SB-PERF-remain-IND | 17-3-village |
| | | "Only elders have remained in the village" | | | |
| | b | kú-mu-dzi | kw-a-khalá | nkhalambá | zókha |
| | | 17-3-village | 17SB-PERF-remain-IND | 10-elder | 10-only |
| | | "In the village have remained only elders" | | | |

([Bresnan & Kanerva 88], p. 19)

Evidence from agreement, word order, and phrasal phonology strongly suggests that the preposed locative phrase functions as a subject, while the postposed subject is an object ([Bresnan & Kanerva 88]). In Lexical Mapping Theory this characterization can be obtained as follows. In both (2-84a) and (2-84b) the partial lexical form for the intransitive verb will be as in (2-85) after intrinsic classifications.

| (2-85) | | | | |
|---|---|---|---|---|
| | *khāla* ⟨ | *th* | *loc* | ⟩ 'remain' |
| | | \| | \| | |
| *intrinsic* : | | $[-r]$ | $[-o]$ | |

If no locative inversion applies, default classification will add the functional feature $[+r]$ to the non-objective locative as shown in (2-86). At this stage, the grammatical function associated with the locative argument is fully specified, i.e. $[-o]$ and $[+r]$ conjunctively define an oblique grammatical function. The theme argument could still be potentially realized as either a subject or an object because the feature $[-r]$ alone does distinguish between these two functions. However, well-formed conditions require that the theme be syntactically realized as a subject since otherwise the subject condition is violated, i.e. there would be no subject within the predicate-argument structure of the verb as a whole.

| (2-86) | | | | |
|---|---|---|---|---|
| | *khāla* ⟨ | *th* | *loc* | ⟩ 'remain' |
| | | \| | \| | |
| *intrinsic* : | | $[-r]$ | $[-o]$ | |
| *default* : | | | $[+r]$ | |
| | | OBJ/SUBJ | $\text{OBL}_{loc}$ | |
| *wf.* : | | SUBJ | $\text{OBL}_{loc}$ | |

If inversion takes place, default classifications will not apply until after the locative argument has received the functional specification $[-r]$ as shown in (2-87); no default classifications can be assigned to the resulting predicate-argument structure since the grammatical function associated with the locative role in (2-87) is fully specified, and there are no default specifications for an unrestricted argument. The locative argument will thus be realized as a subject, while the theme could be either a subject or an object. Well-formedness conditions will require that this argument be realized as an object, i.e. according to the *Biuniqueness* constraints all grammatical functions within the same predicate-argument structure must be distinct.

$$\begin{array}{llccccl}
\text{(2-87)} & & kh\breve{a}la \; \langle & th & loc & \rangle & \text{'remain'} \\
 & & & | & | & & \\
 & intrinsic: & & [-r] & [-o] & & \\
 & loc-inv: & & & [-r] & & \\
 & default: & & & & & \\
\hline
 & & & \text{OBJ/SUBJ} & \text{SUBJ} & & \\
 & wf.: & & \text{OBJ} & \text{SUBJ} & &
\end{array}$$

### Comments on Bresnan's *et al.'s* Theory of GRs and GR-Changing

Bresnan's *et al.'s* Lexical Mapping Theory provides a very appealing approach to GRs and GR-changing. Because the theory is developed within a strongly lexical framework and its rules are information-preserving, the resulting framework provides efficient tools for language processing. At the same time, the theory makes a tangible contribution to the modelling of language universals, and offers a very explicit representation of the relation between syntactic and thematic information. However, these results are obtained on the assumption that grammatical functions (or the atomic features which define them) are primitive notions of the theory of grammar, an assumption which is rather controversial. Insofar as any theory of grammar must provide a theory of case and thematic relations as well as a semantic representation of functor-argument relations, the introduction of primitive grammatical functions may well be unnecessary. A theory such as LFG which takes GRs as primitive elements of grammar implies that GRs cannot be reduced to the interaction of case, combinatorial properties of predicates, and thematic roles. For if GRs could be adequately derived from these factors, primitive GRs would be superfluous. However no conclusive evidence that primitive GRs are absolutely indispensable has yet been provided.

Aside from considerations of economy, a potential problem for the Lexical Mapping Theory stems from the fact that its operations can only take place in the lexicon. In particular, no underspecified grammatical functions will be allowed at the level of f-structure. This is simply because default classifications and well-formedness conditions will induce full instantiation of any functional value in the predicate-argument structure of lexical forms which is still underspecified after the application of other lexical mapping principles. Consequently, no GR-changing operations can be carried out during a syntactic parse since such operations (i.e. Morphological Role Classifications) are effectively formulated as information-preserving operations in Lexical Mapping Theory. While this restriction provides a desirable characterization of morphosyntactic processes which involve affixation (e.g. word formation is carried out within the lexicon), the assumption that all morphosyntactic processes should yield a single lexical form seems inappropriate for cases where two independent words are involved as in the Italian and French causative structures discussed in the previous section.

## 2.3 GRs Derived from the Semantic Constituency of Predicates

As was mentioned at the beginning of the last section, the quest for a nonconfigurational approach to GRs within surface oriented theories of grammar has generated alternative programs of research. In addition to the practice in LFG to treat GRs as primitive, a considerable amount of effort has been devoted to derive GRs from the semantic constituency of predicate-argument structures. This approach has been mainly pursued in Categorial Grammar.

### 2.3.1 Dowty on GRs and GR-Changing Rules

Working within a Montague Grammar (MG) framework, Dowty ([Dowty 82a], [Dowty 82b]) has developed an approach where GRs are derived from the hierarchical order in which a verb combines with its arguments. Following Montague and Schoenfinkel, Dowty assumes that verbs are $n$-place functions from argument denotations into $n-1$-place functions:

*Montague-Schoenfinkel Principle*
A multi-place verb of $n$ arguments is always represented as a functor of one argument that yields a *n-1* place verb (phrase) as its value. ([Dowty 82b], 116)

It is the order inherent in functor-argument structures which gives rise to GRs. In MG, the *Montague-Schoenfinkel Principle* results from three interacting factors:

- the requirement that each syntactic rule be associated with a semantic rule,
- the relation between syntactic categories and the logical types of expressions, and
- the categorial calculus used to define syntactic categories and their combinatory properties.

Each linguistic expression is associated with a logical type corresponding to the semantic object denoted by the expression. The set of types is recursively defined in terms of primitive objects such as $t$ and $e$ denoting respectively the set of truth values ($\{1,0\}$) and the set of individuals.[15]

(2-88) a $< t >$ is a type
b $< e >$ is a type
c If $a$ and $b$ are any types, then $< a, b >$ is a type denoting a function from denotations of type $a$ into denotations of type $b$.

The correspondence between the semantic translation of an expression and its related logical type is governed by definitions such as in (2-89) ($ME_\alpha$ stands for "the set of meaningful expressions of type $\alpha$").

(2-89) a Every variable of type $a$ is in $ME_a$
b Every constant of type $a$ is in $ME_a$
c If $\alpha \in ME_a$ and $u$ is a variable of type $b$, then $\lambda u\alpha \in ME_{<b,a>}$
d If $\alpha \in ME_{<a,b>}$ and $\beta \in ME_a$, then $\alpha(\beta) \in ME_b$
$\vdots \qquad \vdots \qquad \vdots$

Syntactic categories and combinatory relations between them are defined in terms of three primitive category types $t$, $CN$ and $IV$ within a categorial grammar calculus ([Ajdukiewicz 35]) as follows:

[15] For ease of exposition, reference to the senses (or intensions) of types is omitted. See [Dowty *et al.* 81] for a comprehensive presentation of Montague's framework.

(2-90) a *basic categories*
$t$, $CN$ and $IV$ are syntactic categories

b *composite categories*
If $A$ and $B$ are any syntactic categories, then A/B is also a syntactic category.

c *functional application*
An expression of category $A/B$ can combine with an expression of category $B$ to yield an expression of category $A$; i.e. $apply(A/B,\ B) = A$

Category types are mapped into logical types through a function $f$ in such a way that:

(2-91) a $f(t) = t$

b $f(CN) = f(IV) = < e, t >$

c For all categories $A$ and $B$, $f(A/B) = < f(B), f(A) >$.

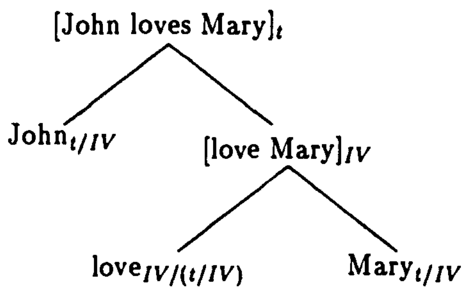
Because of the correspondence between syntactic and logical types, each occurrence of functional application for syntactic categories will be related to a rule of functional application for logical types. Given the correspondence between logical types and expressions indicated in (2-89d), functional application will always be associated with a semantic rule which has the effect of applying the semantic translation of the functor expression to that of the argument, e.g.

(2-92) $apply(A/B,\ B) = A \leftrightarrow apply(< f(B), f(A) >,\ f(B)) = f(A)$.

Crucially functional application will allow a functor category to combine with one argument at a time. For example, given an assignment of categories to expressions as in (2-93), the transitive verb will be represented as a functor of one argument which combines with a object noun phrase to yield a functor of the same sort which combines with a subject noun phrase to yield a sentence as indicated in (2-94).

(2-93) *Noun phrases*: John, Mary $\in ME_{t/IV}$
*Transitive Verbs*: love $\in ME_{IV/(t/IV)}$

(2-94)




Following [Montague 70], Dowty considers each syntactic rule to be a triple consisting of:

- a function $F_i$ which realizes syntactic and morphological operations such as concatenation, agreement, case marking etc.
- a sequence of input categories to the rule
- the output category of the rule

For example, the two rules involved in the derivation of a sentence like (2-94), the *Subject-Predicate Rule* and the *Direct-Object Rule*, and the rule for combining a ditransitive verb with its indirect object are represented as in (2-95).

(2-95) a *Subject-Predicate Rule*
S1: $< F_1, < IV, t/IV >, t >$

b *Verb-Direct Object Rule*
S2: $< F_2, < IV/(t/IV), t/IV >, IV >$

c *Verb-Indirect Object Rule*
S2: $< F_3, < (IV/(t/IV))/(t/IV), t/IV >, IV/(t/IV) >$

Dowty suggests that by parametrizing $F_1$, $F_2$, $F_3$ so as to account for language-specific conventions about case/agreement marking and word order, these rules can be taken to provide a universal characterization of the way in which a verb combines with its arguments. For example, in SVO and SOV languages like English and Japanese $F_1$ and $F_2$ will involve concatenation, in VSO languages like Breton $F_1$ will involve Bach's rule of *right wrap* ([Bach 79]), and in free word order languages like Latin both operations will involve set union. Yet in all these languages, the semantic association of a verb with its arguments is carried out uniformly through functional application, and therefore the hierarchical order in which a verb joins its arguments will be the same. Dowty proposes that GRs can be seen as deriving from this universal characterization of the functor-argument association according to the following scheme:

1. A SUBJECT is any NP [i.e. an expression of category type $t/IV$] combined with an IV to produce an S [ $t$].
2. A DIRECT OBJECT is any NP combined with a TV [ $IV/(t/IV)$] to produce an IV.
3. An INDIRECT OBJECT is any NP combined with a TTV [ $(IV/(t/IV))/(t/IV)$] to produce a TV. [Dowty 82a]

GR-changing is characterized through syntactic rules similar to S1, S2 and S3 in (2-95) which can reduce, rearrange or expand the arity of a given predicate. For example, agentless passive is treated as a rule which converts a category of type $IV/(t/IV)$ into a category of type $IV$ as shown in (2-96). The semantic counterpart of the rule specifies that the lexically designated subject is existentially quantified. The remaining argument, the lexically designated object, will have subject status since it is the last argument to combine with the verb.

(2-96) a S6: $< F_6, < IV/(t/IV) >, IV >$ (Agentless Passive)

Semantic Operation: $\lambda y(\exists x)[(\alpha'(y))(x)$

English: $F_6(\alpha) = be^\frown alpha'$, where $\alpha'$ is the passive form of $\alpha$

b [John is loved]$_t$

John$_{t/IV}$ [be loved]$_{IV}$ (by S6)

love$_{IV/(t/IV)}$

### 2.3.2 Grammatical Relations and Thematic Roles

To capture generalizations about the association of GRs and thematic roles, [Dowty 87] has developed an approach where GR-selection in the lexicon can be related to entailments of verb meanings. Dowty assumes that there are only two "thematic-role-like concepts" for verbal predicates: the *proto-agent* and *proto-patient* role. Proto-roles are conceived of as "cluster-concepts" which are determined for each choice of predicate with respect to a given set of semantic properties. The properties which contribute to the definition of the proto-agent and proto-patient roles are listed below.

(2-97) **Contributing Properties for the Proto-Agent Role**
- a volition
- b sentience (and/or perception)
- c causes event
- d movement

(2-98) **Contributing Properties for the Proto-Patient Role**
- a change of state (including coming-to-being, going-out-of-being)
- b incremental theme (i.e. determinant of aspect)
- c causally affected by event
- d stationary (relative to movement of Proto-Agent)

Proto-roles are related to argument selection through the *Argument Selection Principle* and two corollaries which govern the lexicalization of GRs.

> ARGUMENT SELECTION PRINCIPLE: The argument of a predicate having the greatest number of Proto-Agent properties entailed by the meaning of the predicate will, all else being equal, be lexicalized as the subject of the predicate; the argument having the greatest number of Proto-Patient properties will, all else being equal, be lexicalized as the direct object of the predicate.
>
> COROLLARY 1: If two arguments of a relation have (approximately) equal numbers of entailed Proto-Agent and Proto-Patient properties, then either may be lexicalized as the subject (and similarly for objects).
>
> COROLLARY 2: With a three-place predicate, the non-subject argument having the greater number of entailed Proto-Patient properties will be lexicalized as the direct object, the non-subject argument having fewer entailed Proto-Patient properties will be lexicalized as an oblique or prepositional object (and if two non-subject arguments have approximately equal entailed Proto-Patient properties, either may be lexicalized as direct object). ([Dowty 87], p. 20)

The basic idea underlying this approach to argument selection is that the clustering of semantic properties such as those in (2-97) and (2-98) provide a ranking according to which the arguments of a verb "compete" with one another for subjecthood and objecthood. For example, the subjects of a ditransitive verb such as *write* correspond to the arguments for which the properties volitionality, sentiency, causation and motion are entailed, while the direct object argument is generally understood as being an incremental theme,[16] causally affected and stationary as well as undergoing change; the indirect object in turn has fewer entailed proto-agent properties than the subject argument (e.g. it lacks volitionality and causation) and fewer proto-patient properties than the direct object arguments (it does not undergo change and is not causally affected). At parity of ranking, alternative lexicalization patterns may arise. According to Dowty, this is what happens with lexical "doublets" such as *buy* and *sell*:

> Consider first the case of *buy* vs. *sell*, *lend* vs. *borrow*. A sale transaction requires both a buyer and a seller to be sentient, to act volitionally, causally and — normally — with some movement (so that the buyer gets the sold object and the seller gets the buyer's money). Both these participants qualify well for subjecthood according to the selection principle (22), but moreover they qualify *equally* well, so (22) licences both lexicalizations.

In some cases, the determination of grammatical relations is more subtle. Consider the case psychological verbs such as *like* and *please* where the syntactic realization of the *experiencer* and *stimulus* arguments differ in spite of meaning similarities. Dowty observes that with respect to properties which promote agentivity (e.g. volitionality, sentiency, causation, motion) either the stimulus or experiencer role can be realized as a subject.

> (i) the predicate entails that the Experiencer has some perception of the Stimulus — thus the Experiencer is entailed to be sentient/perceiving though the Stimulus is not — and (ii) the stimulus causes some emotional reaction or cognitive judgement in the Experiencer. The first of these is a property that counts licensing the Experiencer as subject, while the second is one that counts as licensing the Stimulus as Subject.

What tips off the scale in favour of the stimulus argument with verbs such as *please* is the possibility of an inchoative interpretation which implies a change of state in the Experiencer as shown in (2-99). Argument roles which have the property of undergoing change of state are canonically more suitable to be realized as objects.

(2-99) The birthday party is pleasing Mary (right now)

[16] I.e. "Being an incremental theme" is the property ascribed to the argument of a verb whose reference properties are involved in the determination of telic aspect for the event denoted by the resulting verb phrase or sentence, see §3.1.1 and §6.1.

All else being equal, psychological verbs which may express change of state (e.g. *amuse, please, frighten, irritate*) will thus realize the stimulus argument as subject and the experiencer as object. Interestingly enough, verbs such as *like* where the experiencer surfaces as the subject do not seem to be able to give rise to an inchoative interpretation ([Croft 86]). As Dowty observes verbs such as *like* may not be construed as expressing change of state; e.g.

(2-100) *Mary is liking the birthday Party (right now)

Dowty suggests that proto-roles may function as semantic defaults in the acquisition of lexical meanings. By default, Dowty argues, the language learner assumes that verb meanings will satisfy all proto-agent and proto-patient entailments for their subject and object arguments respectively. If a conflict arise, then the assumed proto-role entailment which leads to conflict is removed without causing a change in argument selection. This default mechanism allows the language learner to create a core representation for a given verb meaning, and then derive specific word senses by overriding (or confirming) semantic defaults. The possibility of encoding proto-roles as semantic defaults provides an explanation for the emergence of argument selection patterns which do not seem to follow from diverging rankings of arguments in terms of proto-role entailments. Consider the example of psychological predicates such as *please* discussed in the previous paragraph. According to the hypothesis that proto-roles may function as semantic defaults in the acquisition of lexical meanings, the language learner will assume that the experiencer of such verbs satisfies the proto-patient entailment "change of state". Such assumption will lead to the realization of the experiencer argument as object since — all else being equal — the argument of a transitive verb which the verb characterizes as undergoing change makes a better proto-patient. However, verbs such as *please* need not entail change of state for their experiencer argument. This is simply because verbs such as *please. worry, annoy, frighten, surprise* allow for either a stative or inchoative interpretation as indicated in (2-101) (see 6.1.2 for details).

(2-101) a Bill worried Mary
b Mary got worried because of Bill (*inchoative interpretation*)
c Mary worried about Bill (*stative interpretation*)

The "change of state" entailment for the experiencer argument holds when the verb is understood as involving inchoation, but not under a stative interpretation. Dowty's idea is that the meaning that is learned for verbs such as *please, worry, annoy, frighten, surprise* would serve for either a stative or inchoative interpretation. Under the stative interpretation the default proto-patient entailment "change of state" for the experiencer argument is removed, while the argument selection pattern determined by the core meaning representation of the verb persists.

### 2.3.3 Comments On Dowty's Approach

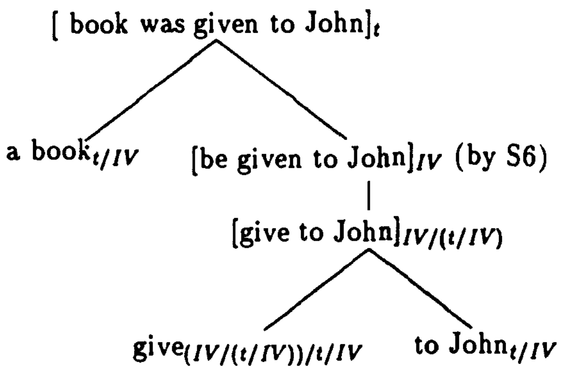
Dowty's approach provides several advantages over a syntax-driven account of GRs such as the one proposed in GB, or the LFG account where GRs emerge from the association of thematic roles with primitive functional specifications. First of all, Dowty is able to define GRs without having to rely on configurationality. This result is important since in many languages, word order is irrelevant in the determination of GRs. Moreover, Dowty's theory provides a monostratal account of GRs in which functional notions such as "subject" and "object" emerge as derived notions rather than primitives. Second, Dowty provides a clear mechanism to relate thematic information to lexically designated GRs. Such mechanism relies on a treatment of thematic roles which eschews the shortcomings of traditional role classifications — such as the one adopted in LFG — where thematic roles are assumed to be discrete. Third, Dowty's theory of GRs is semantically well-grounded, and eschews the circularity inherent to the GB practice of defining both argument roles and lexically designated GRs in syntactic terms.

Dowty argues also that his account correctly predicts that relation-changing morphology is marked on verbs:

> ... the only constituent the relation-changing rules have to operate on at the time they apply is the verb, hence there is nothing else that a morphological marker could be attached to by the relation-changing rule. ([Dowty 82a], p. 99)

I think that this prediction can essentially made to follow from Dowty's system, although its implementation give rise to questionable results under processing considerations. Recall that in Dowty's approach GR-changing rules are formulated as syntactic rules. Consequently, the input expression to the rule may be a phrase containing more material than a single verb. To see this, consider a derivation where the passive rule in (2-96) applies to a ditransitive verb as shown below.

(2-102)




First, the verb combines with its indirect object to yield an expression of category $IV/(t/IV)$. (Recall that in Dowty's system the indirect object of a ditransitive verb is the first argument to combine with the verb.) At this stage the passive rule S6 applies, reducing the category type of the input expression to $IV$ and introducing the verb *be* and the passive form of *give*. One might wonder at this point how the rule S6 can be made to provide the right results. The function $F_6$ — the rule component which is responsible for the introduction of the auxiliary and passive morphology — will take as argument the string *give to John*, and will return a string which results from concatenating the auxiliary *be* to the passive form of the input string, e.g.

(2-103) $F_6([give\ to\ John]) = be^\frown PASSIVE(give\ to\ John)$

The question arises then as to how passive morphology can be appropriately affixed to the verb in (2-103) since the word formation rule which should perform such operation takes as input the verb as well as its indirect object in this case. The mechanism required is one which makes it possible to perform word formation processes on stems which are included in syntactic constituents. A mechanism of this kind has been recently proposed by [Bach 83]. According to Bach, morphological features are expressed as functions which perform morphological operations on abstract phonological representations, e.g.

(2-104) $PLURAL(\alpha) =$ men is $\alpha = MAN$

Two basic conditions govern the application of rules such as (2-104):

- the input expression (e.g. $MAN$ in (2-104)) is defined for the feature-attribute to which reference is made in the rule (e.g. $NUMBER$)

- the input expression is unspecified for the feature-value mentioned in the rule (e.g. $PLURAL$)

In Bach's approach, morphological operations can take as input a complex phrase rather than a single stem. In this case, the rule will analyze each word of the input phrase seeking for expressions which meets the specifications of the rule. The following German example discussed by Bach provide a clear exemplification of such occurrence.

> So, for example, suppose we have gotten the function [FEM SG DAT WK] and it is to be applied to an adjective phrase like **meines Erachtens ALT** "in my opinion very OLD". The function marches through the phrase leaving it intact until it reaches ALT, at which point the word function [FEM SG DAT WK] applies to ALT to give *alten*. ([Bach 83], pp. 78-79)

Bach develops a rather sophisticated system of feature encoding, feature passing, and feature realization mechanisms where this approach to word formation can be effectively integrated with a categorial grammar framework (see Bach's paper for details). The augmentation of Dowty's approach to GR-changing with Bach's treatment of word formation can in principle provide a solution to the passivization problem in (2-103). For example, when the morphological rule responsible for the introduction of passive morphology applies to the phrasal expression *give to John* only the verb will meet the requirements of rule. The function *PASSIVE* will "march" through the phrase changing *give* into *given* and leaving intact the remaining expressions. This is because the verb is the only expression which is defined for the feature-attribute *VOICE* and no value has yet been specified for such feature-attribute.

However, this treatment of word formation gives rise to questionable conclusions. Note that if passivization applies to a coordinated $IV/(t/IV)$, as shown in (2-105a),[17] the function *PASSIVE* cannot resume after the first verb has been changed into its passive form since both verbs should be affected by the rule as shown in (2-105b).

(2-105) a give or sell to John

b *PASSIVE(give or sell to John) = given or sold to John*

[17]Note that passivization in this case must apply after the two verbs are coordinated. This is simply because the two verbs combine with their indirect object argument simultaneously, and passivization can only apply to an expression of category type $IV/(t/IV)$, e.g. a transitive verb according to Dowty's formulation of the rule.

In general, each single expression of the input to a morphological rule would have to be checked by the rule to ensure that no potential candidates are left unprocessed. But, must we assume that when processing a sentence such as (2-106a) each single word in the VP constituent is separately checked by the passive function?

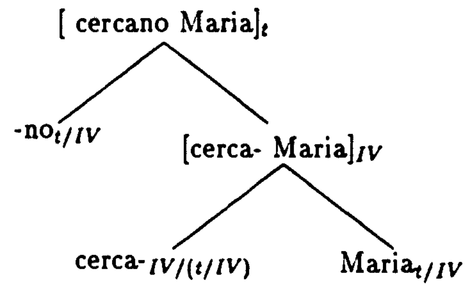
(2-106) The painting was sold to a woman who likes Bill and might give it to him as a birthday present

From a processing viewpoint, I think that such an assumption is in principle as objectionable as the assumption in Baker's theory of incorporation that morphosyntactic affixation results from head-movement.

This problem is not limited to GR-changing rules. Consider for example the following case. In null subject languages, subject-agreement morphology may satisfy the subject-subcategorization of a verb without changing the lexically designated GR-configuration of the verb. Klein (pers. com.) has observed that in these cases the agreement morpheme must be the last term to combine with the verb, otherwise some other argument would become the subject of that verb according to Dowty's appraoch. Consequently, the derivation for the Italian sentence in (2-107a) will be roughly as in (2-107b).

| | | | |
|---|---|---|---|
| (2-107) | a | Cerca-no | Maria |
| | | look for-they(AGR) | Maria |
| | | "They are looking for Maria" | |

b




The morphological operation associated with $F_1$ in the subject-predicate rule for Italian would have to be as complex as in the passive case discussed above to deal efficiently with coordinated structures such as the one in (2-108).

| | | | | |
|---|---|---|---|---|
| (2-108) | Ama-no | e | odia-no | le stesse cose |
| | love-they(AGR) | and | hate-they(AGR) | the same things |
| | "They love and hate the same things" | | | |

Note that the assumption that word formation processes such as those involved in the passive and subject-predicate rule discussed above are intermingled with phrase formation operations is essentially a consequence of the hierarchical order according to which a verb combines with its arguments, a major aspect of Dowty's theory of GRs. In particular, such an assumption would still be crucial to Dowty's account even if the goal to predict that relation-changing morphology is marked on the verb were dropped (the attainment of such goal is indeed not crucial to Dowty's approach to GRs).

An additional potential problem for Dowty's practice of deriving GRs from the hierachical order in which a predicate combines with its arguments is that this method of predicate-argument association does not work too well for null anaphora languages like Chinese or Japanese where the arguments of a verb may be freely omitted despite the lack of agreement features on the verb. If we take seriously Dowty's suggestion ([Dowty 89]) that optional arguments (e.g. arguments of event nominals) should be treated as modifiers, it would be sensible to treat Japanese and Chinese verbs as sentential categories and the nominals they optionally combine with as sentential modifiers, following Parsons' treatment of adverbial modification (see also [Carlson 84] and chapter 4). Within a grammar which adopted a treatment of predicate-argument association of this kind, Dowty's characterization of GRs would have to be radically modified.

## 2.4 Summary

Chomsky's initial approach to GRs established a program of research within transformational grammar whose primary goals have been to specify how lexical and syntactic information interact in determining dominance and precedence relations in phrase structure, and how this interaction can be modified through morphosyntactic operations. Williams' theory of argument structure provides a general framework in which these goals can be attained, maximizing the role of thematic structure and its relation to syntactic predication. However, both the conception of argument structure proposed and the augmentation of the system with coanalysis raise a number of issues which remain unsolved. First, the taxonomy of thematic roles proposed is inadequate since it enforces a syntactic characterization of thematic information which is too rigid and ultimately does not comply with the fact that thematic information is essentially semantic in nature. Second, the system uses a notion of coanalysis which although very powerful does not fully succeed in providing an account of the intermingling of syntactic and lexical representations which results from the approach to GR-changing pursued by Williams and his associates. Baker's theory of incorporation provides the means to redress the inadequacies of coanalysis by reducing morphosyntacic operations to syntactic movement. However Baker's treatment makes crucial use of theoretical devices which turn out to be rather problematic, and does not yield a well-motivated system from a processing viewpoint.

Within surface-oriented, monostratal grammars two major approaches to GRs and GR-changing have been proposed. LFG's Lexical Mapping theory yields a system which has nice processing properties and is linguistically motivated, but relies on the assumption that grammatical functions are primitive elements of the theory of Grammar. While the controversial status of this assumption alone does not undermine the approach as a whole, a system which offered qualitatively comparable results without assuming GRs as primitives would be more desirable on grounds of economy. In addition, because Mapping Lexical Theory yields fully specified lexical forms, GR-changing operations may not be carried out during a syntactic parse. This restriction yields unintuitive results in cases where GR-changing involve independent words (rather than affixes and stems). Dowty's approach provides a framework where GRs are derived from the functor-argument structure of predicates within a model of grammar based on Montague's insights. The framework has a clear semantic interpretation and offers a well-developed characterization of the interation between thematic and functional properties. However Dowty's approach crucially relies on the assumption that word formation can be carried out in parallel with phrase formation operations. From a processing viewpoint, such assumption is as questionable as any other treatment which relies of syntactic affixation. In addition, the method of predicate-argument association adopted by Dowty enforces a relation between syntactic subcategorization and semantic predication which may be too strict to provide a natural account of verb-argument relations in null anaphora languages. Yet, I think that Dowty's framework presents several advantages over the approach to GRs proposed in GB and LFG in that it has a precise model-theoretic interpretation, integrates an appealing account of thematic relations, and succeeds in providing a monostratal account where GRs are derived from independent factors rather than assumed as primitives. In keeping with this assessment, the goal of the following chapters, and in particular chapters 4 and 5, will be to develop an account which integrates the basic insights of Dowty's approach with a more flexible treatment of GRs and GR-changing where word formation processes need not involve syntactic affixation.

# Chapter 3

# Two Theories of Thematic Relations

In this chapter, I will review some recent proposals regarding the treatment of thematic information in grammar, and give a general sketch of the approach which I will adopt in the following chapters. I will be primarily concerned with the two systems of thematic encoding which arise from the model-theoretic accounts presented in [Parsons 80], [Carlson 84] and [Dowty 89]. The fundamental issue which will be explored regards the question of whether thematic roles should be defined as relations between individuals and eventualities or as second order properties of $n$-place relations. As Dowty points out, these two approaches are related to two different conceptions of how verb and NP meanings are assembled into sentence meanings. The encoding of thematic roles as properties of predicates is most appropriate within an *ordered-argument system* where verbs denote $n$-place relations which operate on a sequence of $n$ arguments to yield sentence meanings, as in Montague Grammar (see §2.3). According to this method of predicate-argument association, a thematic role is best characterized as a cluster of entailments which are shared by one of the arguments of a given set of verbs. Thematic roles are instead best characterized as relations between individuals and eventualities in the context of a *neo-Davidsonian* approach according to which verbal predicates denote *one*-place properties of eventualities ([Parsons 80]); within a characterization of verb semantics of this kind, thematic relations effectively provide an indispensable layer of semantic interpretation to combine verb and noun phrase meanings into sentence meanings. Insofar as the choice of one of these two methods of predicate-argument association is an empirical question, our main objective in the pursuit of a linguistically motivated model of thematic encoding will be to discuss and evaluate natural language data which have been used as evidence in the assessment of these two approaches.

Alongside issues regarding the role of thematic relations in semantic interpretation, the chapter is concerned with the question of how to determine the semantic content of roles. It has been often observed that thematic roles are semantically relevant only if they have some "real world" content. However, decades of research have shown that a systematic characterization of semantic properties which can be made to yield a comprehensive classification of role types is essentially impossible if each role type is to be conceived of as a discrete cluster of properties. This concern has been recently addressed by [Dowty 87] whose alternative treatment involves a characterization of thematic roles as prototypical clusters of properties viewed as semantic defaults (see chapter 2). In keeping with Dowty's characterization, our objective will be to integrate the definition of thematic roles as semantic defaults with a Neo-Davidsonian approach to verb semantics.

The chapter is organized into four sections. In §3.1 some general background information on thematic roles is provided. §3.2 and §3.3 contain a discussion of thematic encoding and verb semantics relative to neo-Davidsonian and ordered-argument systems of predicate-argument association. A comparison between the two approaches is included in §3.3. In §3.4 I will present an event-based system based on Parsons' approach to verb semantics where, following [Dowty 87], thematic roles are characterized as prototypical notions.

## 3.1 Background

Thematic relations were introduced in generative grammar during the mid-1960s and early 1970s ([Gruber 76] (*written in 1965*), [Fillmore 68], [Jackendoff 72]) as a way of classifying the arguments of natural language predicates into a closed set of participant types which were thought to have a special status in grammar. A list of the most popular roles and the properties usually associated with them is given below.

(3-1) **Agent:** A participant which the meaning of the verb specifies as doing or causing something, possibly intentionally. Examples: subjects of *kill, eat, hit, smash, kick, watch.*

**Patient:** a participant which the verb characterizes as having something happen to it, and as being affected by what happens to it. Examples: objects of *kill, eat, smash* but not those of *watch, hear, love.*

**Experiencer:** A participant who is characterized as aware of something. Examples: subject of *love*, object of *annoy.*

**Theme:** A participant which is characterized as changing its position or condition, or as being in a state or position. Examples: objects of *give, hand,* subjects of *walk, die.*

**Location:** The thematic role associated with the NP expressing the location in a sentence with a verb of location. Examples: subjects of *keep, own, retain, know,* locative PPs.

**Source:** Object from which motion proceeds. Examples: subjects of *buy, promise,* objects of *deprive, free, cure.*

**Goal:** Object to which motion proceeds. Examples: subject of *receive, buy,* dative objects of *tell, give.* (adapted from Dowty ([Dowty 89])

One of the basic ideas underlying this new enterprise was that thematic roles formed a hierarchy, and that a number of linguistic generalizations could be stated in terms of this hierarchy or though direct reference to the roles contained in the hierarchy. For example, [Jackendoff 72] proposed that the ungrammaticality of sentences such as those in (3-2) could be accounted for in terms of a regime of constraints based on the hierarchy in (3-3).[1]

| | | | | | |
|---|---|---|---|---|---|
| (3-2) | a | i. *Two hundred | pounds are weighed | by Bill |
| | | ii. *Five dollars | are cost | by the book |
| | | LOCATION | | THEME |
| | b | *John | was shaved | by himself |
| | | THEME | | AGENT |

(3-3) *The Thematic Hierarchy*
1. Agent
2. Location, Source, Goal
3. Theme

[1]The relevance of thematic restrictions on reflexive binding has been recently discussed by [Engdahl 89]. Engdahl observes that structural constraints fail to account for the possibility of reflexive binding in sentences containing psycological verbs with stimulus subjects as in (i), i.e. the antecedent NP does not c-command the reflexive pronoun (see [Pesetsky 87]).

(i) Pictures of *each other* annoyed *the politicians*

Engdahl proposes that with psychological verbs the experiencer NP may function as an antecedent in spite of structural contraints because it provides "a kind of internal perspective".

In (3-2a) the surface subject of each one of the two sentences corresponds to a location role (it indicates a position with respect to the weight/currency scale), and the *by*-phrase is a theme (the argument whose position on the weight/currency scale is being asserted). In (3-2b) the reflexive is an agent, while its antecedent is a theme. Insofar as the theme is lower on the Thematic Hierarchy than an agent or location role, the ungrammaticality of the two sentences could be directly captured in terms of rule-specific thematic conditions as in (3-4).

(3-4) a *Thematic Hierarchy Condition on Passive*
The passive *by*-phrase must be higher on the Thematic Hierarchy than the derived subject

b *Thematic Hierarchy Condition on Reflexives*
A reflexive may not be higher on the Thematic Hierarchy than its antecedent

Thematic relations have also been employed extensively to state generalization on argument selection, GR-changing, and control of infinitival complements. As we saw in chapter 2, thematic ranking plays a determinant role in the syntactic realization of argument roles both in LFG and Dowty's theory of argument selection. In LFG, for example, the assignment of functional specifications (i.e. [±*restrictive*], [±*objective*]) relative to both argument selection and GR-changing is made through reference to the ranking relations emerging from the thematic hierarchy in (3-5), or through direct reference to the roles contained in the hierarchy (see §2.2 for details).

(3-5) *Universal Thematic Hierarchy*
*ag > ben/mal > recip/exp > ins > pt/th > loc > mot*

The import of thematic information for control has been repeatedly established in the work of Jackendoff ([Jackendoff 72], [Jackendoff 87]), Sag & Pollard ([Sag & Pollard 88]), and many others where the contrast between the two sets of sentences in (3-6) with respect to subject and object control is accounted for through the generalizations in (3-7).

$$\text{(3-6)}\quad \text{a}\quad \text{John} \left\{ \begin{array}{l} \text{ordered} \\ \text{persuade} \\ \text{encourage} \\ \text{influence} \end{array} \right\} \text{Sue}_i \text{ [PRO to leave]}$$

$$\text{b}\quad \text{John}_i \left\{ \begin{array}{c} \text{promised} \\ \text{threaten} \\ \text{proposed} \end{array} \right\} \text{Sue [PRO}_i \text{ to leave]}$$

(3-7) a With directive-type predicates (e.g. *order, persuade, encourage, influence, etc.*), the goal argument is controller

b With commitment-type predicates (e.g. *promise, threaten, propose etc.*) the source argument is controller

As Jackendoff points out, a thematic account of control is preferable to either a structural or functional account in that the control patterns stated in (3-7) appear to be independent of the syntactic realization of the controlling NP. According to (3-7), the controller of the infinitival in (3-8a) is the goal NP of the main verb since such infinitival is contained within an NP headed by a directive-type nominal predicate (i.e. *orders*); in (3-8b), where the infinitival is contained within an NP headed by a commitment-type nominal, the controller is the source argument.

(3-8) a John gave $\text{Sue}_i$ orders [$\text{PRO}_i$ to leave]

b $\text{John}_i$ gave Sue a promise [$\text{PRO}_i$ to leave]

As shown in (3-9), these control patterns persist even though the controlling NP is assigned a different grammatical function.

(3-9) a $\text{Sue}_i$ got from John orders [$\text{PRO}_i$ to leave]

b Sue got from $\text{John}_i$ a promise [$\text{PRO}_i$ to leave]

### 3.1.1 Semantic Content of Roles

Since its inception, the classification of argument positions into role types was meant to be carried out in terms of primitive semantic properties of predicates. [Jackendoff 72] suggested that thematic relations should be defined in terms of the three semantic subfunctions CAUSE, CHANGE and BE which constitute some of the primitive building blocks of lexical meanings.

> The thematic relations can now be defined in terms of these semantic subfunctions. Agent is the argument of CAUSE that is an individual; theme is the argument of CHANGE that is an individual; source and goal are the initial state arguments of CHANGE. Location will be defined in terms of a further semantic function BE that takes an individual (the Theme) and a state (the Location). ([Jackendoff 72], p. 39)

For example the semantic representation of a transitive verb like *open* would be (3-10) where, according to Jackendoff's characterization of roles in terms of semantic subfunctions, $NP^1$ is agent and $NP^2$ theme.

$$\text{(3-10)} \quad \text{CAUSE}\left(NP^1, \begin{bmatrix} \text{CHANGE} \\ \textit{physical} \end{bmatrix} (NP^2, \text{NOT OPEN}, \text{OPEN})\right)$$

Although this general direction has been pursued by Jackendoff for some time ([Jackendoff 83], [Jackendoff 87]), on the whole a rigorous definition of thematic relations in terms of predicate decomposition remains a goal to be achieved. Definitions such as those in (3-1) have represented a common point of reference for years despite their fuzziness, vagueness and recognized inadequacy in providing reliable means for a thematic classification of predicate-argument structures. As a result, assumptions regarding the semantic content of roles and their representation in grammar tend to have a very speculative character. Both the number of roles needed to provide an exhaustive and linguistically motivated taxonomy of argument types and the exact import of thematic information in grammar remain open questions.

Dowty ([Dowty 87], [Dowty 89]), for example, has pointed out that when thematic roles like those in (1-1) are subjected to closer scrutiny they tend to fragment into a number of independent role types in such a way that the hypothesis that there exists a small and discrete set of such roles is seriously undermined. Some fragmentation is already evident in the disjunctive character of role definitions. For example the definition of theme in (1-1) involves two independent notions: the *dynamic* theme (i.e. a participant which is characterized as changing its position or condition), and the *static* theme (the participant which is characterized as being in a state or position). Insofar as two notions cannot be combined to yield a consistent thematic notion, they should be considered as giving rise to two distinct role types.

A further fragmentation of the theme role arises from the distinction between *incremental* and *holistic* themes. An incremental theme corresponds to the actant of a telic predicate (an accomplishment or achievement in terms of the aspectual taxonomy developed by [Vendler 67] which is specified as undergoing a gradual change of state. Event descriptions such as *write a letter, paint a table, build a house, destroy a castle, unload a truck* are typically understood as involving a number of successive phases through which the object is incrementally affected; any intermediate stage of completion of the event corresponds to an intermediate change of state for the object. Consider, for example, a situation in which a group of workers is unloading a truck and the truck driver is monitoring the process from time to time. By inspecting the status of the truck, the driver will be able to tell whether the unloading is still in progress or done. To characterize the role of the incremental theme with respect to aspect determination, [Krifka 87] has suggested that that the semantics of telic predicates should be computed in terms of a homomorphism from algebraically structured theme denotations into algebraically structured event denotations in such a way that successive phases of change of the theme argument are reflected as successive stages of development of the event (see chapter 6). However, Dowty observes that not all themes of telic predicates are gradually affected:

> If John drives from New York to Chicago, John necessarily undergoes a change of location, from being in New York to being in Chicago, so the NP *John* is theme by the traditional definition. But suppose the event of John's driving from NY to Chicago is started but interrupted before being completed. The Hinrichs-Krifka hypothesis then seems to predict that part of John has arrived in Chicago while the rest of him is still in New York. But this is absurd.

*Drive* and *load* crucially differ in that only the latter verb involves a "part-by-part" change of its theme argument, whereas the theme argument of *drive* is typically understood as being *holistically* affected. The set of telic predicates which take holistic themes includes verbs such as *run to, walk to, become NP/ADJ, grow ADJ, arrive, come, reach.*[2] Insofar as the holistic/incremental difference is relevant in regimenting the semantics of telic aktionsart, this distinction should be represented in grammar. If so, then incremental and holistic themes should be viewed as two distinct roles.

A somewhat similar problem derives from the possibility of compounding thematic roles. [Jackendoff 72], for example, allows the agent role to combine with theme, source and goal roles. In (3-11a), *John* is an agent because he is the protagonist of a volitional act, and a theme because he undergoes change of location. In (3-11b) *Harry* functions both

[2] As Dowty points out, with these verbs "gradual change" is a property of the *path* which is traversed by the theme, e.g. the directional argument in the sentence *John drives from New York to Chicago* (see §6.1.2 for further remarks):

> A little reflection on such examples will reveal that what is partially but not totally affected in this case, in a way parallel to the themes in (3) [e.g. *build a house, write a letter, perform a sonata*], is in the *path* John traverses in driving from NY to Chicago: if the event is started but not completed, then part of this path has been traversed by John, not all of it, but the position of John of course remains intact with respect to each other. ([Dowty 87], p. 6)

as source and as agent, while in (3-11c) *Charlie* is both goal and agent.

(3-11) a John deliberately moved away
b Harry gave the book away
c Charlie bought the lamp from Max

[Culicover & Wilkins 86] allow any role combinations to be constructed out of the two sets of *intensional* (agent, patient, instrument, benefactee) and *extensional* (source, goal theme) roles, as long as no more than one role from each set is chosen. Compound roles are also assumed in LFG as was briefly mentioned in §3.2. Notice that each compound role forms a thematic unit corresponding to a new role type. A theme-agent, for example, is neither an agent nor a theme since the theme argument role of many verbs is incompatible with an additional agentive specification and the agent argument role of many verbs is incompatible with an additional theme specification. The possibility of compounding roles thus extends further the number of role types.

Given the combined effects of role fragmentation and compounding, it soon becomes clear that a classification of verbal arguments into discrete roles cannot in principle be guaranteed to provide a finite (possibly small) set of role types which is rich enough to express generalizations about grammar rules. Difficulties of this kind have led some to doubt the usefulness of assigning grammatical status to thematic roles. [Ladusaw & Dowty 88], for example, have argued that grammatical generalizations which have been stated in terms of thematic relations (e.g. control of subjectless infinitives) should be rather determined by "entailments of verbs' meaning together with principles of human action that exist quite apart from language" ([Ladusaw & Dowty 88], p. 73).

### 3.1.2 Thematic Roles in Sentence Processing

In contrast with Ladusaw's & Dowty's assessment, there is an increasing consensus that thematic structure plays a leading role in grammar. This attitude is corroborated by recent experimental studies on language comprehension showing that appeal to thematic structure is needed to explain differences in ease of resolution of local ambiguities and garden-paths.

[Carlson & Tanenhaus 88] report the results of an experiment on sentence comprehension where sentences containing polysemous verbs such as those in (3-12) were found harder to process than sentences with verbs displaying thematic ambiguities as in (3-13).

(3-12) a Bill set the alarm clock for six in the morning (*set* $\approx$ *adjust*)
b Bill set the alarm clock onto the shelf (*set* $\approx$ *put*)

(3-13) a Bill loaded the truck with bricks (*truck* is Location)
b Bill loaded the truck onto the ship (*truck* is Theme)

They suggest that this difference can be explained by assuming that thematic assignment is made on-line and that thematic reassignment is relatively cost-free in processing time when compared to reopening lexical entries. This account is motivated by the fact that preferences in the incremental building of syntactic structure (e.g. minimal attachment and late closure) cannot explain the differences in processing time relative to the set of contrasts in question.

Additional evidence that thematic information is highly instrumental in the resolution of local ambiguity during comprehension is provided by [Stowe 89].[3] Stowe's results show that temporally ambiguous sentences such as (3-14) are processed more quickly when the subject in the adverbial clause (*police/truck*) is inanimate.

(3-14) a Before *the police* stopped the driver was already getting nervous
b Before *the truck* stopped the driver was already getting nervous

A verb like *stop* can potentially give rise to either an causative or inchoative reading according to whether it is realized as a transitive or intransitive predicate. As a transitive, *stop* assigns an agent role to its subject, and a theme role to its object. As an intransitive it only assigns a theme role to its subject. On grounds of plausibility, an animate subject is more likely to be assigned an agent role than an inanimate subject is ([Fillmore 68], [Gruber 76]). Hence *stopped* in (3-14a) is more likely to be interpreted as a transitive verb. In this case, hearers will be more attuned to analyze the following noun phrase (i.e. *the driver*) as the object of the adjunct clause, and will eventually have to reanalyze the initial structural assignment to attain the correct interpretation for the whole sentence. However, in (3-14b), *stopped* will preferably be analyzed as an intransitive verb because the assignment of an agent role to an inanimate subject is less plausible. Consequently, hearers will not try to interpret the following noun phrase as the object of the adjunct clause. This choice leads subjects to the correct structure

[3] See also [Pritchett 88].

assignment for the whole sentence without need to backtrack. Stowe's explanation suggests that subjects rely on animacy information to make syntactic decisions. Insofar as animacy information is accessed through thematic assignment, it can be concluded that thematic structure can help decide among syntactic structures and that thematic assignment is made on-line.

### 3.1.3 Formal Representation of Roles

Aside from questions of content and sentence processing, a major issue that has characterized the study of thematic relations more recently concerns model-theoretic interpretation. The relative novelty of this pursuit is primarily to be attributed to the fact that thematic roles were essentially a linguistic invention, and it was not until the advent of Montague semantics in the mid 1970s that a concern with model-theoretic interpretation became relevant in linguistic theory. As was anticipated in the introduction, two competing model-theoretic accounts of thematic relations have been suggested in the last decade according to whether thematic roles are derived as second order properties of $n$-place relations, or formalized as relations between individuals and eventualities. In the remainder of this chapter I will discuss some of the issues which arise from these two proposals, and consider ways in which insights from both approaches can be integrated.

## 3.2 Thematic Roles in Event Semantics

One of the first model-theoretic accounts of thematic relations was introduced by [Parsons 80] within the event-based approach to verb semantics developed by [Davidson 67]. Davidson's basic insight was that action sentences involve implicit reference to events. To represent this fact in logical form Davidson suggested that events should be treated as primitive ontological elements, and that verbs expressing action should be constructed so as to include an argument place for event terms. For example, the logical form of a sentence like *I flew my spaceship to the moon* would involve existential quantification over an event term which occurs as an argument of both the verbal and prepositional predicates:

(3-15) $\exists e[flew(I, my\text{-}spaceship, e) \wedge to(the\text{-}moon, e)]$

### 3.2.1 Parsons' Neo-Davidsonian Account

Parsons generalized Davidson's treatment of action sentences to sentences expressing processes and states, and extended his analysis of modifiers to characterize all relations between individuals and expressions denoting events, processes and states. Following Bach, Parsons adopts the term *eventuality* as a cover label for events, processes and states. In Parsons' account, verbs give rise to 1-place predicates of eventualities, while the individual terms which in Davidson's approach appeared as arguments of verbs are introduced through thematic relations such as *Agent* and *Obj(ect)*.[4] Eventuality variables occur as arguments of verbs and modifiers as well as thematic relations. In Parsons' approach, for example, the logical form of a transitive sentence like *I flew my spaceship to the moon* would involve event quantification over four conjuncts corresponding to the semantic translation of the verb, the subject and object phrases and the modifier:

(3-16) $\exists e[flew(e) \wedge Agent(I, e) \wedge Obj(my\text{-}spaceship, e) \wedge to(the\text{-}moon, e)]$

For ease of exposition I will adopt the term *neo-Davidsonian* (a term coined by Dowty) to refer to this way of associating a predicate with its arguments.

Parsons provides two major reasons for introducing (thematic) relations between individuals and eventualities as independent predicates. First, this encoding provides a desirable logical characterization of sentence structure for languages where subject and object phrases occur as adjuncts (e.g. Japanese, see [Whitelock 87]) and are thus more appropriately characterized as modifiers in logical form. Secondly, it provides a natural account of the entailment relation between pair of sentences such as in (3-17) which differ only with respect to the presence of the agent actant.

(3-17) a John opened the door
b The door opened

From the truth of the sentence in (3-17a), it is possible to infer that (3-17b) is also a true sentence while the converse does not hold. In Parsons' approach, this inferential pattern follows directly from the logical form of the two sentences, e.g.

(3-18) $\exists e[open(e) \wedge Agent(john, e) \wedge Obj(the\text{-}door, e)] \rightarrow \exists e[open(e) \wedge Obj(\text{-}door, e)]$

[4] In Parsons' approach, the relation *Obj* corresponds to the role *theme* ([Parsons 80], p. 52, fn. 21).

By contrast, if transitive and intransitive predicates were construed so as to include argument places for their agent and theme arguments, the entailment relation between the two sentences will have to be stated independently since (3-19a) does not entail (3-19b).

(3-19) a $\exists e[open(john, the\text{-}door, e)]$

b $\exists e[open(the\text{-}door, e)]$

In Parsons' approach, thematic assignment properties of verbs are directly encoded in the rules which allow a verb to combine with its subject and object arguments. No such encoding is needed with respect to adjuncts, since no thematic assignment is involved in adverbial modification. Consequently, arguments and adjuncts can be differentiated according to mode of combination. Consider, for example, the following grammar fragment adapted from [Parsons 80]. The fragment consists of three expressions, five rules and it is intended to generate the sentence *Mary flies to the moon.* Each expression is associated with a categorial specification and a symbol. The symbol associated with "Mary" stands for an individual constant, the symbol associated with "run" corresponds to a 1-place predicate of eventualities, and the symbol associated with the directional adverbial is an operator which combines with a relation between eventualities and moments of time and produces an expression of the same sort.

| | | | |
|---|---|---|---|
| (3-20) | **Mary** | name | $mary$ |
| | **fly** | intransitive verb | $fly$ |
| | **to the moon** | directional adverbial | $\lambda P \lambda e \lambda t[P(e,t) \wedge to(the\text{-}moon, e)]$ |

As in Montague Grammar, each syntactic rule has a semantic translation. For example, the rule in (3-21a) turns an intransitive verbs into a VP which according to (3-21b) is interpreted as a relation between eventualities and moments of time, as shown in (3-22).

(3-21) a R1: If $\alpha$ is an intransitive verb then $\alpha$ is a VP

b T1: If the symbol associated with $\alpha$ if $G$ then $\alpha$ translates as $\lambda e \lambda t[G(e) \wedge Occurs(e,t)]$

(3-22) $[\mathbf{fly}]_{IV} \rightarrow [\mathbf{fly}]_{VP}$ (by R1)

$fly \rightarrow \lambda e \lambda t[fly(e) \wedge Occurs(e,t)]$ (by T1)

R2 and T2 below make it possible to combine a VP and an adverbial into a VP, and to give a semantic characterization of the rule in terms of functional application as indicated in (3-24).

(3-23) a R2: If $\alpha$ is an adverbial and $\beta$ is a VP then $\beta\alpha$ is VP

b T2: If $\alpha$ translates as $\alpha'$ and $\beta$ as $\beta'$ then their combination translates as $\alpha'(\beta')$, with the understanding that this may be simplified through lambda conversion whenever possible.

(3-24) $[\textbf{fly}]_{IV}$ $[\textbf{to the moon}]_{ADV} \rightarrow [\textbf{fly to the moon}]_{VP}$ (by R2)

$\lambda e \lambda t[fly(e) \wedge Occurs(e,t)]$ $\lambda P \lambda e \lambda t[P(e,t) \wedge to(the\text{-}moon, e)] \rightarrow$
$\lambda P \lambda e \lambda t[P(e,t) \wedge to(the\text{-}moon, e)](\lambda e \lambda t[fly(e) \wedge Occurs(e,t)]) =$
$= \lambda e \lambda t[[fly(e) \wedge Occurs(e,t)] \wedge to(the\text{-}moon, e)]$ (by T2)

R3 combines a name and a VP into an (untensed) sentence. The semantic translation of the rule involves the introduction of the thematic role "Agent" which takes as arguments the individual constant associated with the name and an eventuality variable which is co-bound with the eventuality variable of the VP semantics as shown in (3-26).

(3-25) a R3: If $\alpha$ is a name and $\beta$ a VP then $\alpha\beta$ is an untensed sentence

b T3: If $\alpha$ translates as $\alpha'$ and $\beta$ as $\beta'$ then $\alpha\beta$ translates as $\lambda e \lambda t[\beta'(e,t) \wedge Agent(\alpha', e)]$

(3-26) $[\textbf{Mary}]_{Name}$ $[\textbf{fly to the moon}]_{VP} \rightarrow [\textbf{Mary fly to the moon}]_{S}$ (by R3)

$mary$ $\lambda e \lambda t[[fly(e) \wedge Occurs(e,t)] \wedge to(the\text{-}moon, e)] \rightarrow$
$\lambda e \lambda t[[[fly(e) \wedge Occurs(e,t)] \wedge to(the\text{-}moon, e)] \wedge Agent(mary, e)]$ (by T3)

The rule in (3-27) introduces present tense, and the rule in (3-28) maps a tensed sentence into a *closed* sentence. In Parsons' approach, a closed sentence translates as an expression which stands for *properties of moments of time* as shown in (3-29).

(3-27) a R4: If $\alpha$ is an untensed sentence then Pres($\alpha$) is a tensed sentence defined as:
Pres($\alpha$) = the result of putting the main head verb of $\alpha$ into the present tense.

b T4: Pres($\alpha$) translates as $\alpha'$

(3-28) a R5: If $\alpha$ is a tensed sentence, $\alpha$ is a closed sentence

b T5: if $\alpha$ translates as $\alpha'$ translates as $\lambda e \lambda t[G(e) \wedge Occurs(e,t)]$

(3-29) $[\textbf{Mary fly to the moon}]_{S} \rightarrow [\textbf{Mary flies to the moon}]_{S}$ (by R4, R5)

$\lambda e \lambda t[[[fly(e) \wedge Occurs(e,t)] \wedge to(the\text{-}moon, e)] \wedge Agent(mary, e)] \rightarrow$
$\lambda t \exists e[[[fly(e) \wedge Occurs(e,t)] \wedge to(the\text{-}moon, e)] \wedge Agent(mary, e)]$ (by T4, T5)

A comparison of T2 and T3 shows that the difference between arguments and adjuncts follows from the fact that only arguments involve the introduction of a thematic relation, i.e. thematic marking. Needless to say, the implementation of thematic marking used in Parsons' fragment is too simplistic in that it only takes into consideration the Agent and Obj (e.g. theme) roles, and always associates these two roles with the subject and object positions respectively. Parsons himself is careful to point out that this practice is inadequate, and that a more detailed analysis would require the use of different primitives along with a more flexible translation procedure. In chapter 4, I will show how this question can be solved by developing a system in which information concerning thematic assignment properties of verbs can be explicitly represented within a neo-Davidsonian approach to verb semantics.

### 3.2.2 Carlson on Thematic Roles

As mentioned in §2.3, in Montague grammar verbs are treated as $n$-place functions which operate on sequences of noun phrase denotations to yield sentence meanings. All that is needed to combine a verb with one of its arguments is the syntactic/logical type of the noun phrase and the verb, and information regarding morphosyntactic marking and word order. Carlson observes that in a system of semantic interpretation of this kind the introduction of thematic roles as independent model-theoretic elements would be redundant and ultimately could be easily dispensed with. For example it would in principle be possible to treat thematic relations as functions from NP denotations into NP denotations. Where $\lambda P[P\{john\}]$ denotes sets of properties of the individual named *John*, the result of applying the appropriate translation for the agent role to it would give rise to the expression $\lambda P[P\{john\} \wedge agent(john)]$ denoting the set of agentive properties of *john* (e.g. subject of *chase*, *walk*, *hit* etc.). However, since the logical and syntactic type of the NP would basically be unaffected by its association with the thematic role, the type-theoretic import of the thematic role with respect to sentence formation would effectively be trivial. Both (3-30a) and (3-30b) would in principle be possible semantic translations for the sentence *John walks*.

(3-30) a $walk(john) \wedge agent(john)$

b $walk(john)$

Given an assignment of denotations to expressions of this kind, Carlson suggests that the semantics of a sentence like *John walks* can be constructed as the intersection of the two expressions *walk'* and *agent(John')* denoting respectively the set of all possible token events characterized by "some walking going on" and the set of all eventualities in which *John* functions as an agent:

(3-32) $walk' \cap agent(John')$

Because the denotations of verbs and NPs belong to disjoint sets (e.g. the set of eventualities and the set of individuals), verbs and NPs can be assembled into sentence meanings only if NP denotations are mapped onto eventualities through the mediation of thematic roles. A logical form built as the intersection of the two logical expressions *walk'* and *John'* will necessarily express the False since the "meet" of verb and NP denotations within the algebraic specification of ontological types assumed by Carlson is null, e.g.

(3-33) $walk' \cap John' = \emptyset$

As [Dowty 89] points out, Carlson's treatment of verbs and thematic relations is effectively equivalent to that of Parsons; to avoid introducing a different notation I will continue to use the method of representation used by Parsons where eventuality variables are explicitly represented in logical form, e.g. $\exists e[walk(e) \wedge agent(John', e)]$.

Carlson argues that one of the advantages of an event-based system of semantic interpretation where thematic relations between eventualities and individuals are introduced as distinct entities is that no additional rules are needed to account for the optional occurrence of arguments with nominalized verbs. In Carlson's framework, for example, all the nominals in (3-34) are treated as eventuality-denoting expressions which need not combine with agent and theme arguments to yield a closed formula as indicated in (3-35).

(3-34) a [Kicking] is fun
b [ Kicking a punch-ball] is fun
c [ The mule's kicking] scared Bill to death
d [ The mule's kicking Bill] caused an uproar

(3-35) a $\exists e[kick(e)]$

b $\exists e[kick(e) \wedge theme(a\text{-}punch\text{-}ball', e)]$

c $\exists e[kick(e) \wedge agent(the\text{-}mule', e)]$

d $\exists e[kick(e) \wedge theme(bill', e) \wedge agent(a\text{-}punch\text{-}ball', e)]$

If the verb *kick* were treated as a two-place relation of individuals, the occurrence of nominalizations such as *kicking* and *kicking Bill* would require semantic rules which quantified over the argument positions which were not syntactically realized as indicated in (3-36).

(3-36) a $\lambda y \lambda x[kick'(x, y)] \rightarrow \exists x \exists y[kick'(x, y)]$

b $\lambda x[kick'(x, bill')] \rightarrow \exists x[kick'(x, bill')]$

No such rules are needed within the event-based account proposed by Carlson since the arguments of the event nominal which are not syntactically realized do not occur as abstracted variables.

## Subcategorization and Thematic Assignment

Notice, however, that on Carlson's view the obligatory occurrence of subject and object arguments in indicative tensed sentences remains something of a puzzle. Insofar as the verb *kick* need not combine with any of its arguments to yield a closed formula, we would expect the tensed verb form *kicked* to give rise to a complete sentence, but this expectation is obviously incorrect (at least for English). Within a Montague Grammar framework, the syntactic subcategorization frame of a verb arises from the equivalence between syntactic and semantic types. Because verbs denote functions from sequences of NP denotations into propositions, they behave syntactically as functor categories which operate on sequences on noun phrases to yield sentences. In Carlson's approach. the denotations of verbs are not construed to include in their domain the denotations of their (syntactic) arguments. A mapping from verb denotations into category types will be of no help in establishing subcategorization.

Carlson claims that the independence of syntactic subcategorization from principles of semantic interpretation is a desirable consequence in that it yields a more elegant account of sentence structures which involve missing arguments. Consider for example the *Unspecified Object Deletion* rule relating pairs of sentences such as in (3-37).

(3-37) a John ate an apple

b John ate

In syntactic terms, the rule is generally formulated as an operation which removes the direct object from the subcategorization frame of a verb. From the point of view of semantic interpretation a sentence whose verb has been affected by the rule appears to involve covert reference to an unspecified object. The sentence in (3-37b), for example, is understood as expressing an event of eating in which some unspecified quantity and type of food was consumed even though the object is syntactically absent. Within a system where syntactic subcategorization reflects semantic valency, the rise of covert reference to the missing object of a detransitivized sentence can be accommodated by pairing the object deletion rule with a semantic operation which binds the object variable to an existential quantifier. This is essentially the characterization of *Unspecified Object Deletion* given by Dowty, repeated here as (3-38).

(3-38) S5: $\langle F_5, \langle TV \rangle, IV \rangle$ ("Unspecified Object Deletion")
Semantic Operation: $\lambda x (\exists y)[\alpha'(y)(x)]$
English: $F_5(\alpha) = \alpha$ ([Dowty 82a], p. 91)

Carlson argues that a neo-Davidsonian account yields a simpler analysis of detransitivization since it need not assume any explicit semantic operation. The fact that the deleted object is understood as being existentially quantified follows from our general knowledge of the meaning of the verb *eat* which induces us to infer that whenever an event of eating takes place there is always something that gets eaten. But such an inference will not be necessarily drawn with respect to a sentence like *the mule kicked*, since our knowledge about the meaning of *kick* does not require that every event of kicking involves a patient actant. Within a system where subcategorization is related to semantic valency, the fact that the missing object of *kick* need not involve existential quantification would lead us to the conclusion that a rule different from (3-38) is needed to account for detransitivization in this case.

Carlson suggests that a proper assignment of thematic roles to syntactic arguments could be characterized in terms of thematic entailments of verb meanings. More precisely he proposes that a model-theoretic characterization of verb meanings could be obtained in terms of the thematic relations that they necessarily entail, and that thematic assignment should be related to such entailment. On this view a verb like *eat* would denote the set of all (token) events of eating which necessarily involve the presence of theme and agent participants, e.g.

(3-39) $\forall\Box[eat(e) \rightarrow \exists x \exists y[agent(x,e) \wedge theme(y,e)]]$.

The syntactic subcategorization frame of *eat* could then be related to these thematic entailments. More generally, we could say that the subcategorized arguments of a verb realize thematic roles which the verb necessarily entails. The argument/adjunct distinction could be made to follow by assuming that no such entailments are involved when a verb combines with an adjunct. What remains to be established is precisely how subcategorization is to be derived from entailments such as those in (3-39).

### Thematic Uniqueness

Since, in Carlson's approach, thematic roles provide the only way in which verb and NP meanings can be combined into sentence meanings, it follows that all NPs which occur as arguments of verbs will be associated with a thematic role. However this is not enough to ensure that each argument will be assigned a unique role; indeed, the same role type could be used a number of times to combine a verb with an argument phrase. Nevertheless this degree of freedom never obtains in natural language: for each predicate there can at most be one single instance of the same role. For example, Carlson observes, there is no verb that assigns a theme role both to its object and subject NPs. In LFG and GB, thematic uniqueness follows from the way Biuniqueness and the Theta-criterion are formulated: both conditions establish a one-to-one relation between argument roles and grammatical functions (see chapter 2). Carlson argues that syntactic constraints of this kind typically fail to account for cases where two verbs which are independently associated with the same thematic role only allow one syntactic realization of the role when construed as a single event.

> So, for example, *try* is a verb that allows an instrument role as in *open*:
>
> (12) a. John tried it with an ax
>      b. John opened the present with an ax
>
> However, the example in (13) allows but one instrument expression, even though there are two verbs in the construction each allowing an instrument independently:
>
> (13) a. John tried to open the present with an ax
>      b. *John tried, with a sharp instrument, to open the present with an ax
>
> ([Carlson 84], p. 272)

Carlson suggests that this puzzle can be solved if we regard thematic uniqueness as a property of eventualities: two arguments may not be associated with the same thematic role within the same eventuality, i.e.

(3-40) $\forall x \forall y \forall \theta \forall e[\theta(x,e) \wedge \theta(y,e) \rightarrow x = y]$

The ungrammaticality of a sentence like **John tried, with a sharp instrument, to open the present with an ax* would follow from the fact that there are two instrument expressions within the same event and each of them takes a distinct argument.[6] Incidentally, this characterization of thematic uniqueness explains why if the two verbs *try* and *open* are introduced as distinct events within the same sentence, an instrument participant for each verb is allowed:

(3-41) Before trying it with an ax, John opened the present with a sharp instrument

Carlson argues that thematic uniqueness provides a very important cognitive function in organizing our perception of reality into discrete units of information around which semantic interpretation is centered. Within a Davidsonian system where sentences involve reference to eventualities, the assignment of truth conditions to sentences will require of cognitive agents the ability to individuate the eventualities which sentence-descriptions denote. Thematic uniqueness provides just the kind of criterion needed to exercise this ability. Because thematic uniqueness holds for each single eventuality, it follows that repeated occurrence of the same role would necessarily signal the occurrence of distinct eventualities. The occurrence of two themes for example would signal the occurrence of two eventualities, the occurrence of three goals would correspond to three distinct eventualities and so on. The principle of thematic uniqueness will therefore provide means for distinguishing eventualities from one another.

[6] Note, however, that the ungrammaticality of a sentence like *John tried, with a sharp instrument, to open the present with an ax* persists even when the arguments of the two instrumental roles are undestood as referring to the same object, e.g.

(i) *John tried, with an ax, to open the present with the ax

## 3.3 Thematic Roles as Second Order Properties of $n$-Place Relations

Within the neo-Davidsonian approach proposed by Parsons and Carlson, the argument/adjunct distinction is rendered according to mode of combination. The association of a verb with one of its arguments involves the introduction of a thematic role, possibly induced by necessary entailments of verb meanings as suggested by Carlson. By contrast, grammar rules for adverbial modification do not introduce thematic roles. This distinction, however, is somewhat obscured by the fact that arguments and adjuncts are represented alike in the logical form of sentences, eg.[7]

(3-42) $\exists e[flew(e) \wedge agent(mary, e) \wedge to(boston, e)]$

Reasoning on the basis of grammatical contrasts which appear to make a net discrimination between arguments and adjuncts, [Dowty 89] has argued in favour of a more explit encoding of the argument/adjunct distinction than that available within a neo-Davidsonian system. In the light of Dowty's proposal, adjuncts and arguments of event nominal are introduced according to a neo-Davidsonian mode of combination, while the relation between a verb and its arguments is characterized as in Montague Grammar. This proposal effectively amounts to reinstating the original Davidsonian approach according to which adjuncts denote properties of eventualities, and where argument denotations are included in the domain of their subcategorizing predicates. Dowty suggests that within such a system the semantic relations of adjuncts and arguments of nominals can be made to correspond to prepositional predicates (eg. *to, with, for* etc.) which, following Davidson's initial insight, he treats as relations between individuals and events. A definition of thematic relations is thus only needed for verbal arguments.

### 3.3.1 Thematic Roles as Entailments of Verbs' Meanings

As was mentioned in the introduction, the task of a theory of thematic roles is to provide a semantic classification of argument positions of verbs into a discrete and reasonably small set of role types. [Dowty 89] has suggested that these goals should be attained by defining roles in terms of entailments of verb meanings in such a way that the three con-

[7]Notice, however, that arguments and adjuncts could still be distinguished if thematic roles were reserved to arguments, while the semantic relations of adjuncts were made to correspond to prepositional predicates, e.g. *to, from, with* etc.

ditions *completeness, distinctness,* and *independence* are satisfied. Completeness ensures that every argument position of every verb is subsumed by a role type. Distinctness guarantees that there are enough roles to provide a distinct characterization for every pair of argument positions of every verb. Independence requires that the defining properties of a thematic role be characterizable independently of the relations that entail them, so that trivial role definitions such as (3-43) can be eschewed.[8]

(3-43) $\lambda x[\exists y kill(y,x) \vee \exists y build(y,x) \vee \exists y \exists z give(y,x,z) \vee \ldots]$

Dowty's first step in providing a characterization of the semantic content of roles is to define the *individual thematic role* of a verb as the set of all properties which the verb entails for a given argument position.

(3-44) Given an $n$-place predicate $\delta$ and a particular argument $x_i$, the *individual thematic role* $\langle \delta, i \rangle$ is the set of all properties $\alpha$ such that the entailment

$$\Box[\delta(x_1, \ldots, x_i, \ldots, x_n) \rightarrow \alpha(x_i)]$$

holds. ([Dowty 89], p. 76)

For example the individual role $\langle love, 1 \rangle$ would correspond to the set of properties which can be attributed to the first argument of the predicate *love* through entailment, eg. the properties which characterize a *lover*:

(3-45) $\langle love, 1 \rangle = \lambda P \exists x, y \Box[love(x,y) \rightarrow P(x)]$
where $P \in \{\lambda x[sentient(x)], \lambda x[animate(x)], \lambda x \exists y[feel\text{-}desire\text{-}for(x,y)], \lambda x \exists y[like(x,y)], \ldots\}$

A *thematic role type* can then be defined as the intersection of some set of individual thematic roles.

(3-46) Given a set $T$ of pairs $\langle \delta, i_\delta \rangle$ where $\delta$ is an $n$-place predicate and $i_\delta$ the index of one of its arguments (possibly a different $i$ for each verb), a *thematic role type* $\tau$ is the intersection of all the individual thematic roles determined by $T$. ([Dowty 89], p. 77).

For example, the role type $GOAL$ could be defined as the set of all entailments which are shared by the particular individual role of verbs which are in the set of predicates

[8]It is clear that role definitions of this kind are to be regarded as trivial. The basic motivation for postulating a given role type is that it expresses generalizations across a set of predicates in the form of clusters of properties which are shared by an argument of each predicate in the set. But if we can do no more than express the content of the role type as a disjunction of all the argument positions which the role type is meant to identify, it means that no such generalization is possible and therefore there is no motivation for positing the role type.

which include *give, sell, buy, receive and tell*, eg.

$$
\begin{array}{lll}
(3\text{-}47) & GOAL = \lambda Q[ & \Box[\lambda x_{1_1},...,x_{1_i},...,x_{1_n}[\delta_1(x_{1_1},...,x_{1_i},...,x_{1_n}) \rightarrow Q(x_{1_i})]] \\
& & \wedge,...,\wedge \\
& & \Box[\lambda x_{n_1},...,x_{n_i},...,x_{n_n}[\delta_n(x_{n_1},...,x_{n_i},...,x_{n_n}) \rightarrow Q(x_{n_i})]] \quad ] \\
& \multicolumn{2}{l}{\text{where } \{\delta_1,...,\delta_n\} = \{give, sell, buy, talk, receive, tell, ...\}}
\end{array}
$$

Of course, it remains to be seen whether a relatively small number of role types which satisfy completeness, distinctness and independence can be actually derived by intersecting sets of individual roles. Even assuming that each individual role will effectively intersect with at least another individual role, the cardinality of each set of intersecting individual roles may be so small that the number of role types would be just too big to be useful at all. If we take into account previous results concerning role definitions, prospects are indeed grim, as pointed out by [Ladusaw & Dowty 88]. Ultimately, it may be necessary to give up on the idea of defining role types as discrete entities to adopt an approach such as that proposed by [Dowty 87] (see §2.3) where thematic roles are defined as prototypical clusters of entailments conceived of as semantic defaults (see §2.3). In the light of this approach, the attainment of completeness, distinctness and independence in role definitions can be achieved maintaining a small number of role types because role (proto)types are effectively determined for each choice of predicate. The cluster of properties which contributes to a given role-type need not be the same across verbs as these properties are defeasible. Consequently, proto-roles are neither unique nor discrete. For example, the proto-agent of a given verb may in principle contain the same properties which qualify the proto-patient of another verb; this would be allowed as long as the principles which govern the determination of proto-roles within the argument structure of each of the two verbs are complied with. This is essentially the approach which will be adopted in the following chapters with respect to the determination of role content.

Aside from issues concerning role content, an approach where roles are defined as properties of relations raises the question of how thematic information is to be referred to in grammar rules. The question arises because this characterization is not intended to represent thematic information on-line. In Dowty's approach, thematic roles can be inferred from verb meanings, but are not explicitly represented in the logical form of sentences. This is simply because Dowty adopts a method of predicate-argument association — namely, Montague's ordered argument system — where thematic roles are entirely dispensable as noted earlier. To be fair, this is not a problem for Dowty since in his opinion thematic relations are only relevant to argument selection. From this vantage point, thematic relations could simply be regarded as constraints on lexical forms which determine the hierarchical order of argument positions at the level of functor-argument structure. Suppose, however, we wished to use thematic relations in syntax, eg. to state constraints on control. In order to recover thematic information relative to the argument position at stake (eg. the controller), we would have to infer what role that argument bears on the basis of its entailed properties. For example, if we wished to know whether the $i$th argument $x_i$ of a predicate $\delta_i$ bears the goal role, we could define a relation between $n$-place predicates, individuals, and properties of $n$-place predicates which given $\delta_i$ and $x_i$ returns the set of properties of relations which define the goal role (ie. "GOAL" in (3-47)) just in case *delta* and $x_i$ are defined for such set of properties, eg.

$$
\begin{array}{lll}
\text{(3-48)} & \lambda\Delta\lambda x_{i_i}\lambda Q[ & \Box[\lambda x_{1_1},\ldots,x_{1_i},\ldots,x_{1_n}[\delta_1(x_{1_1},\ldots,x_{1_i},\ldots,x_{1_n}) \rightarrow Q(x_{1_i})]] \\
 & & \wedge,\ldots,\wedge \\
 & & \Box[\lambda x_{i_1},\ldots,x_{i_i},\ldots,x_{i_n}[\Delta(x_{i_1},\ldots,x_{i_i},\ldots,x_{i_n}) \rightarrow Q(x_{i_i})]] \\
 & & \wedge,\ldots,\wedge \\
 & & \Box[\lambda x_{n_1},\ldots,x_{n_i},\ldots,x_{n_n}[\delta_n(x_{n_1},\ldots,x_{n_i},\ldots,x_{n_n}) \rightarrow Q(x_{n_i})]] \quad ]
\end{array}
$$

where $\{ \delta_1,\ldots,\delta_n \} = \{$ *give, sell, buy, receive, tell, ...* $\}$

However, it seems to me that this way of thinking about thematic information induces unnecessary complexities in the formulation of grammar rules. If the semantic content of roles could be efficiently defined within a neo-Davidsonian approach to verb semantics and predicate-argument association, the expression of thematic constraints on grammar rules would be highly simplified since within such system roles are explicitly represented in logical form. The question arises then as to why the neo-Davidsonian system of semantic interpretation should not be extended to characterize the relation between verbs and their subcategorized arguments.

### 3.3.2 Two Theories of Predicate-Argument Association

As indicated in the introductory paragraph of this section, Dowty maintains that both the neo-Davidsonian and ordered argument systems of semantic interpretations are operative in natural languages. Dowty's basic motivation for maintaining Montague's ordered argument system is that it provides a direct way to relate syntactic subcategorization (or its absence) to semantic interpretation. Dowty's argument can be summarized as follows. In Montague Grammar, the homomorphism between syntactic and logical types makes it possible to establish the subcategorization frame of a verb on the basis of its semantic valency (see §2.3). Because verbs are treated as functions from sequences of NP denotations to propositions, syntactically they behave as functor categories from noun phrases into sentences. For example the impossibility of combining a verb like *dine* with an object as in (3-49a) or omitting the object of *devour* as in (3-49b) would follow from the fact that *dine* is a one-place predicate while *devour* is a two-place predicate (not counting the argument position for eventuality terms).

(3-49) a *John dined his lunch
b *John devoured

According to the correspondence between syntactic and logical types, *dine* and *devour* will be characterized as expressions of category $IV$ (intransitive) and $IV/(t/IV)$ (transitive) respectively. Neither (3-49a) nor (3-49b) will result in a well-formed sentence: in the first case an argument has been added which was not subcategorized for, while in the second case the object subcategorization of the verb has not been satisfied. By the same token, the fact that the arguments of event nominals can be freely omitted suggests that event nominals do not have a subcategorization frame and that they are to be treated as one-place predicates of eventualities rather than multi-functions of eventualities and individuals. In this case Dowty shares Carlson's view that event nominals and their arguments combine according to a neo-Davidsonian system of semantic interpretation.

### Verbal and Nominal Arguments

Dowty argues that the practice of distinguishing between two methods of argument association provides a desirable characterization of the difference between verbal and nominal arguments. For example, Dowty observes that while the *by*-phrase of verbal passive can bear any thematic role that is assigned to the subject of the corresponding active verb, the *by*-phrase of nominals may only refer to the agent or cause of an event, eg.

(3-50) a Carthage was destroyed by fire/the Romans
b That fact is now known/believed by almost everyone
c He is still loved by his parents

(3-51) a The destruction of Carthagen by fire/the Romans
b *The knowledge/belief (of that fact) by almost everyone
c *The love (of him) by his parents

According to Dowty, the ease with which the *by*-phrase of a passive verb can take any thematic value associated with the initial subject of the verb would follow if the agentive passive rule were formulated as an argument rearranging operation which turns the subject of an active verb into a subcategorized oblique object (as discussed in §2.3). The *by*-phrase of event nominals would instead form a predicate of its own since in Dowty's system an event nominal and its arguments combine according to a neo-Davidsonian method of argument association. The semantic representation for the passive sentence in (3-52) and the nominal expression in (3-53) provide a concrete example of how the two *by*-phrases would differ semantically.

(3-52) a Carthagen was destroyed by the Romans
b $\exists e[destroy(carthage, the\text{-}romans, e)]$

(3-53) a The destruction of Carthage by the Romans
b $\exists e[destruction(e) \wedge of(carthage, e) \wedge by(the\text{-}romans, e)]$

The restricted character of the *by*-phrase in event nominals would result from the fact that the predicate *by* assigns an agentive role (eg. "agent" or "cause") to its object argument. The difference between the two kinds of *by*-phrase therefore follows from the existence of the two modes of argument association.

Notice, however, that Dowty's motivation for relating the thematic (un)restrictedness of *by*-phrases to mode of argument association is weakened by the fact that the *by*-phrase of verbal passive is not immune to thematic restrictions. This is shown by the impossibility of passivizing verbs of measure and stimulus-experiencer psychological predicates as shown in (3-54).

(3-54) a *Two hundred pounds are weighed by Bill
b *Five dollars are cost by the book
c *Harry is impressed/struck by Bill as pompous

As was briefly mentioned in §3.1 this restriction on passive may be accounted for in terms of Jackendoff's generalization that a passive *by*-phrase must be higher on the thematic hierarchy than the derived subject. But if the *by*-phrases of verbal passives and event nominals are both subject to thematic restrictions (although different ones), by Dowty's criteria they should both be semantically characterized in terms of a neo-Davidsonian method of argument association. Note also that according to Dowty the *by*-phrase of verbal passives is a subcategorized argument. This conclusion is at odds with the fact that across languages *by*-phrases in passive constructions are optional elements and would thus be more naturally treated as adjuncts (further evidence that the *by*-phrase is an adjunct is provided in chapter 5).

A second argument that Dowty uses to support the hypothesis that differences between arguments of event nominals and verbs arise from the two different methods of argument association involves the possibility of "adding" a participant to an event across a sentence boundary. As the examples in (3-55a) and (3-55b) show, this phenomenon gives rise to different results according to whether the event for which a participant is introduced in the second sentence is expressed by a verb or a nominal. In both (3-55a) and (3-55b) the pronoun *it* in the second sentence makes reference to the event expressed in the first sentence. However only in (3-55a), where the antecedent event is expressed by means of a nominal (eg. *sale*), reference to the previous event can be used to introduce a goal argument (eg. *to Mary*) as a participant of the previous sentence.

(3-55) a John made a sale yesterday. It was to Mary
b John sold a house yesterday.*It was to Mary

Dowty argues that this difference stems from the fact that a participant can be added — in the sense made precise above — across a sentence boundary only by way of a neo-Davidsonian method of argument association. The impossibility of interpreting the goal argument of the second sentence in (3-55b) as a participant of the first sentence would then be a consequence of the fact that a neo-Davidsonian system of semantic interpretation cannot be used to combine a verb with its arguments.

However, in practice it is not clear how this explanation works. Dowty suggests that his account of the contrast between verbs and event nominal in (3-55) could be derived by assuming that event nouns differ from verbs in that only the former directly refer to events. If I understand Dowty correctly, this assumption could be made to yield the desired results in the following way. Within a neo-Davidsonian system of semantic interpretation, direct reference to eventualities is necessary to combine a predicate with one of its arguments. In (3-55a), the goal participant can be added to the event of the previous sentence since the antecedent event is expressed through a nominal and therefore the pronoun in the second sentence involves direct reference to an event. No such possibility is available in (3-55b) where the antecedent event is expressed through a verb; in this case the pronoun in the second sentence does not involve direct reference to an event. Consequently, such an account requires that event nominals, but not verbs, have an argument place for eventualities, eg.

(3-56) a $\exists e[sale(e)]$

b $sell(john, books, peter)$

Notice, however, that Dowty intends to use a neo-Davidsonian system of semantic interpretation to combine verbs with their modifiers. But to do so, verbs should be allowed to involve direct reference to events. For example, in order to combine the two adverbials of the first sentence in (3-57) with the verb, the predicate *happen* should be construed so as to include an eventuality argument variable. This assessment is confirmed by the fact that the introduction of the adverbial of the second sentence in (3-57) as a modifier of the event expressed by the first sentence requires that the pronoun *it* make direct reference to such event.[9]

(3-57) It happened *rapidly, at 2 pm.* It was *totally unexpected*

Therefore Dowty's suggested account of the data in (3-55) cannot be correct. Although the possibility of adding a participant to an event across a sentence boundary seems to depend on whether the event is expressed through a noun or a verb, it still remains to be shown that this difference is reducible to the two methods of argument association.

### On Detransitivization

According to our discussion above, it seems that little is to be gained by assuming two distinct methods of argument association for verbal and nominal arguments. Consequently Dowty's motivations for maintaining a homomorphism between syntactic subcategorization and semantic valency appear considerably less compelling. Indeed, if Carlson is correct in claiming that the independence of subcategorization from principles of semantic interpretation yields a simpler account of phenomena such as detransitivization. it might well be the case that a neo-Davidsonian system of semantic

[9] I am indebted to Elisabet Engdahl for bringing the example in (3-57) to my attention.

interpretation provides a more desirable characterization of the relation between verbs and their arguments.

Since the subcategorization of a verb is not dependent on the semantic valency of the verb within a neo-Davidsonian approach, the relation between sentences like (3-58a) and (3-58b) can be simply captured through a syntactic rule which removes the direct object from the subcategorization frame of a verb.

(3-58) a John ate an apple
b John ate

No additional semantic rule is needed: the "missing object" in (3-58b) is understood as being existentially quantified by virtue of our general knowledge about the meaning of verbs like *eat* which establishes that every event of eating necessarily entails the presence of a patient actant, eg.

(3-59) $\forall e \Box[eat(e) \rightarrow \exists x \exists y[agent(x, e) \wedge theme(y, e)]]$

Dowty, however, has observed that this account cannot be generalized to cases like (3-60a) where the missing object is understood as being coreferential with the subject, and (3-60b) where the missing object is understood indexically as referring to some entity mentioned (or implied) earlier in the discourse context.

(3-60) a John $\left\{\begin{array}{l}\text{shaved}\\ \text{bathed}\\ \text{dressed}\end{array}\right\}$

b John entered, but no one noticed
(= ... but no one noticed him enter)
($\neq$ ... but no one noticed anything/something)

Even within a neo-Davidsonian system a proper account of the detransitivization patterns in (3-60) requires either a verb-specific semantic rule, or a double entry in the lexicon. Dowty argues that since the number of verbs for which Carlson's account holds is somewhat limited the advantage of a neo-Davidsonian treatment of detransitivization becomes marginal.

The question arises then as to whether failure to provide a fuller account of detransitivization undermines the potential advantages of a neo-Davidsonian treatment of verb semantics. If the only parameter of comparison was the attainment of a proper treatment of detransitivization, Dowty's criticism would arguably suffice to show that not much is to be gained from adopting a neo-Davidsonian approach to combine verbs with their arguments. However, insofar as there are independent reasons to maintain such a treatment, even a limited contribution towards a simpler account of detransitivization should be positively assessed. First, a neo-Davidsonian system of semantic interpretation makes it possible to represent thematic roles on-line, and therefore it is better equipped to model the import of thematic information in grammar and sentence processing. Second, because the possibility of omitting the arguments of verbs is subject to parametric variation, it would be advisable not to have a very tight relation between the subcategorization of verbs and their type-theoretic interpretation. For example, if we were to adopt an ordered argument system of semantic interpretation for Japanese and Chinese, we would be at loss to explain the extreme ease with which the argument of verbs can be omitted in these languages. Clearly, more needs to be said about how to relate subcategorization to the meaning of verbs; however it seems quite clear that a more flexible relation between syntactic subcategorization and verb semantics is needed that the one afforded by a Montague-style homomorphism between syntactic and logical types.

## 3.4 Proto-Roles in Event Semantics

In the light of the issues discussed above, a neo-Davidsonian system of semantic interpretation seems to provide a significant number of advantages with respect to the encoding of thematic information. This assessment is corroborated by the fact that within an ordered-argument framework completeness, distinctness and independence have to be explicitly stated, while within a neo-Davidsonian approach to thematic specification they can be independently derived ([Dowty 89]). No special provision needs to be made to capture completeness. Because thematic roles provide an indispensable layer of semantic interpretation in combining predicates with their arguments, every argument of every verb will have to be necessarily associated with a thematic role. The constraint of distinctness follows from Carlson's condition of thematic uniqueness on eventualities. The encoding of independence—the requirement that the defining properties of roles be characterizable independently of the predicates that entail them—would ultimately depend on how role content is characterized. However, since thematic roles form predicates of their own within a neo-Davidsonian system, their interpretation should be independent of the predicates that entail them.

### 3.4.1 Role Content in Event-Semantics

Consider next the question of how to determine the semantic content of roles. In principle we could reproduce Dowty's method for defining roles in terms of entailments of verb meanings within a neo-Davidsonian system so that roles could be defined as relations between individuals and eventualities rather than properties of relations. For example, a given role type such as "goal" could be defined as the set of all individual-eventuality pairs $< x, e >$ such that if the set of predicates $\delta_1, ..., \delta_n$ — chosen so as to include *sell, give, talk, buy, tell, receive* — holds of $e$, then each $\delta_i$ necessarily entails the same set of 2-place relations $\vartheta_1, ..., \vartheta_n$ which hold of $e$ and $x$, eg.

$$\text{(3-61)} \quad \lambda x \lambda e[goal(e,x)] = \lambda x \lambda e[\ \begin{array}{l} \Box[\delta_1(e) \rightarrow \vartheta_1(e,x) \wedge, ..., \wedge \vartheta_n(e,x)] \\ \wedge, ..., \wedge \\ \Box[\delta_2(e) \rightarrow \vartheta_1(e,x) \wedge, ..., \wedge \vartheta_n(e,x)] \end{array}\ ]$$
$$\text{where } \{\delta_1, ..., \delta_n\} = \{give, sell, buy, talk, receive, tell, ...\}$$

Of course the question to ask at this point is whether given the constraints of completeness, distinctness and independence a significantly small set of role types can be obtained in terms of shared sets of entailed relations of verb meanings. In view of our discussion in §3.1 and §3.3 this enterprise does not appear to be very promising. A major problem with definitions such as (3-61) is that they are meant to yield a set of discrete roles. However, as we saw in §3.1, traditional thematic roles tend to fragment and compound into a number of independent roles in such a way that no bound can be placed a priori on the actual number of roles which may be needed to attain an adequate classification of participant types in eventualities.

Dowty himself has expressed serious doubts about the feasibility of defining role types as discrete entities and has provided an alternative according to which this problem can be avoided by giving up on discreteness and limiting the number of roles to the two prototypical notions *Proto-Agent* and *Proto-Patient* (henceforth *p-agt* and *P-pat*). In Dowty's view, these two *proto-roles* are defined as clusters of properties which arise from selected entailments of verb meanings such as those in (3-62) and (3-63) (see §2.3 for details).

(3-62) **Contributing Properties for the Proto-Agent Role**

a volition

b sentience (and/or perception)

c causes event

d movement

(3-63) **Contributing Properties for the Proto-Patient Role**

a change of state (including coming-to-being, going-out-of-being)

b incremental theme

c causally affected by event

d stationary (relative to movement of Proto-Agent)

The p-agt argument of a verb is the argument to which the highest number of proto-agent properties can be attributed, while the p-pat corresponds to the argument of a verb having the highest number of proto-patient properties. Dowty's proposal could accommodated within a neo-Davidsonian system by defining p-agt and p-pat roles as relations between individuals and events, eg.

(3-64) $\exists e[invite(e) \wedge \textit{p-agt}(e, john) \wedge \textit{p-pat}(e, mary)]$

With respect to role content, p-agt and p-pat roles could be characterized in terms of clusters of entailed properties (ie. those in (3-63) and (3-64)) which hold of the individual object argument of the two roles for each choice of verb. For example, given a predicate of eventualities $\delta$ of $e$ and a sequence of two proto-roles $\theta_1, \theta_2$ of $e$ entailed by $\delta$, the p-agt relation of $\delta$ would be the $\theta_i$ whose individual object argument has the greater number of entailed proto-agent properties, and the p-pat relation the $\theta_j$ whose individual object argument has the greater number of entailed proto-patient properties. To achieve this characterization of role content, I will first define the relations *agentive strength* and *patientive strength*; these two relations make it possible to compare the number of proto-patient and proto-agent properties which hold of the individual object argument of any two argument roles with respect to a given verb:

(3-65) Let:

a $P^{agt}$ and $P^{pat}$ be the sets of 1-place predicates of individuals contributing to the proto-agent and proto-patient roles

b $\pi_1^{agt}, \ldots, \pi_n^{agt}$ the members of the power set $\Pi^{agt}$ of $P^{agt}$

c $\pi_1^{pat}, \ldots, \pi_n^{pat}$ the members of the power set $\Pi^{pat}$ of $P^{pat}$

d $\Pi^{\theta}$ the power set of $P^{agt} \cup P^{pat}$

e $>_{agt}$ the relation of *agentive strength* such that for any pair $Q, R \in \Pi^{\theta}$ if $Q >_{agt} R$ then the cardinality of the set of properties contributing to the proto-agent in $Q$, $\pi_i^{agt} \in Q$, is greater than the cardinality of the set of proto-agent relations in $R$ $\pi_j^{agt} \in R$

f $>_{pat}$ the relations of *patientive strength* such that for any pair $Q, R \in \Pi^{\theta}$ if $Q >_{pat} R$ then the cardinality of the set of properties contributing to the proto-patient in Q, $\pi_i^{pat} \in Q$, is greater than that of the set of proto-patient relations in R $\pi_j^{pat} \in R$.

Using the two relations $>_{agt}$ and $>_{pat}$ and the sets of proto-role properties $\pi_1^{agt}, \ldots, \pi_n^{agt}$ and $\pi_1^{pat}, \ldots, \pi_n^{pat}$, the proto-agent proto-patient roles can be defined as in (3-66) and (3-67).

(3-66) *P-agent Role*
For any eventuality $e$ and individual $x$ if $\theta(e, x)$ is the proto-agent participant of $e$ and $\delta$ a predicate of $e$, then there is a cluster of proto-agent properties $\pi_i^{agt}$ entailed by $\delta$ such that $\pi_i^{agt}(x)$ and there is no $\pi_j^{agt} >_{agt} \pi_i^{agt}$ such that for some individual $y$ distinct from $x$ and $\theta'$ distinct from or equal to $\theta$ if $\theta'(e, y)$ then $\pi_j^{agt}(y)$.

(3-67) *P-patient Role*
For any eventuality $e$ and individual $x$ if $\theta(e, x)$ is the proto-patient participant of $e$ and $\delta$ a predicate of $e$, then there is a cluster of proto-patient properties $\pi_i^{pat}$ entailed by $\delta$ such that $\pi_i^{pat}(x)$ and there is no $\pi_j^{pat} >_{pat} \pi_i^{pat}$ such that for some individual $y$ distinct from $x$ and $\theta'$ distinct from or equal to $\theta$ if $\theta'(e, y)$ then $\pi_j^{pat}(y)$.

No additional role definition is needed for ditransitive verbs since the thematic roles of indirect and oblique objects can be made to correspond to prepositional predicates, extending Dowty's treatment of adjuncts to prepositional arguments. For example the semantic translation of a sentence like *John introduced Bill to Mary* would be rendered as in (3-68).

(3-68) $\exists e[introduce(e) \wedge p\text{-}agt(e, john) \wedge p\text{-}pat(e, bill) \wedge to(e, mary)]$

Since the p-agt and p-pat roles are defined as the most and least agentive participant roles of an eventuality, it follows that any other role, i.e. the *to*-role in (3-68), will occupy an intermediate position. The roles of oblique and indirect object will then correspond to the non p-agt participant of an eventuality that has fewer entailed proto-patient properties.[10]

## 3.5 Summary

For years, the study of themantic relations and their relevance in stating grammatical generalizations has provided a topical area of research in theoretical linguistics. This enterprise has produced valuable insights with respect to a number of natural language phenomena. However, these insights have been somewhat obscured by the fact that the thematic classifications used in linguistics have not been very reliable. Recent work by Carlson, Dowty and others[11] have proposed to redress this inadequacy by giving a model-theoretic account in which thematic roles can be assigned a precise semantic interpretation. In Dowty's account, issues concerning the semantic content of roles have also been addressed. With respect to semantic interpretation, two models of thematic encoding have been proposed. In keeping with the neo-Davidsonian approach pioneered by Parsons, Carlson has suggested to treat thematic roles as functions from individuals into eventualities (eg. sets of token events, states and processes). This method of thematic encoding yields a suitable way to represent thematic information on-line, and a desirable account of optional arguments with event nominals as well as missing argument constructions (eg. null anaphora, causative-inchoative alternations, and unspecified object deletion). In addition, it provides a notion of thematic uniqueness which makes interesting predictions about linguistic stategies concerning the individuation of events. Dowty's account is more attuned to a system of semantic interpretation similar to

[10]The resulting role ranking (ie. according to agentive strength) shares the basic ordering of Jackendoff's thematic hierarchy, but differs from Bresnan's where roles such as "location" and "motive" rank lower than theme.

(i) Our Thematic Hierarchy
*proto-agent > prepositional roles > proto-patient*

(ii) Jackendoff's Thematic Hierarchy
*Agent > Location, Source, Goal > Theme*

(iii) Bresnan's Thematic Hierarchy
*ag > ben/mal > recip/exp > ins > pt/th > loc > mot*

[11]See [Chierchia 84].

that of Montague grammar where roles are best encoded as properties of relations. This account provides a natural way of defining the semantic content of roles, and an explicit characterization of the argument/adjunct distinction. To give a comparative assessment, we discussed a number of phenomena which have been used by Carlson and Dowty as evidence in favour (or against) these two approaches. Although conclusive evidence in favour of either proposal was not reached, Parsons' neo-Davidsonian system was found to have some major advantages with respect to Dowty's. In particular, the neo-Davidsonian approach was argued to provide more suitable ways to make reference to thematic information in grammar rules. In keeping with this assessment, a proposal was broached to integrate the neo-Davidsonian system with Dowty's definition of role content in terms of prototype entailments of verb meanings. In the next two chapters I will show how this proposal can be used to develop an approach to grammatical relations and relation-changing within a unification-based categorial grammar framework.

# Chapter 4

# Grammatical Relations, Thematic Roles and Verb Semantics: A UCG Specification

In keeping with the assessment of current approaches to grammatical relations and thematic roles presented hitherto, the aim of this chapter is to develop a grammar framework which provides:

1. a model-theoretic characterization of thematic information which integrates a semantic classification of role types, and where participant roles can be represented on-line

2. a monostratal, computationally efficient account of grammatical relations and argument selection.

The basic strategy which I will follow in attaining these objectives consists in combining a neo-Davidsonian system of semantic interpretation augmented with Dowty's theory of grammatical relations and argument selection with the Unification Categorial Grammar framework developed in [Zeevat *et al.* 87] (henceforth UCG).

The chapter opens with a discussion of unification and categorial grammar which has the purpose of introducing the conceptual bases of UCG. In §4.2, I give a somewhat detailed description of the modules which form the basis for a UCG-style model of grammar. In §4.3, the question of how to provide a UCG specification of a neo-Davidsonian framework augmented with Dowty's theory of proto-roles is taken into consideration. Some of the consequences of the approach proposed are considered with respect to argument selection.

## 4.1 UCG: An Overview

UCG partakes of the general trends in theoretical and computational linguistics that have characterized the surge of unification-based grammar frameworks throughout the last decade. More specifically, UCG combines general properties of sign-based and categorial grammar formalisms with a typed system of unification within a PATR-style architecture ([Shieber *et al.* 83], [Pereira & Shieber 84], [Shieber 86]). The interaction of these tools for grammar development forms the basis for a model of natural language understanding which provides a novel and sophisticated integration of syntax and semantics within a computationally efficient system of linguistic description. First of all, the adoption of a sign-based approach to the encoding of linguistic information yields a linguistic model where phonology, syntax and semantics are treated as equal partners in every grammar object. A sign-based approach makes it possible to represent the incremental accretion of syntactic and semantic information in parallel, and therefore offers a concrete basis for an integrated model of grammar. Second, the use of unification as the only basic operation for constructing complex expressions at each level of grammatical representation allows for a simple account of the interaction between different linguistic levels within a constraining, monostratal theory. Third, the choice of a categorial calculus as the formal mechanism to handle the relation between sign-based descriptions of lexical and phrasal objects provides a very elegant solution to the problem of how to regiment the merging and propagation of linguistic information (e.g. feature percolation). In particular, it yields an account of compositionality where the properties of a phrasal sign can be seen as a function of the properties of the signs from which it is immediately derived through rules of *functional application.*

### 4.1.1 Unification Grammar

One of the central issues in grammar design and implementation is to determine how linguistic information is assembled into a structured meaning representation as a result of parsing an utterance. In the last decade there has been a growing consensus among linguists and computational linguists that this process is best characterized as the unification of partial information structures which mutually constrain the range of representations attainable. As a result of this line of inquiry, there has been an increasing interest in feature-value formalisms and their potential for developing grammars which provide mathematically well-founded, computationally efficient, and cognitively motivated models of natural language understanding. This enterprise has generated a variety of closely related grammar frameworks which have come to play a central role in the development of both theoretical and computational linguistics.[1] UCG shares with these frameworks the practice of representing grammar objects as complex feature structures, and the use of unification as the basic operation to relate these structures to one another.

Informally, a feature structure is a set of equations which provide a (partial) representation of the information relative to an object by specifying *values* for various *attributes* of the object. For example, the feature structure description of a lexical item within a sign-based grammar can be thought of as a set of pairs specifying a value for each of the three attributes *phonology*, *syntax* and *semantics*.[2]

(4-1)

| attribute | *value* |
|---|---|
| phon | *Gianni* |
| syn | *noun phrase* |
| sem | *gianni* |

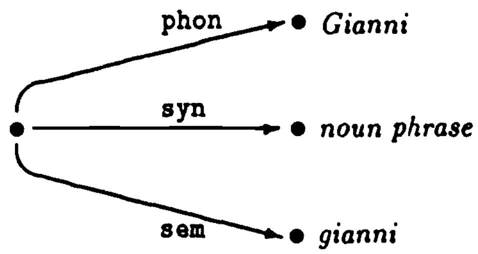
Feature structures are usually represented either as *attribute-value matrices* (AVM'S) or as *graphs* where attributes are rendered as *arcs* and values as *nodes*:

[1] E.g.: Functional Unification Grammar ([Kay 79]), PATR-II ([Shieber *et al.* 83], [Pereira & Shieber 84], [Shieber 86]), Lexical Functional Grammar ([Kaplan & Bresnan 82]), Head Phrase Structure Grammar ([Pollard 85], [Pollard & Sag 87]), Categorial Unification Grammar ([Karttunen 86], [Uszkoreit 86]), Situation Grammar ([Cooper *in prep.*]). Clearly, Generalized Phrase Structure Grammar ([Gazdar *et al.*]), with its concern for the logic of categories and rules, also falls within this tradition.

[2] Throughout the thesis, the orthographic convention is adopted to use typewriter type style for attributes and italics for values.

(4-2) a AVM notation: $\begin{bmatrix} \textbf{phon} = \textit{Gianni} \\ \textbf{syn} = \textit{noun phrase} \\ \textbf{sem} = \textit{gianni} \end{bmatrix}$

b GRAPH notation:




(In this thesis the AVM notation will be used.) The value of an attribute can either be an atomic specification as in the examples above, or a complex one as shown in (4-3) where the syntax attribute is paired with a feature structure indicating a value for the *category* and *case* features of the noun phrase. Notice that in both cases we could say that each of the attributes in question takes as value a feature structure. Atomic values such as *Gianni* and *noun phrase* in (4-2) are in fact considered to be feature structures consisting of a single attribute-value pair in which the attribute is empty.

(4-3) $\begin{bmatrix} \textbf{phon} & = & \textit{Gianni} \\ \textbf{syn} & = & \begin{bmatrix} \textbf{cat} = \textit{noun phrase} \\ \textbf{case} = \textit{nom} \end{bmatrix} \\ \textbf{sem} & = & \textit{gianni} \end{bmatrix}$

The possibility of assigning non-atomic specifications to attributes provides an appropriate way to capture the hierarchical nature of linguistic information by decomposing a complex information structure into a conjunction of attribute-value equations recursively.

Given the practice of pairing attributes with complex values, feature structures can sometimes come to be rather complex. If so, it may be rather cumbersome to refer unambiguously to a deeply embedded value. To circumvent this problem, the convention has been established of referring to an embedded value in terms of the *path of attributes* which leads to it. For example, the case value for the noun phrase described in (4-3) could be simply referred to as the value for the path **syn:case**. This convention makes it possible to differentiate distinct occurrences of the same type of value (i.e. values which are type identical, but occur as distinct tokens) by means of different paths (see below).

In describing the properties of grammar objects, it is often appropriate to be somewhat vague about the value to be assigned to a given attribute in such a way that what is asserted in the object description is simply the occurrence of the attribute without any specific reference to the value it takes. Suppose, for example, we wanted to give a general definition of nominative noun phrases abstracting away from item specific properties. In this case, it would be appropriate to leave the phonology and semantic attributes unspecified so that the resulting description would be suitable to represent any kind of nominative noun phrase. In other words, we want to be able to say that nominative noun phrases all share the same values for the attributes **cat** and **case**, without committing ourselves as to what the values for their phonology and semantic attributes are. Within a feature-value formalism, this underspecification can be encoded by letting an attribute take a value which is compatible with any possible instantiation. Such a value is represented as the least informative feature structure (a feature structure encoding no information) notated as "[ ]" or "⊤". The feature structure in (4-4) will thus serve as a description for any type of nominative noun phrase.

$$(4\text{-}4) \quad \begin{bmatrix} \textbf{phon} = [\,] \\ \\ \textbf{syn} = \begin{bmatrix} \textbf{cat} = \textit{noun phrase} \\ \textbf{case} = \textit{nom} \end{bmatrix} \\ \\ \textbf{sem} = [\,] \end{bmatrix}$$

Insofar as the values assigned to the phonology and semantic attributes of the feature structure in (4-4) are compatible with all phonological and semantic specifications which can be assigned to a noun phrase, there is a clear sense in which this feature structure is less informative than the one in (4-3). This difference in information content can be formally expressed in terms of *subsumption*. In general, an expression $A$ is said to subsume an expression $B$ if $A$ and $B$ do not contain incompatible information, and $B$ is at least as informative as $A$. In the case where $A$ and $B$ are atomic (i.e. they each consist of a single attribute-value pair where the attribute is empty), then we say that $A$ subsumes $B$ if $A$ is equal to $B$. Where $A$ and $B$ are non-atomic, subsumption is defined recursively through the requirement that for every path in $B$ with value $B'$ there is a path in $A$ whose value subsumes $B'$; this condition is trivially satisfied if there are no paths in $A$, i.e. $A$ is [ ]. According to this definition, the feature structure in (4-4) subsumes that in (4-3). Note also that the subsumption relation will hold between two expressions which are equally informative; in this case, each expression will subsume the other. Subsumption is transitive: given three expressions $A$, $B$ and $C$ where $A$ subsumes $B$ and $B$ subsumes $C$, it will also be the case that $A$ subsumes $C$. These properties can be summarized by saying that the relation of subsumption gives rise to a *reflexive partial ordering* $\sqsupseteq$ (i.e. reflexive, antisymmetric and transitive), where the least informative expression corresponds to the maximum element $\top$.

The subsumption relation provides the key notion for defining unification:[3]

(4-5) The unification of two expressions $A$ and $B$ is the least informative expression which is subsumed by both $A$ and $B$.

As previously noted, the qualification "least informative" in this context is meant to refer to specificity. According to (4-5), the unification of the two feature structures in (4-4) and (4-6) will be equal to the feature structure in (4-3).

$$\text{(4-6)}\quad \begin{bmatrix} \textbf{phon} = \textit{Gianni} \\ \textbf{syn} = \begin{bmatrix} \textbf{cat} = \textit{noun phrase} \\ \textbf{case} = [\,] \end{bmatrix} \\ \textbf{sem} = [\,] \end{bmatrix}$$

The unification of two expressions fails if the two expressions encode incompatible information. In the two feature structures shown below, for example, the case attributes are paired with different values. Hence there will be no expression which is subsumed by both feature structures, and unification will fail.

[3]In fact, subsumption and unification are interdefinable, see (4-7f).

$$
\text{(4-7)} \quad a \quad \begin{bmatrix} \textbf{phon} & = & \textit{Io} \\ \textbf{syn} & = & \begin{bmatrix} \texttt{cat} & = & \textit{noun phrase} \\ \texttt{case} & = & \underline{\textit{nom}} \end{bmatrix} \\ \textbf{sem} & = & \textit{I} \end{bmatrix}
$$

$$
b \quad \begin{bmatrix} \textbf{phon} & = & [\,] \\ \textbf{syn} & = & \begin{bmatrix} \texttt{cat} & = & \textit{noun phrase} \\ \texttt{case} & = & \underline{\textit{acc}} \end{bmatrix} \\ \textbf{sem} & = & [\,] \end{bmatrix}
$$

More formally, unification corresponds to the *meet* operation ($\sqcap$) relating any two feature structures $A$ and $B$ within a meet semilattice with top and bottom where the following properties hold:

(4-8)
*a. idempotency* $A \sqcap A = A$
*b. commutativity* $A \sqcap B = B \sqcap A$
*c. associativity* $(A \sqcap B) \sqcap C = A \sqcap (B \sqcap C)$
*d. top* $\top \sqcap A = A$
*e. bottom* $\bot \sqcap A = \bot$
*f. interdefinability* $A \sqsupseteq B$ (*i.e.* $A$ subsumes $B$) *iff* $A \sqcap B = B$.

Whenever two expressions encode incompatible information, the result of their unification is said to be equal to the minimum element of a reflexive partial ordering "$\bot$".

So far we have only considered cases where subsumption relates either atomic or conjunctive feature structure. That means that there is no way to calculate the unification of pairs of expressions containing feature structures such as that in (4-9) where the path syn:case takes a disjunctive value (i.e. the join ($\sqcup$) of the two feature specifications *nom* and *acc*), or a negative one.

$$
(4\text{-}9)\quad
\begin{bmatrix}
\textbf{phon} = \textit{Gianni} \\
\textbf{syn} = \begin{bmatrix} \textbf{cat} = \textit{noun phrase} \\ \textbf{case} = \textit{nom} \sqcup \textit{acc} \end{bmatrix} \\
\textbf{sem} = [\,]
\end{bmatrix}
$$

$$
\begin{bmatrix}
\textbf{phon} = \textit{Gianni} \\
\textbf{syn} = \begin{bmatrix} \textbf{cat} = \textit{noun phrase} \\ \textbf{case} = \neg \textit{obl} \end{bmatrix} \\
\textbf{sem} = [\,]
\end{bmatrix}
$$

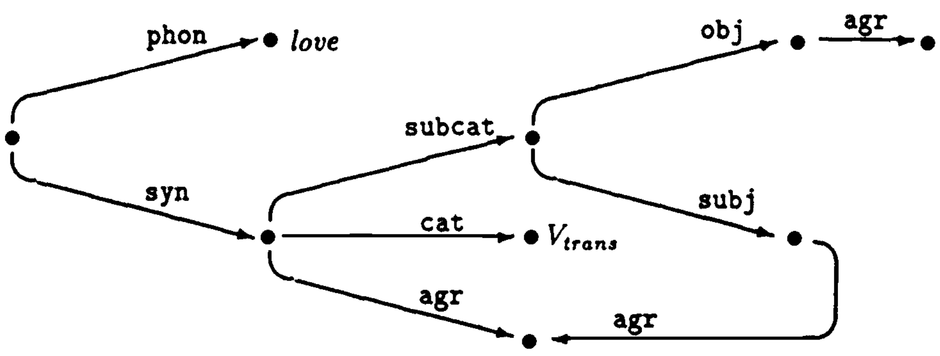
We may thus want to extend our notion of subsumption so as to allow feature structures to include disjunctive and negative information. Given two feature structures $A$ and $B$, where $A$ is $A_1 \sqcup \ldots \sqcup A_n$ and $B$ is $B_1 \sqcup \ldots \sqcup B_m$ and each $A_i$, $B_i$ is a basic feature structure (e.g. one which contains no disjunctions or implications) we say that $A$ subsumes $B$ if and only if each $B_i$ in $B$ is subsumed by an $A_i$ in $A$. The unification of feature structures which involve disjunctive information can then be stated as in (4-8f) using this new notion of subsumption. Negative information can be treated in terms of conditional unification and subsumption. The negation of a feature structure A, "$\neg A$", can be encoded as the *conditional feature structure* "$A \Rightarrow \perp$". The symbol "$\Rightarrow$" in a conditional feature structure is an operator such that if A and B are feature structures then A $\Rightarrow$ B is the least informative feature structure whose unification with $A$ is subsumed by $B$ ([Pollard & Sag 87]).

A very important distinction to make with respect to the assignment of values to attributes concerns the notions of *type* and *token* identity. As the name suggests, two values are *type identical* if they have the same type, but are not necessarily the one and same object: one may vary independently of the other. If in addition to being of the same type the values are also "coinstantiated", i.e. their attributes point to the same piece of structure within the feature description, the two values are said to be *token identical*. The import of this difference can be briefly shown construing an example involving agreement in English. Suppose, for example, we wished to give a lexical treatment of subject-verb agreement by stating that the agreement features of a verb are the same as those of its subject argument. This analysis could be carried out by construing the feature structure of verbs in such a way that the path terminating with the agreement attribute of the verb and that terminating with the agreement attribute of the verb's subject point to the same value. This equality can be represented as the *path equation* in (4-10) where **syn** represents the syntactic attribute of a verb, and **subcat** is the attribute leading to the verb's subcategorized arguments (**agr** and **subj** stand for "agreement" and "subject").

(4-10) **syn:agr = syn:subcat:subj:agr**

This sharing of values is most clearly represented using graph notation. As shown in (4-11) the paths of arcs containing the agreement attribute for both the verb *love* and its subject terminate at the same value node.

(4-11)




This situation is often described by saying that the coinstantiated values are *reentrant*. In AVM notation, reentrancy is conventionally notated by using boxed integers to index the values for the paths of attributes involved in structure sharing. For example the AVM version of the feature structure above would be rendered as in (4-12).

$$
\text{(4-12)}\quad
\begin{bmatrix}
\textbf{phon} & = & \textit{love} \\
\textbf{syn} & = & \begin{bmatrix}
\textbf{cat} & = & V_{trans} \\
\textbf{agr} & = & \boxed{1} \\
\textbf{subcat} & = & \begin{bmatrix}
\textbf{obj} & = & \begin{bmatrix}\textbf{agr} = [\,]\end{bmatrix} \\
\textbf{subj} & = & \begin{bmatrix}\textbf{agr} = \boxed{1}\end{bmatrix}
\end{bmatrix}
\end{bmatrix}
\end{bmatrix}
$$

This means that whenever a specification for the shared value is entered, the resulting instantiation will count as a value specification for both the verb and subject agreement attributes. The feature structure for the third person singular, present tense form of *love* will be as in (4-13).

$$
(4\text{-}13)\quad
\begin{bmatrix}
\textbf{phon} = \textit{loves} \\
\textbf{syn} = \begin{bmatrix}
\textbf{cat} = V_{trans} \\
\textbf{agr} = \boxed{1}\begin{bmatrix} \textbf{pers} = \textit{3rd} \\ \textbf{num} = \textit{sg} \end{bmatrix} \\
\textbf{subcat} = \begin{bmatrix}
\textbf{obj} = \begin{bmatrix} \textbf{agr} = [\,] \end{bmatrix} \\
\textbf{subj} = \begin{bmatrix} \textbf{agr} = \boxed{1} \end{bmatrix}
\end{bmatrix}
\end{bmatrix}
\end{bmatrix}
$$

It should be pointed out that although the value for the agreement attribute of the object is not coinstantiated with that of the verb and the subject, it could still be the case that the object agreement features are of the same type as those of the verb and its subject. For example a situation may occur where the subject and object arguments are both third person and singular as indicated below.

$$
(4\text{-}14)\quad
\begin{bmatrix}
\textbf{phon} = \textit{loves him} \\
\textbf{syn} = \begin{bmatrix}
\textbf{cat} = V_{trans} \\
\textbf{agr} = \boxed{1}\begin{bmatrix} \textbf{pers} = \textit{3rd} \\ \textbf{num} = \textit{sg} \end{bmatrix} \\
\textbf{subcat} = \begin{bmatrix}
\textbf{obj} = \begin{bmatrix} \textbf{agr} = \begin{bmatrix} \textbf{pers} = \textit{3rd} \\ \textbf{num} = \textit{sg} \end{bmatrix} \end{bmatrix} \\
\textbf{subj} = \begin{bmatrix} \textbf{agr} = \boxed{1} \end{bmatrix}
\end{bmatrix}
\end{bmatrix}
\end{bmatrix}
$$

In this case however the agreement feature of the object and those of the verb are simply type identical (i.e. they are not coinstantiated); further information (e.g. gender information) could in fact be introduced which made the agreement feature of the object differ from those of the verb as shown in (4-15), while an analogous instantiation with respect to the verb and the subject is obviously impossible.

$$
(4\text{-}15)\quad
\begin{bmatrix}
\textbf{phon} = \textit{she loves him} \\
\textbf{syn} = \begin{bmatrix}
\textbf{cat} = V_{trans} \\
\textbf{agr} = \boxed{1}\begin{bmatrix}\textbf{pers} = \textit{3rd} \\ \textbf{gen} = \textit{fem} \\ \textbf{num} = \textit{sg}\end{bmatrix} \\
\textbf{subcat} = \begin{bmatrix}
\textbf{obj} = \begin{bmatrix}\textbf{agr} = \begin{bmatrix}\textbf{pers} = \textit{3rd} \\ \textbf{gen} = \textit{masc} \\ \textbf{num} = \textit{sg}\end{bmatrix}\end{bmatrix} \\
\textbf{subj} = \begin{bmatrix}\textbf{agr} = \boxed{1}\end{bmatrix}
\end{bmatrix}
\end{bmatrix}
\end{bmatrix}
$$

Notice, incidentally, that reentrant structures may be obtained from nonreentrant ones by unifying a feature structure containing type identical values with another feature structure where their structurally corresponding values are coinstantiated. A clear example of this case will be shown in §5.1.1 with respect to reflexivization in Romance.

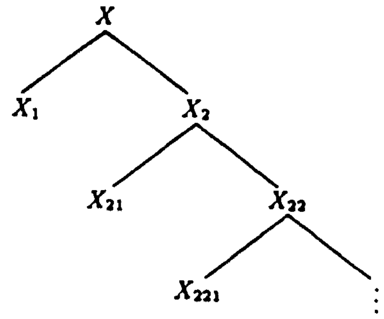
In addition to the types of data structures which can be defined in terms of attribute-value equations together with conjunction, disjunction and implication, I will allow feature structures to be combined into *string forms* — i.e. ordered sequences constructed with the associative operator "o" — as shown below.[4]

(4-16) a If $A$ is a feature structure, a variable, or the empty string ($\Lambda$) then $\langle A \rangle$ is a string

b if $\langle A \rangle$ and $\langle B \rangle$ are strings, then $\langle A \circ B \rangle$ is also a string.

The basic algorithm for computing the unification of string forms was developed by [Siekmann 75]. According to Siekmann, the unification of two string forms $\Sigma$ and $\Sigma'$ involves an assignment of values to variables such that each $\sigma_i$ in $\Sigma$ — where $\sigma_i$ is not itself a string — is subsumed by the $i$th element in $\Sigma'$. In carrying out this assignment of values, we are allowed to replace each variable by a string of subvariables and then evaluate the corresponding substitution instance. More precisely, each variable in a string form may be replaced with a string of two subvariables of which the second one may itself be a string of two subvariables and so on, e.g.

[4] I am indebted to Jo Calder and Steven Bird for many valuable suggestions concerning this point.




For example, the unification of the two strings in (4-17a) where tags are used as names of variables and lower case letters correspond to either constants or (non-empty) feature structures, will be effectively computed as the unification of the two strings in (4-17b) where the variable $\boxed{1}$ in the first string has been replaced by the string of subvariables $\langle \boxed{1}_1 \circ \boxed{1}_{21} \circ \boxed{1}_{22} \rangle$. The unification of the two strings will give rise to the substitutions in (4-17c).

(4-17) a $\langle \boxed{1} \circ d \rangle \sqcap \langle a \circ b \circ c \circ d \rangle$

b $\langle \boxed{1}_1 \circ \boxed{1}_2 \circ \boxed{1}_{21} \circ d \rangle \sqcap \langle a \circ b \circ c \circ d \rangle$

c $\boxed{1}_1/a$

$\boxed{1}_{21}/b$

$\boxed{1}_{22}/c$

The use of string forms and string unification is particularly useful when we want to perform complex operations such as selecting an arbitrary element out of a sequence. Suppose for example that we wished to remove a feature structure $f_i$ from any given string $\Sigma$ which may contain it. The intended removal operation could be performed by unifying $\Sigma$ with the string form $\langle \boxed{1} \circ f_i \circ \boxed{2} \rangle$ to obtain $\Sigma'$, and then removing $f_i$ from $\Sigma'$. Moreover, the basic algorithm for string unification can be easily augmented with the inclusion of the identity axiom in (4-18) so that the selection of an arbitrary element out of a sequence will also succeed with sequences where the element to be selected occurs in final or initial position within the sequence (e.g. $\langle f_i \circ \ldots \rangle$ or $\langle \ldots \circ f_i \rangle$).

(4-18) The symbol $\Lambda$ is a string (i.e. the empty string), such that $\Lambda \circ \sigma = \sigma = \sigma \circ \Lambda$ for any element $\sigma$ of a sequence.

For example, the unification of two strings such as those in (4-19) will be performed as in (4-19b) according to (4-18).

(4-19) a $\langle \boxed{1} \circ f_i \rangle \sqcap \langle f_i \rangle$

b $\langle \boxed{1} \circ f_i \rangle \sqcap \langle \Lambda \circ f_i \rangle = \langle \Lambda \circ f_i \rangle = \langle f_i \rangle$

It should be pointed out that in the general case the unification of two string forms presents computational complexities with respect to both completeness and termination, unless the occurrence of repeated variables is limited to only one of the two string forms ([Siekmann 75], [Siekmann 84]). Siekmann, for example, shows there are infinitely many solutions for the class of unification problems exemplified by the string equation in (4-20).

(4-20) $yay = xxa$ (in my notation: $\langle \boxed{1} \circ a \circ \boxed{1} \rangle \sqcap \langle \boxed{2} \circ \boxed{2} \circ a \rangle$)

Fortunately unification instances of this kind will never arise in this thesis, as string forms containing repeated variables will not be used.

### 4.1.2 A Unification Approach to Categorial Grammar

A brief introduction to Categorial Grammar was already presented along with the discussion of Dowty's theory of GRs and GR changing in chapter 2, section 2. This section is thus primarily intended to show how a categorial calculus can be introduced within a sign-based unification grammar framework by summarizing the approach to category specification developed in [Zeevat *et al.* 87], [Klein 88] and related works. A more formal description of the framework is presented in the next section.

Within a Montagovian framework, each grammar rule consists of a set of syntactic subrules and a semantic operation taking as input a functor and argument expressions. Any such rule will yield an expression which combines properties of the input according to a categorial grammar calculus and additional rule-specific processes. The syntactic part of the rule provides a specification of phonological and (morpho)syntactic operations to be performed on input expressions, and the type of processes which they undergo. More specifically, it provides a specification of:

- the phonology and category type of the input expressions
- ordering function relating the phonologies of the input expressions
- word formation processes which involve the input phonologies where necessary (e.g. case marking, agreement, etc.)
- the categorial rule to be performed on the input categories

- phonology and category of the output expression

The semantic half of the rule contains information regarding:

- the semantic translation of the input expressions
- the semantic operation involved in relating them
- the semantics of the output expression.

In the most common case, the ordering function involves either right or left concatenation (RC, LC) of the input phonologies, the categorial rule results in cancelling the functor category with the argument, and the operation performed on the semantics of the input expressions corresponds to *functional application.* Abstracting away from specific rule formulations, the general format of a grammar rule of this kind can be schematically represented as follows.

(4-21)

| | | Grammar Rule | | | | | |
|---|---|---|---|---|---|---|---|
| | | Input Expressions | | Processes | | | Output |
| | | Functor | Argument | Concatenation (Word Order) | Categorial Rule | Semantic Operation | |
| Syn | Phon | $W_1$ | $W_2$ | RC($W_1$, $W_2$) or LC($W_1$, $W_2$) | | | $W_1 ^\frown W_2$ or $W_2 ^\frown W_1$) |
| | Cat | A/B | B | | apply(A/B, B) | | A |
| Semantics | | $\lambda x[\alpha(x)]$ | $\beta$ | | | apply($\lambda x[\alpha(x)]$, $\beta$) | $\alpha(\beta)$ |

In order to provide a unification-based specification of the rule above it is necessay:

- to represent the input expressions as feature structures,
- and to relate them in such a way that their unification plus cancellation yields a feature structure corresponding to the output expression.

The basic strategy followed in UCG to attain this goal is to adopt a sign-based representation where the input expressions to the rule are structured as triplets of attribute-value pairs encoding phonological, categorial and semantic information. For example the UCG representation for the argument expression in (4-21) is:

$$(4\text{-}22)\quad \begin{bmatrix} \textbf{phon} & = & W_2 \\ \textbf{cat} & = & B \\ \textbf{sem} & = & \beta \end{bmatrix}$$

In addition, the category of a functor expression includes information regarding the phonology, category type and semantics of its argument. The *active part* of a functor category (i.e. the expression on the right side of the categorial slash) is specified as a complex object encoding phonological, categorial and semantic information, e.g. a *sign* rather than a simple category type as in standard categorial grammar. Given a functor expression with category type $A/B$ as in (4-21), where $W_2$ and $\beta$ are the phonology and semantic attributes of its argument, the representation of the category attribute of the functor expression is:

$$(4\text{-}23)\quad A\Big/\begin{bmatrix} \textbf{phon} & = & W_2 \\ \textbf{cat} & = & B \\ \textbf{sem} & = & \beta \end{bmatrix}$$

The sign-based representation of the whole functor expression will be as in (4-24), where $W_1$ and $\lambda x[\alpha(x)]$ are the phonology and semantic attributes of the functor expression.

$$(4\text{-}24)\quad \begin{bmatrix} \textbf{phon} & = & W_1 \\ \textbf{cat} & = & A\Big/\begin{bmatrix} \textbf{phon} & = & W_2 \\ \textbf{cat} & = & B \\ \textbf{sem} & = & \beta \end{bmatrix} \\ \textbf{sem} & = & \lambda x[\alpha(x)] \end{bmatrix}$$

The next step is to integrate the phonology and semantics of the argument with the phonology and semantics of the functor. To do so, the concatenation and semantic processes of the rule are also given a unification interpretation. The phonology and semantics of the functor, $\mathrm{W}_1$ and $\lambda x[\alpha(x)]$, are replaced with the phonology and semantics of the *result category* (i.e. the symbol on the left side of the categorial slash, corresponding to the category of the output expression in (4-21)):

$$(4\text{-}25)\quad \begin{bmatrix} \textbf{phon} & = & W_1{}^\frown W_2 \sqcup W_2{}^\frown W_1 \\ \textbf{cat} & = & A\Big/\begin{bmatrix} \textbf{phon} & = & W_2 \\ \textbf{cat} & = & B \\ \textbf{sem} & = & \beta \end{bmatrix} \\ \textbf{sem} & = & \alpha(\beta) \end{bmatrix}$$

Repeated variable are substituted with *tags* such as " $\boxed{1}$ "*and*" $\boxed{2}$ " to indicate structure sharing, e.g.

$$(4\text{-}26)\quad \begin{bmatrix} \textbf{phon} = W_1{}^\frown \boxed{1} \cup \boxed{1}{}^\frown W_1 \\ \textbf{cat} = A\Big/\begin{bmatrix} \textbf{phon} = \boxed{1} \\ \textbf{cat} = B \\ \textbf{sem} = \boxed{2} \end{bmatrix} \\ \textbf{sem} = \alpha(\boxed{2}) \end{bmatrix}$$

Finally, a unification-based specification of the categorial rule is provided as shown in (4-27).

(4-27) **Functional Application**
Given functor and argument expressions $\Sigma$, $\Sigma'$:

a INSTANTIATION
Find the *most general unifier* of $\Sigma$ and $\Sigma'$, i.e. the least informative expression which is subsumed by $\Sigma$, and whose active category attribute is the unification of $\Sigma$'s active category attribute with $\Sigma'$:

$$\text{If } \Sigma \text{ is } \begin{bmatrix} \textbf{phon} = W_1{}^\frown \boxed{1} \cup \boxed{1}{}^\frown W_1 \\ \textbf{cat} = A\Big/\begin{bmatrix} \textbf{phon} = \boxed{1} \\ \textbf{cat} = [\,] \\ \textbf{sem} = \boxed{2} \end{bmatrix} \\ \textbf{sem} = \alpha(\boxed{2}) \end{bmatrix} \text{ and } \Sigma' \text{ is } \begin{bmatrix} \textbf{phon} = W_2 \\ \textbf{cat} = B \\ \textbf{sem} = \beta \end{bmatrix}$$

then the *most general unifier* of $\Sigma$ and $\Sigma'$ is:

$$\begin{bmatrix} \textbf{phon} = W_1{}^\frown \boxed{1} \cup \boxed{1}{}^\frown W_1 \\ \textbf{cat} = A\Big/\begin{bmatrix} \textbf{phon} = \boxed{1}\, W_2 \\ \textbf{cat} = B \\ \textbf{sem} = \boxed{2} \end{bmatrix} \\ \textbf{sem} = \alpha(\boxed{2}\,\beta) \end{bmatrix}$$

b CANCELLATION
remove the active sign from *most general unifier* of $\Sigma$ and $\Sigma'$:

$$\begin{bmatrix} \textbf{phon} = W_1{}^\frown \boxed{1}\, W_2 \cup \boxed{1}{}^\frown W_1 \\ \textbf{cat} = A\Big/\begin{bmatrix} \textbf{phon} = \boxed{1} \\ \textbf{cat} = B \\ \textbf{sem} = \boxed{2} \end{bmatrix} \\ \textbf{sem} = \alpha(\boxed{2}\,\beta) \end{bmatrix} \rightarrow \begin{bmatrix} \textbf{phon} = W_1{}^\frown \boxed{1}\, W_2 \cup \boxed{1}{}^\frown W_1 \\ \textbf{cat} = A \\ \textbf{sem} = \alpha(\beta) \end{bmatrix}$$

For ease of exposition, the rule is described as comprising two operations (i.e. instantiation and cancellation). However, it should be stressed that the two operations are part of the same process and occur simultaneously. From now on, I will refer to this process simply as *functional application*.

One of the most conspicuous differences between the approach to functional application introduced in UCG and the one pursued in standard categorial grammar (e.g. as in Montague Grammar) is the switch from a purely applicative approach to a unification one. This switch is most evident with respect to the incremental building of semantic representation. In standard categorial grammar semantic compositionality results from associating a semantic rule with each set of syntactic operations. Typically this semantic rule involves $\lambda$-abstraction and $\beta$-conversion. Within the approach to category specification and functional application adopted in UCG instead, semantic compositionality involves (incremental) instantiation of partially specified feature structures. This process is carried out during functional application through unification and is facilitated by structure sharing. Suppose, for example, we were to apply the functional application rule in (4-27) to the pair of UCG-like signs below.

$$\text{(4-28)}\quad \text{a}\quad \left[\begin{array}{lll} \textbf{phon} & = & \boxed{1}{}^\frown walks \\ \textbf{cat} & = & sent/\left[\begin{array}{lll} \textbf{phon} & = & \boxed{1} \\ \textbf{cat} & = & np[nom] \\ \textbf{sem} & = & \boxed{2} \end{array}\right] \\ \textbf{sem} & = & walk(\boxed{2}) \end{array}\right]$$

$$\text{b}\quad \left[\begin{array}{lll} \textbf{phon} & = & Mary \\ \textbf{cat} & = & np[nom] \\ \textbf{sem} & = & mary \end{array}\right]$$

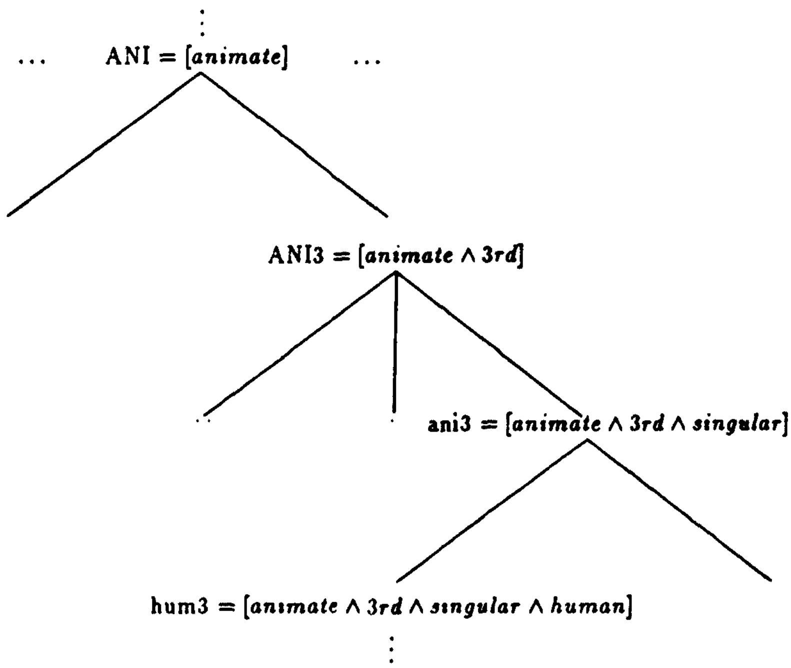
In the instantiation phase, the sign for the noun phrase *Mary* is unified with the active part of the verb sign. The instantiation of values relative to the active sign of the verb will be shared by the result phonology and semantics attributes of the verb sign, as shown in the feature structure below, which represents the output of this intermediate stage of the rule (i.e. the most general unifier of the two feature structures in (4-28)).

$$\text{(4-29)}\quad \left[\begin{array}{lll} \textbf{phon} & = & \boxed{1}{}^\frown walks \\ \textbf{cat} & = & sent/\left[\begin{array}{lll} \textbf{phon} & = & \boxed{1}\,Mary \\ \textbf{cat} & = & np[nom] \\ \textbf{sem} & = & \boxed{2}\,mary \end{array}\right] \\ \textbf{sem} & = & walk(\boxed{2}) \end{array}\right]$$

This is because the phonology and semantic of the verb sign contain values which are coinstantiated with the phonology and semantics of the active sign in the verb's category structure as indicated by the tags $\boxed{1}$ and $\boxed{2}$. The semantic representation for the sentence *Mary walks*, i.e. *walk(mary)*, will thus arise from the unification of the argument semantics and the semantics for the active sign of the verb.

A unification-based approach to functional application allows for a finer grained notion of semantic compositionality than that available within an applicative system with $\lambda$-abstraction and $\beta$-conversion. Given the possibility of partial instantiation, it is possible to create a situation where the same object reaches its full specification gradually through successive stages of instantiation, whereas within an applicative system the assignment of values to variables is a one-step-only process. In UCG the possibility of partial instantiation for atomic objects is obtained by setting an algebraically specified system of *sorted variables*. Informally, the basic idea is to use propositional constants (e.g. *animate, human, singular, plural, 1st, 2nd and 3rd person* and so forth) and cooccurrence restrictions regimenting their distribution (e.g. $human \rightarrow animate$, $\neg[singular \wedge plural]$, $1st \rightarrow singular \vee plural \wedge human$) to define a partial ordering of typed variables (i.e. sorts). For example given the partial hierarchy of sorts in (4-30) where subsumption relations among sorts are indicated in terms of dominance (i.e. a less specific sort dominates a more specific one), we can imagine a situation where the final instantiation for the argument variable of a predicate like *growl* is carried out gradually through a sequence of unification steps induced by grammar rules (i.e. lexical rules and functional application) as shown in (4-31).

(4-30)



(4-31) *a.* *growl*(ANI) growl

$\vdots$

*b.* *growl*(ani3) growls

$\vdots$

*c.* *growl*(hum3) ∧ *man*(hum3) a man growls

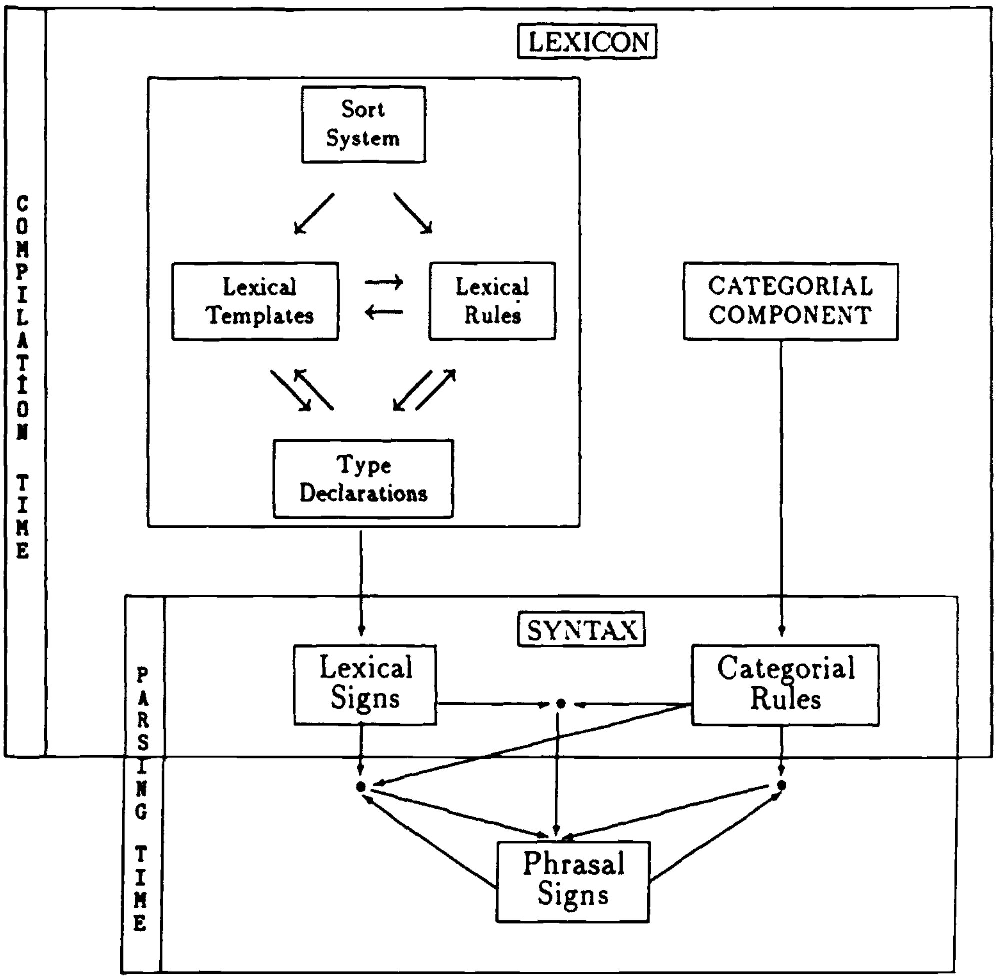
## 4.2 System Architecture

Like most unification-based models of grammar, UCG places a strong emphasis on lexical specification. Schematically, the lexicon comprises four interactive modules and a Categorial Component. The four interactive modules are:

- the Type Declaration (TD) module;
- the Lexical Template (LT) module;
- the Lexical Rule (LR) module,
- the Sort System module.

The **TD** module provides a definition of all admissible grammar objects (aside from rules). The **LT** module consists of statements intended to capture generalizations about classes of lexical items and relate them to properties specific to individual lexical items. The **LR** module establishes relations among lexical items through operations which perform transitions between lexical templates (also known as "lexical redundancy rules"). The Sort System module provides a lattice-theoretic specification of the typed variables used in semantic representation. The Categorial Component contains a sign-based specification of rules of functional application. The interaction of the **TD**, **LT**, **LR** and Sort System modules at compilation time yields *sign*-based representations of lexical items which are then assembled into phrasal signs through the categorial rules of functional application in the syntax at parsing time. Phrasal signs can be further combined with one another or with lexical signs to yield new phrasal signs. The schema below provides an intuitive idea of how lexical and phrasal processing procedes in UCG.

(4-32)




### 4.2.1 Type Declarations

As in HPSG, each lexical item is represented as a feature structure where phonological, syntactic and semantic information is simultaneously represented as a conjunction of attribute-value pairs forming a *sign*. The structure of a sign and its attributes is established in an axiomatic fashion through *type declarations*. Type declarations have the general form *label* $\Rightarrow$ *type* where *label* is the object to be defined and *type* encodes the range of admissible instantiations which it can receive. The restrictions on the assignment of types to labels encoded in the TD module are enforced through a type checking algorithm on the ouput of the other modules of the lexicon. In specifying type assignments to labels, I will use the two specifications *nil* and *basic*: *nil* denotes a value which is only compatible with itself and $\top$, while the type *basic* designates an atomic instantiation (e.g. an *atom* in Prolog, or a *symbol* in LISP).

The top-level label is a *sign*. A sign is declared as a feature structure consisting of exactly three attributes: phonology, category, and semantics.

(4-33) TD1

$$sign \Rightarrow \begin{bmatrix} \mathbf{phon} & = & \mathit{phon\_struct} \\ \mathbf{cat} & = & \mathit{basic\_cat} \sqcup \mathit{complex\_cat} \\ \mathbf{sem} & = & \mathit{formula} \end{bmatrix}$$

From TD1, it follows that every legal instantiation of a lexical item as determined by the **LT**, **LR** modules and the sort system must have a value for each one of these three attributes. None of the feature structures in (4-34) will therefore correspond to a legal instantiation of a grammar object: in (4-34a) an additional attribute (**agr**) is encoded which does not match the type declaration in (4-33), and in the three remaining cases one of the attributes which define a sign as a type is missing.

(4-34) a $\begin{bmatrix} \mathbf{phon} = \mathit{John} \\ \mathbf{cat} = \mathit{np} \\ \mathbf{agr} = \begin{bmatrix} \mathbf{num} & = & \mathit{sg} \\ \mathbf{gen} & = & \mathit{masc} \\ \mathbf{pers} & = & \mathit{3rd} \end{bmatrix} \\ \mathbf{sem} = \mathit{he} \end{bmatrix}$

b $\begin{bmatrix} \mathbf{phon} & = & \mathit{John} \\ \mathbf{cat} & = & \mathit{np} \end{bmatrix}$

c $\begin{bmatrix} \mathbf{phon} & = & \mathit{John} \\ \mathbf{sem} & = & \mathit{john} \end{bmatrix}$

d $\begin{bmatrix} \mathbf{cat} & = & \mathit{np} \\ \mathbf{sem} & = & \mathit{john} \end{bmatrix}$

Each attribute of a sign is likewise associated with a type declaration indicating restrictions on the range of values that it may take.

**Phonology** The type *phon_struct* in (4-33) indicates that the value for the phonology attribute of a sign is either a "morpheme unit" (e.g. a single word or bound morpheme), or a triple consisting of an word order operator — RC and LC for right and left concatenation[5] — a morpheme unit, and either a second morpheme unit or another triple of the same sort.

[5]These are the two word order operators which will be used throughout the thesis. Additional ones can be easily introduced where necessary.

(4-35) **TD2**

$$phon\_struct \Rightarrow basic \sqcup \begin{bmatrix} \mathbf{ord} & = & \textsc{rc} \sqcup \textsc{lc} \\ \mathbf{phon1} & = & basic \\ \mathbf{phon2} & = & phon\_struct \end{bmatrix}$$

For example the phonology attribute of the sign for the noun *man* will be as in (4-36a), while that for the sentence *a man walks* will be as in (4-36b), where the specification LCindicates the subject phonology is concatenated to the left of the verb phonology, and the specification RCindicates that the noun phonology is concatenated to the right of the determiner phonology. (For simplicity, phonological items will be represented orthographically.)

(4-36) a $\mathbf{phon} = man$

b $$\mathbf{phon} = \begin{bmatrix} \mathbf{ord} & = & \textsc{lc} \\ \mathbf{phon1} & = & walks \\ \mathbf{phon2} & = & \begin{bmatrix} \mathbf{ord} & = & \textsc{rc} \\ \mathbf{phon1} & = & a \\ \mathbf{phon2} & = & man \end{bmatrix} \end{bmatrix}$$

I will occasionally omit reference to the word order attribute, and represent a complex phonological structure as a sequence of concatenated word atoms, e.g.

$$\text{phon} = a^\frown man^\frown walks$$

**Syntax** In keeping with the basic insights of a categorial calculus, the type restrictions relative to the second attribute of the definition in **TD1** state that the category of a sign can either be basic or complex. Basic categories are binary structures consisting of a category name — *np*, *n* or *sent* short for "noun phrase", "noun" and "sentence" respectively — and a list of attribute-value pairs which encode morphosyntactic information (e.g. agreement, government, voice and mood features).

(4-37) a **TD3**

$$basic\_cat \Rightarrow \begin{bmatrix} \mathbf{name} & = & basic \\ \mathbf{feats} & = & feat\_list \end{bmatrix}$$

b **TD4**

$$feat\_list \Rightarrow nil \sqcup \begin{bmatrix} \mathbf{1st} & = & mfeat\_attval \\ \mathbf{rest} & = & feat\_list \end{bmatrix}$$

c **TD5**

$$mfeat\_attval \Rightarrow \begin{bmatrix} \mathbf{att\_name} & = & basic \end{bmatrix}$$

For example, the category for the English pronoun *she* may be represented as:

(4-38) $\begin{bmatrix} \mathbf{cat} = np & \\ \mathbf{feats} = & \begin{bmatrix} \mathbf{1st} = [\mathbf{gender} = \textit{feminine}] \\ \mathbf{rest} = \begin{bmatrix} \mathbf{1st} = [\mathbf{number} = \textit{singular}] \\ \mathbf{rest} = \begin{bmatrix} \mathbf{1st} = [\mathbf{person} = \textit{third}] \\ \mathbf{rest} = [\mathbf{1st} = [\mathbf{case} = \textit{nominative}]] \end{bmatrix} \end{bmatrix} \end{bmatrix} \end{bmatrix}$

To enhance readibility, I will omit internal bracketing and include the attribute-value pairs of each morphosyntactic feature lists within a feature-matrix which has no internal nesting, e.g.

(4-39) $\begin{bmatrix} \mathbf{name} = np & \\ \mathbf{feats} = & \begin{bmatrix} \mathbf{gender} = \textit{feminine} \\ \mathbf{number} = \textit{singular} \\ \mathbf{person} = \textit{third} \\ \mathbf{case} = \textit{nominative} \end{bmatrix} \end{bmatrix}$

Whenever reference to the morphosyntactic features of a basic category is omitted. I will use the following abbreviatory convention:

(4-40) **catn** abbreviates **cat:name**

According to the UCG approach to category specification discussed in the previous section, complex categories are recursively defined by letting the category attribute of a sign be of the form *result / active* where the *active* part of the category is a sign, and the *result* part is either a basic or complex category. Note that in the attribute-value notation below the categorial slash is eliminated in favour of the attribute specifications **res(ult)** and **act(ive)**.

(4-41) TD6
$\textit{complex\_cat} \Rightarrow \begin{bmatrix} \mathbf{res} = \textit{cat} \\ \mathbf{act} = \textit{sign} \end{bmatrix}$

For typographical convenience, I will continue to use the slash notation as a simplification of the attribute-value representation of complex categories, e.g.

(4-42) $\textit{cat}/\textit{sign}$ simplifies $\begin{bmatrix} \mathbf{res} = \textit{cat} \\ \mathbf{act} = \textit{sign} \end{bmatrix}$

**Semantics** The semantic representation language adopted in UCG is INL (Indexed Language). INL combines the general insights of Kamp's Discourse Representation Theory ([Kamp 81]) with a Davidsonian approach to verb semantics. In INL, a formula is defined as a triple consisting of an index, a predicate and a list of arguments.

(4-43) a TD7

$$formula \Rightarrow \begin{bmatrix} \textbf{ind} & = & sort \\ \textbf{pred} & = & basic \\ \textbf{args} & = & arg\_list \end{bmatrix}$$

b TD8

$$arg\_list \Rightarrow nil \bigsqcup \begin{bmatrix} \textbf{1st} & = & basic \sqcup formula \\ \textbf{rest} & = & arg\_list \end{bmatrix}$$

The index of a formula is a sorted variable corresponding to the first argument of a/the predicate within the formula. The index-variable of a formula provides (partial) information with respect to the ontological identity of the object denoted by the formula. For example the INL representation for a sentence such as *Mary walked for hours* will be a formula whose index is a sorted variable over *processes*, while the formula denoting the meaning of a noun like *book* will have as index a sorted variable over inanimate, countable, and singular objects. The predicate of a formula is either a lexical predicate (e.g. *meet, book, red, yesterday, in*), or a logical constant (*and* for conjunction and *imp* for implication). The arguments of a predicate can either be variables (both sorted and unsorted), individual constants or formulae. The logical representations of the prepositional phrase *in Rome* and the sentence *Fiona met Charles in Dundee* shown below provide a concrete example of how atomic and composite formulae are represented in INL ($e$ is a typed variable over eventualities).

(4-44)

$$\begin{bmatrix} \textbf{ind} & = & \boxed{1} \\ \textbf{pred} & = & in \\ \textbf{args} & = & \begin{bmatrix} \textbf{1st} & = & \boxed{1}\, e \\ \textbf{rest} & = & \begin{bmatrix} \textbf{1st} & = & rome \\ \textbf{rest} & = & nil \end{bmatrix} \end{bmatrix} \end{bmatrix}$$

(4-45)

$$\begin{array}{lll} \textbf{ind} & = & \boxed{1} \\ \textbf{pred} & = & and \\ \textbf{args} & = & \begin{bmatrix} \textbf{1st} & = & \begin{bmatrix} \textbf{ind} & = & \boxed{1} \\ \textbf{pred} & = & meet \\ \textbf{args} & = & \begin{bmatrix} \textbf{1st} & = & \boxed{1}\, e \\ \textbf{rest} & = & \begin{bmatrix} \textbf{1st} & = & fiona \\ \textbf{rest} & = & \begin{bmatrix} \textbf{1st} = charles \end{bmatrix} \end{bmatrix} \end{bmatrix} \end{bmatrix} \\ \textbf{rest} & = & \begin{bmatrix} \textbf{ind} & = & \boxed{1} \\ \textbf{pred} & = & in \\ \textbf{args} & = & \begin{bmatrix} \textbf{1st} & = & \boxed{1} \\ \textbf{rest} & = & \begin{bmatrix} \textbf{1st} = dundee \end{bmatrix} \end{bmatrix} \end{bmatrix} \end{bmatrix} \end{array}$$

To reduce excessive nesting of feature structures I will use the following abbreviatory conventions:

(4-46) **arg1** abbreviates **args:1st**
**arg2** abbreviates **args:rest:1st**
**arg3** abbreviates **args:rest:rest:1st**

When introducing new semantic structures, I will also provide linear representations for the formulae in question as shown in (4-47) where the index attribute of formulae is enclosed in square brackets.

(4-47) $[e][[e]meet(e, fiona, charles) \wedge [e]in(e, dundee)]$

In linear representations, I will use subscripts to indicate reentrancy and upper case letters as untyped variables, e.g.

(4-48) $[e_1][[e_1]A \wedge [e_1]in(e_1, dundee)]$

For ease of exposition, I will also omit reference to the index of subformulae, as shown below for the formula in (4-47).

(4-49) $[e_1][meet(e_1, fiona, charles) \wedge in(e_1, dundee)]$

### 4.2.2 Template Definitions and Lexical Rules

Following the general practice adopted in grammar development formalisms PATR-style ([Shieber *et al.* 83]), lexical items are generated through *templates* which capture generalizations about classes of lexical items, and express morpheme-specific properties. In keeping with the abbreviatory conventions used by Karttunen ([Karttunen 86]), items preceded by the symbol "@" refer to lexical templates, and feature paths are construed as sequences of attributes separated by colons. For example, the word "book" receives a specification as a UCG sign in terms of the *lexical class template* in (4-50a) which defines the phonological, syntactic and semantic properties of nouns as a word class, and the *lexical item template* in (4-50b) which adds properties inherent to the noun *book* to the general template for nouns (OBJ is the sort for non-temporal objects).

(4-50) a **LCT1**

$$\text{@Noun} \Rightarrow \left[\begin{array}{ll} \mathbf{phon} = [\,] & \\ \mathbf{cat} = & \left[\begin{array}{ll} \mathbf{name} = n & \\ \mathbf{feats} = & \left[\begin{array}{l} \mathbf{gender} = \textit{masculine} \\ \mathbf{number} = [\,] \\ \mathbf{person} = \textit{third} \end{array}\right] \end{array}\right] \\ \mathbf{sem} = & \left[\begin{array}{l} \mathbf{ind} = \boxed{1} \\ \mathbf{pred} = [\,] \\ \mathbf{arg1} = \boxed{1}[\,] \end{array}\right] \end{array}\right]$$

b **LIT1**

$$\text{book} : \left[\begin{array}{l} \text{@Noun}, \\ \mathbf{phon} = \textit{book}, \\ \mathbf{sem{:}pred} = \textit{book}, \\ \mathbf{sem{:}ind} = \text{OBJ} \end{array}\right]$$

In (4-50a), the symbol [ ] — a symbol which is used to refer to the least informative feature structure, as specified in §4.1.1 — indicates that the phonology, number and index attributes are left unspecified. This means that these attributes can be assigned any value which is compatible with the type declarations which specify their form. According to **TD5** and **TD7**, for example, the assignment of values to the number and predicate attributes is restricted to atomic specifications. The merger of the information relative to the noun template and the specifications for the noun *book* in (4-50b) will generate the lexical item in (4-51).

$$(4\text{-}51) \quad \left[\begin{array}{ll} \mathbf{phon} = \textit{book} & \\ \mathbf{cat} = & \left[\begin{array}{ll} \mathbf{name} = n & \\ \mathbf{feats} = & \left[\begin{array}{l} \mathbf{gender} = \textit{masculine} \\ \mathbf{number} = [\,] \\ \mathbf{person} = \textit{third} \end{array}\right] \end{array}\right] \\ \mathbf{sem} = & \left[\begin{array}{l} \mathbf{ind} = \boxed{1} \\ \mathbf{pred} = \textit{book} \\ \mathbf{arg1} = \boxed{1}\,\text{OBJ} \end{array}\right] \end{array}\right]$$

Lexical items can be modified through *lexical rules* to yield new lexical items. Each lexical rule has the format:

$$\begin{array}{ll} \mathbf{rule} & = \text{NAME} \\ \text{in} & = \text{Template1} \\ \text{out} & = \text{Template2} \end{array}$$

where NAME is the name of the rule, *Template1* is the input template to the rule, and *Template2* is the result of applying the changes specified in the rule to the input template. For example, the rule which makes plural nouns in English is stated as shown below where PLU is a sort for plural object variables and *nplural* is a function which given a noun phonology returns its plural form.[6]

**rule** = NOUN PLURAL FORMATION

$$\mathbf{in} = \begin{bmatrix} \mathbf{phon} = \boxed{1} \\ \mathbf{cat} = \begin{bmatrix} \mathbf{name} = n \\ \mathbf{feats} = \begin{bmatrix} \mathbf{gender} = \boxed{2} \\ \mathbf{number} = nil \\ \mathbf{person} = \boxed{4} \end{bmatrix} \end{bmatrix} \\ \mathbf{sem} = \begin{bmatrix} \mathbf{ind} = \boxed{5} \\ \mathbf{pred} = \boxed{6} \\ \mathbf{arg1} = \text{OBJ} \end{bmatrix} \end{bmatrix}$$

$$\mathbf{out} = \begin{bmatrix} \mathbf{phon} = nplural(\boxed{1}) \\ \mathbf{cat} = \begin{bmatrix} \mathbf{name} = n \\ \mathbf{feats} = \begin{bmatrix} \mathbf{gender} = \boxed{2} \\ \mathbf{number} = plural \\ \mathbf{person} = \boxed{4} \end{bmatrix} \end{bmatrix} \\ \mathbf{sem} = \begin{bmatrix} \mathbf{ind} = \boxed{5} \\ \mathbf{pred} = \boxed{6} \\ \mathbf{arg1} = \text{PLU} \end{bmatrix} \end{bmatrix}$$

### 4.2.3 The Sort System

As was mentioned in the introductory section, the semantic variables used in INL are arranged into a hierarchy of sorts. The hierarchy is defined in terms of a subsumption lattice of partial descriptions relative to a given set of defining properties within a propositional calculus ([Calder *et al.*], [Moens *et al.* 89]). For example, given the set of properties in (4-52a), where each property is interpreted as a propositional constant, we can form partial descriptions using the logical constants of sentential logic as indicated in (4-52b).

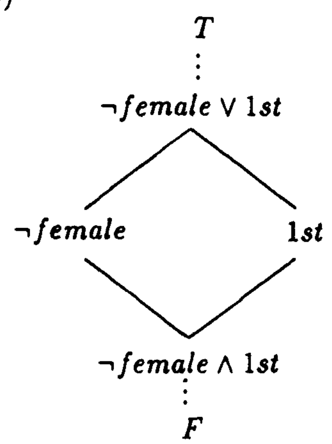
[6]See [Calder 89] for a detailed approach to inflectional and derivational processes within a paradigmatic framework in UCG.

(4-52) a *Set of Defining Properties*
female, singular, 1st (person)

b *Partial Descriptions*
$\neg female \vee 1st$
$\neg female$
$\neg female \wedge 1st$
⋮

Such partial descriptions are formulae of a full propositional language, and as such are partially ordered by the relation of logical consequence and form a lattice where the meet and join operations correspond to logical conjunction and disjunction, and where the top and bottom elements correspond to the truth values "true" ($T$) and "false" ($F$) ([Mellish 88]). For example, the lattice fragment corresponding to the partial ordering of the property descriptions in (4-52b) will be as in (4-53).

(4-53)




Each description denotes a set of models containing all the truth assignments which satisfy the description. For example, $1st$ denotes the set of of all truth assignments to the property set in (4-52a) which makes $1st$ true, and $\neg female$ denotes the set of all truth assignments where $female$ is false:

(4-54) a.

$$\llbracket 1st \rrbracket = \left\{ \begin{array}{l} \begin{bmatrix} \mathtt{female} & \rightarrow F \\ \mathtt{sing} & \rightarrow T \\ \mathtt{1st} & \rightarrow T \end{bmatrix}, \begin{bmatrix} \mathtt{female} & \rightarrow F \\ \mathtt{sing} & \rightarrow F \\ \mathtt{1st} & \rightarrow T \end{bmatrix}, \\ \begin{bmatrix} \mathtt{female} & \rightarrow T \\ \mathtt{sing} & \rightarrow T \\ \mathtt{1st} & \rightarrow T \end{bmatrix}, \begin{bmatrix} \mathtt{female} & \rightarrow T \\ \mathtt{sing} & \rightarrow F \\ \mathtt{1st} & \rightarrow T \end{bmatrix} \end{array} \right\}$$

b.

$$\llbracket \neg female \rrbracket = \left\{ \begin{array}{l} \begin{bmatrix} \mathtt{female} & \rightarrow F \\ \mathtt{sing} & \rightarrow T \\ \mathtt{1st} & \rightarrow T \end{bmatrix}, \begin{bmatrix} \mathtt{female} & \rightarrow F \\ \mathtt{sing} & \rightarrow F \\ \mathtt{1st} & \rightarrow T \end{bmatrix}, \\ \begin{bmatrix} \mathtt{female} & \rightarrow F \\ \mathtt{sing} & \rightarrow T \\ \mathtt{1st} & \rightarrow F \end{bmatrix}, \begin{bmatrix} \mathtt{female} & \rightarrow F \\ \mathtt{sing} & \rightarrow F \\ \mathtt{1st} & \rightarrow F \end{bmatrix} \end{array} \right\}$$

$\neg female \vee 1st$ denotes the set of models where either *female* is false, *1st* is true, or both, and $\neg female \wedge 1st$ set of models where *female* is false and *1st* is true:

(4-55) a.

$$\llbracket \neg female \vee 1st \rrbracket = \left\{ \begin{array}{l} \begin{bmatrix} \mathtt{female} & \rightarrow F \\ \mathtt{sing} & \rightarrow T \\ \mathtt{1st} & \rightarrow T \end{bmatrix}, \begin{bmatrix} \mathtt{female} & \rightarrow F \\ \mathtt{sing} & \rightarrow F \\ \mathtt{1st} & \rightarrow T \end{bmatrix}, \\ \begin{bmatrix} \mathtt{female} & \rightarrow F \\ \mathtt{sing} & \rightarrow T \\ \mathtt{1st} & \rightarrow F \end{bmatrix}, \begin{bmatrix} \mathtt{female} & \rightarrow F \\ \mathtt{sing} & \rightarrow F \\ \mathtt{1st} & \rightarrow F \end{bmatrix}, \\ \begin{bmatrix} \mathtt{female} & \rightarrow T \\ \mathtt{sing} & \rightarrow T \\ \mathtt{1st} & \rightarrow T \end{bmatrix}, \begin{bmatrix} \mathtt{female} & \rightarrow T \\ \mathtt{sing} & \rightarrow F \\ \mathtt{1st} & \rightarrow T \end{bmatrix} \end{array} \right\}$$

b.

$$\llbracket \neg female \wedge 1st \rrbracket = \left\{ \begin{bmatrix} \mathtt{female} & \rightarrow F \\ \mathtt{sing} & \rightarrow T \\ \mathtt{1st} & \rightarrow T \end{bmatrix}, \begin{bmatrix} \mathtt{female} & \rightarrow F \\ \mathtt{sing} & \rightarrow F \\ \mathtt{1st} & \rightarrow T \end{bmatrix} \right\}$$

The partial ordering of property descriptions in (4-53) is thus isomorphic to the partial ordering of the model sets these descriptions denote. More precisely, the sets of models are partially ordered under the subset relation, and form a lattice where the join and meet operations correspond to set union and set intersection respectively, e.g.

(4-56)

$$\left\{\begin{array}{l}\begin{bmatrix}\mathbf{female} & - F\\ \mathbf{sing} & - T\\ \mathbf{1st} & - T\end{bmatrix}, \begin{bmatrix}\mathbf{female} & - F\\ \mathbf{sing} & - F\\ \mathbf{1st} & - T\end{bmatrix},\\ \begin{bmatrix}\mathbf{female} & - F\\ \mathbf{sing} & - T\\ \mathbf{1st} & - F\end{bmatrix}, \begin{bmatrix}\mathbf{female} & - F\\ \mathbf{sing} & - F\\ \mathbf{1st} & - F\end{bmatrix},\\ \begin{bmatrix}\mathbf{female} & - T\\ \mathbf{sing} & - T\\ \mathbf{1st} & - T\end{bmatrix}, \begin{bmatrix}\mathbf{female} & - T\\ \mathbf{sing} & - F\\ \mathbf{1st} & - T\end{bmatrix}\end{array}\right\}$$

$$\left\{\begin{array}{l}\begin{bmatrix}\mathbf{female} & - F\\ \mathbf{sing} & - T\\ \mathbf{1st} & - T\end{bmatrix}, \begin{bmatrix}\mathbf{female} & - F\\ \mathbf{sing} & - F\\ \mathbf{1st} & - T\end{bmatrix},\\ \begin{bmatrix}\mathbf{female} & - F\\ \mathbf{sing} & - T\\ \mathbf{1st} & - F\end{bmatrix}, \begin{bmatrix}\mathbf{female} & - F\\ \mathbf{sing} & - F\\ \mathbf{1st} & - F\end{bmatrix}\end{array}\right\} \qquad \left\{\begin{array}{l}\begin{bmatrix}\mathbf{female} & - F\\ \mathbf{sing} & - T\\ \mathbf{1st} & - T\end{bmatrix}, \begin{bmatrix}\mathbf{female} & - F\\ \mathbf{sing} & - F\\ \mathbf{1st} & - T\end{bmatrix},\\ \begin{bmatrix}\mathbf{female} & - T\\ \mathbf{sing} & - T\\ \mathbf{1st} & - T\end{bmatrix}, \begin{bmatrix}\mathbf{female} & - T\\ \mathbf{sing} & - F\\ \mathbf{1st} & - T\end{bmatrix}\end{array}\right\}$$

$$\left\{\begin{bmatrix}\mathbf{female} & - F\\ \mathbf{sing} & - T\\ \mathbf{1st} & - T\end{bmatrix}, \begin{bmatrix}\mathbf{female} & - F\\ \mathbf{sing} & - F\\ \mathbf{1st} & - T\end{bmatrix}\right\}$$

The conjunction of two property descriptions will therefore denote the intersection (meet) of the two sets of models which satisfy the two descriptions, and the disjunction of two descriptions will be equivalent to the union (join) of the model sets which satisfy these descriptions.

Sorted variables are defined as partial property descriptions, e.g.

- **SD1**: FEM $=_{def.}$ *female*
- **SD2**: SING $=_{def.}$ *singular*
- **SD3**: MAL1 $=_{def.}$ $\neg female \wedge 1st$
- **SD4**: PLU $=_{def.}$ $\neg singular$

The unification of two sorted variables is computed as the conjunction of the formulae (sort descriptions) which define them, and ultimately as the intersection of the model sets associated with these descriptions, e.g.[7]

(4-57) $$\text{MAL1} \sqcap \text{PLU} = \left\{ \begin{bmatrix} \texttt{female} & \rightarrow F \\ \texttt{sing} & \rightarrow T \\ \texttt{1st} & \rightarrow T \end{bmatrix}, \begin{bmatrix} \texttt{female} & \rightarrow F \\ \texttt{sing} & \rightarrow F \\ \texttt{1st} & \rightarrow T \end{bmatrix} \right\} \cap \left\{ \begin{bmatrix} \texttt{female} & \rightarrow T \\ \texttt{sing} & \rightarrow F \\ \texttt{1st} & \rightarrow T \end{bmatrix}, \begin{bmatrix} \texttt{female} & \rightarrow F \\ \texttt{sing} & \rightarrow F \\ \texttt{1st} & \rightarrow T \end{bmatrix}, \begin{bmatrix} \texttt{female} & \rightarrow T \\ \texttt{sing} & \rightarrow T \\ \texttt{1st} & \rightarrow F \end{bmatrix}, \begin{bmatrix} \texttt{female} & \rightarrow F \\ \texttt{sing} & \rightarrow F \\ \texttt{1st} & \rightarrow F \end{bmatrix} \right\}$$

In principle the cardinality of the set of all possible truth assignments within a sort system of this type (i.e. the set of models satisfying the maximally unspecified sort) is related exponentially to the number of properties. That is, the total number of models will be equal to $2^n$ for $n$ properties. This exponential growth is undesirable with respect to both computational efficiency and linguistic plausibility. Suppose for example we start with a set of defining properties as in (4-58).

(4-58) *Set of Defining Properties*
female, neuter, singular. 1st (person), 2nd (person), temporal, stative, telic.

If no restrictions were imposed on the assignment of values to properties, it would be possible to define a number of nonsensical sorts corresponding to descriptions such as those in (4-59).

(4-59) $1st \wedge telic$
$temporal \wedge female$
$[stative \vee telic] \wedge \neg temporal$
$stative \wedge telic$
$[female \vee 2nd] \wedge neuter$

Obviously, we want to be able to set up our sort system in such a way there are no truth assignments which satisfy such sort descriptions. To do so, we can formulate background

[7] To enhance computational efficiency, model sets can be encoded as *bit strings* so that model set union and intersection can be computed as *bitwise-OR* and *bitwise-AND* ([Calder *et al.*], [Moens *et al.* 89]).

constraints which express cooccurrence restrictions among defining properties as axioms of the calculus, e.g.

(4-60) BACKGROUND CONSTRAINTS

**BC1**: $\neg[\textit{temporal} \wedge [\textit{female} \vee \textit{2nd} \vee \textit{1st}]]$
**BC2**: $\textit{stative} \rightarrow \textit{temporal}$
**BC3**: $\textit{telic} \rightarrow \textit{temporal}$
**BC4**: $\textit{stative} \rightarrow \neg\textit{telic}$
**BC5**: $\neg[[\textit{female} \vee \textit{1st} \vee \textit{2nd}] \wedge \textit{neuter}]$
**BC6**: $\neg[\textit{1st} \wedge \textit{2nd}]$

The background constraints in (4-60) will filter out descriptions such as those in (4-59) and many others, hence reducing significantly the potential number of truth assignments attainable.

The sort definitions, properties and background constraints presented hitherto will constitute the starting point for our sort system. Additional ones will be introduced and discussed in due course.

### 4.2.4 Grammar Rules

Phonological, syntactic and semantic relations among signs are captured through rules of functional application. Functional application allows a functor sign to combine with an adjacent argument sign just in case the information contained in the active sign of the functor is compatible with the information encoded in the argument sign. The result of combining a functor with an argument sign is a sign whose phonology is the (right or left) concatenation of the phonologies for the argument and functor signs whose category is equal to the category of the functor with its active sign removed, and whose semantics corresponds to the semantics of the functor. The value relative to the order attribute of the functor phonology establishes the relevant position of functor and argument signs in *forward* and *backward* functional application:

(4-61) **Forward Functional Application**

$$\textit{apply}\left(\begin{bmatrix} \mathbf{phon} = \boxed{1}\begin{bmatrix}\mathbf{ord} = \mathrm{RC}\\ \mathbf{phon1} = [\,]\\ \mathbf{phon2} = [\,]\end{bmatrix} \\ \mathbf{cat} = \boxed{2}/\boxed{3} \\ \mathbf{sem} = \boxed{4}\end{bmatrix}, \boxed{3}\right) = \begin{bmatrix}\mathbf{phon} = \boxed{1}\\ \mathbf{cat} = \boxed{2}\\ \mathbf{sem} = \boxed{4}\end{bmatrix}$$

(4-62) **Backward Functional Application**

$$apply\left(\boxed{3},\ \begin{bmatrix} \textbf{phon} = \boxed{1}\begin{bmatrix}\textbf{ord} = \textsc{lc}\\ \textbf{phon1} = [\,]\\ \textbf{phon2} = [\,]\end{bmatrix}\\ \textbf{cat} \;=\; \boxed{2}/\boxed{3}\\ \textbf{sem} \;=\; \boxed{4}\end{bmatrix}\right) = \begin{bmatrix}\textbf{phon} = \boxed{1}\\ \textbf{cat} = \boxed{2}\\ \textbf{sem} = \boxed{4}\end{bmatrix}$$

## 4.3 Thematic Roles, Grammatical Relations and Verb Semantics

Having provided a description of the basic characteristics of UCG, my next objective is to show how such a system can be developed to accommodate a neo-Davidsonian treatment of verb semantics augmented with Dowty's theory of proto-roles and argument selection.

### 4.3.1 Verb Semantics

In the light of the approach to event semantics adumbrated by [Parsons 80] and [Carlson 84], a verb is an eventuality denoting expression which need not combine with argument phrases to yield a closed formula:

(4-63) $\exists e[walk(e)]$

In UCG, this specification of verb semantics gives rise to an INL formula where event quantification is rendered by making the argument variable of the verb token identical to the index variable of the formula. For example, the first order formula in (4-63) translates into the INL formula in (4-64a) — represented in linear notation as in (4-64b) — where $e$ is a sort for temporal entities (ie. eventualities) as defined in (4-65).

(4-64) a $\begin{bmatrix}\textbf{ind} = \boxed{1}\,e\\ \textbf{pred} = walk\\ \textbf{args} = \boxed{1}\end{bmatrix}$

b $[e_1]walk(e_1)$

(4-65) **SD5:** $e\ =_{def.}\ temporal$

Let us see how this characterization of verb semantics can be used in building verb signs. In "null anaphora" languages like Japanese and Chinese where a single verb can form a sentence, a verb sign could be characterized as having category type *sent* and phonology type "basic" as shown below for the Japanese verb *arukimasu* "walk-PRES" (see [Whitelock 87]).

(4-66) JAPANESE INTRANSITIVE VERB SIGN *first version*

$$\begin{bmatrix} \textbf{phon} = \textit{arukimasu} & \\ \textbf{catn} = \textit{sent} & \\ \textbf{sem} = & \begin{bmatrix} \textbf{ind} = \boxed{1}\, e \\ \textbf{pred} = \textit{walk} \\ \textbf{args} = \boxed{1} \end{bmatrix} \end{bmatrix}$$

Consequently, subject and object phrases would be encoded as sentential modifiers which introduce a thematic role in the semantics of the verb. In keeping with the insights of a neo-Davidsonian treatment, I will represent thematic roles as relations between eventualities and individuals. For example, the INL representation for the argument role in (4-67) is the formula in (4-68a) — linearly represented as in (4-68b) — where the index and argument eventuality sorts are reentrant.

(4-67) $\exists e[agent(john, e)]$

(4-68) a $\begin{bmatrix} \textbf{ind} = \boxed{1}\, e \\ \textbf{pred} = \textit{agent} \\ \textbf{arg1} = \boxed{1} \\ \textbf{arg2} = \textit{john} \end{bmatrix}$

b $[e_1]agent(e_1, john)$

The semantics of an agent subject phrase such as *John ga* in (4-69a) will be a conjunctive formula containing the semantics of the sentential sign with which *John ga* combines (e.g. the verb *arukimasu*), and a thematic formula denoting the set of eventualities in which the individual *john* is the bearer of the agent role (cf. (4-68a)), as shown in (4-69b). The eventuality variable which denotes these sets of eventualities is token identical to the index of the argument semantics as well as the index of the whole formula as indicated with the tag $\boxed{3}$. This identity makes it possible to express the idea that the agent *John ga* is a participant of the event denoted by the sentential expression with which it combines.

(4-69) a **John ga** arukimasu

"John walks"

b
$$\left[\begin{array}{lll}
\textbf{ind} & = & \boxed{3} \\
\textbf{pred} & = & \textit{and} \\
\textbf{arg1} & = & \left[\begin{array}{lll} \textbf{ind} & = & \boxed{3} \\ \textbf{pred} & = & [\,] \\ \textbf{args} & = & [\,] \end{array}\right] \\
\textbf{arg2} & = & \left[\begin{array}{lll} \textbf{ind} & = & \boxed{3} \\ \textbf{pred} & = & \textit{agt} \\ \textbf{arg1} & = & \boxed{3} \\ \textbf{arg2} & = & \textit{john} \end{array}\right]
\end{array}\right]$$

The linear representation below exemplifies the semantic structure in (4-69b).

(4-70) $[e_1][A \wedge agt(e_1, john)]$

The subject phrase as a whole is a functor sign (i.e. S/S) which takes as argument a sentential sign (e.g. the verb) and returns a sentential sign, as shown in (4-71) (the boxes and indexes $A, B, C$ are included for ease of reference and are not formal specifications of the sign).

(4-71) JAPANESE SUBJECT PHRASE *first version*
$$\left[\begin{array}{lll}
\textbf{phon} & = & \left[\begin{array}{lll} \textbf{ord} & = & \mathrm{LC} \\ \textbf{phon1} & = & \textit{John}^\frown\textit{ga} \\ \textbf{phon2} & = & \boxed{1} \end{array}\right] \\
\textbf{cat} & = & \left[\textbf{catn} = \textit{sent}\right] / \boxed{\left[\begin{array}{lll} \textbf{phon} & = & \boxed{1} \\ \textbf{catn} & = & \textit{sent} \\ \textbf{sem} & = & \boxed{2}_{A} \end{array}\right]}_{B} \\
\textbf{sem} & = & \boxed{\left[\begin{array}{lll}
\textbf{ind} & = & \boxed{3} \\
\textbf{pred} & = & \textit{and} \\
\textbf{arg1} & = & \boxed{2}\left[\begin{array}{lll} \textbf{ind} & = & \boxed{3} \\ \textbf{pred} & = & [\,] \\ \textbf{args} & = & [\,] \end{array}\right] \\
\textbf{arg2} & = & \left[\begin{array}{lll} \textbf{ind} & = & \boxed{3} \\ \textbf{pred} & = & \textit{agt} \\ \textbf{arg1} & = & \boxed{3} \\ \textbf{arg2} & = & \textit{john} \end{array}\right]
\end{array}\right]}_{C}
\end{array}\right]$$

- $A$ = active semantics
- $B$ = active sign
- $C$ = subject phrase semantics

Through functional application, the active semantics of the subject phrase ( $\boxed{2}$ in (4-71)) unifies with the semantics of the argument sentence (e.g. the sign in (4-66)) before the active sign as a whole is removed. The instantiations resulting from this unification are transmitted to the first conjunct in the semantics of the subject phrase which is token identical with the active semantics as indicated in (4-71) with the tag $\boxed{2}$. The UCG derivation below provides a concrete example of how the Japanese sentence in (4-69a) would be analyzed in a system of this type.

(4-72) SUBJECT-VERB ASSOCIATION IN JAPANESE *first version*

$$
\text{apply}\left(
\begin{bmatrix}
\textbf{phon} = \begin{bmatrix} \textbf{ord} = \text{RC} \\ \textbf{phon1} = \textit{John}^\frown\textit{ga} \\ \textbf{phon2} = \boxed{1} \end{bmatrix} \\
\textbf{cat} = \begin{bmatrix} \textbf{catn} = \textit{sent} \end{bmatrix} \Big/ \begin{bmatrix} \textbf{phon} = \boxed{1} \\ \textbf{catn} = \textit{sent} \\ \textbf{sem} = \boxed{2} \end{bmatrix} \\
\textbf{sem} = \begin{bmatrix} \textbf{ind} = \boxed{3} \\ \textbf{pred} = \textit{and} \\ \textbf{arg1} = \boxed{2} \begin{bmatrix} \textbf{ind} = \boxed{3} \\ \textbf{pred} = [\,] \\ \textbf{args} = [\,] \end{bmatrix} \\ \textbf{arg2} = \begin{bmatrix} \textbf{ind} = \boxed{3} \\ \textbf{pred} = \textit{agt} \\ \textbf{arg1} = \boxed{3} \\ \textbf{arg2} = \textit{john} \end{bmatrix} \end{bmatrix}
\end{bmatrix},
\begin{bmatrix}
\textbf{phon} = \textit{arukimasu} \\
\textbf{catn} = \textit{sent} \\
\textbf{sem} = \begin{bmatrix} \textbf{ind} = \boxed{4}\,e \\ \textbf{pred} = \textit{walk} \\ \textbf{args} = \boxed{4} \end{bmatrix}
\end{bmatrix}
\right)
$$

$$
= \begin{bmatrix}
\textbf{phon} = \begin{bmatrix} \textbf{ord} = \text{RC} \\ \textbf{phon1} = \textit{John}^\frown\textit{ga} \\ \textbf{phon2} = \textit{arukimasu} \end{bmatrix} \\
\textbf{catn} = \textit{sent} \\
\textbf{sem} = \begin{bmatrix} \textbf{ind} = \boxed{3} \\ \textbf{pred} = \textit{and} \\ \textbf{arg1} = \begin{bmatrix} \textbf{ind} = \boxed{3}\,e \\ \textbf{pred} = \textit{walk} \\ \textbf{args} = \boxed{3} \end{bmatrix} \\ \textbf{arg2} = \begin{bmatrix} \textbf{ind} = \boxed{3} \\ \textbf{pred} = \textit{agt} \\ \textbf{arg1} = \boxed{3} \\ \textbf{arg2} = \textit{john} \end{bmatrix} \end{bmatrix}
\end{bmatrix} .
$$

The problem with this characterization of verb semantics is that it provides no information about the thematic assignment properties of verbs. This omission engenders some obvious disadvantages, even in languages such as Japanese where subject and object phrases can be encoded as adjuncts. First of all, thematic assignment cannot be lexically driven since thematic information about participant roles is not encoded in verb signs; e.g. the verb does instantiate a thematic role within the semantics of the NP. Consequently, the same nominal expression must be assigned as many lexical entries as there are thematic roles. Such practice creates unwanted redundancy within the lexicon whenever a difference in thematic role is not morphologically realized. Note, incidentally, that this state of affairs should also be considered in light of the fact that a one-to-one correspondence between thematic roles and morphological cases, prepositions or postpositions is virtually never found in natural language. Therefore even for languages where all argument NPs are morphologically marked (e.g. Finnish, Japanese, Latin), the verb contribution in establishing the thematic role of a given phrase needs to be taken into consideration. Second, to make sure that the role associated with a nominal expression is appropriate to the meaning of the verb with which it combines (e.g. to avoid combining the predicate *walk* with a patient nominal), the semantics of a sentence would have to be checked against meaning postulates like the one in (4-73) or some equivalent constraint. Such a practice can induce considerable complexities, especially if the relevant constraints were to be checked on-line.

(4-73) $\forall e \Box[run(e) \rightarrow \neg\exists x[patient(e, x)]]$

Third, this treatment of verb semantics does not have a natural extension for languages like English where a verb alone cannot form a tensed declarative sentence. To account for the obligatory occurrence of subject and object phrases, English verbs should be assigned a subcategorization frame. However since a verb sign structured like the one in (4-66) does not include any information about the arguments with which the verb must combine. it is not clear how such subcategorization frame could be derived, and how each subcategorized argument could be made to correspond to the appropriate semantic argument and thematic role.

It seems to me that the only reasonable way out of undesirable consequences such as those discussed above is to enrich the lexical representation of verbal predicates with information about thematic structure and assignment. To do so, I will take as starting point Carlson's suggestion ([Carlson 84]) that within a neo-Davidsonian approach the thematic assignment properties of a verb should be derived from the model-theoretic characterization of verb meanings in terms of thematic entailments (see §3.2). Suppose, for example, we wished to express Carlson's generalization as a restriction on thematic assignment and subcategorization. The participant roles assigned by a verb could be identified as roles which the verb necessarily entails, and subcategorization (for those languages which require it) could be seen as the syntactic encoding of these entailments.

Clearly, not all participant roles which are necessarily entailed by a verb are syntactically realized as arguments of the verb. For example, an event of *selling* necessarily entails the existence of a seller, a buyer, and an object on sale, as well as a location where the transaction takes place. Yet, only the first three participant roles correspond to subcategorized arguments (i.e. subject, object and indirect object of *sell*). Therefore, this account of subcategorization requires a specific indication of which thematic entailments of a verb must be realized syntactically. Intuitively, principles governing the grammaticalization of thematic entailments could be seen as a reflection of acquisition strategies that the language learner adopts to enhance economy in lexical representation. For example, there is a clear sense in which entailments that are syntactically realized are most likely to correspond to those which express the most salient aspects of verb meanings, and therefore contribute to maximize lexical differentiation with the least deployment of explicit specifications (e.g. avoiding specifications which can be inherited by default). Consider the verb *sell* discussed above. Since virtually any eventuality entails a location at which the eventuality takes place, the entailment of a locative role with *sell* will not contribute a sufficiently distinctive definitional marker. My proposal then is that the selection of role entailments for syntactic realization is guided by economy considerations which enhance efficiency in shaping representations at the level of lexical semantics. The question of how to formalize this intuition properly will be left open in this thesis. For ease of reference, the thematic entailments of a verb which are lexicalized as subcategorized arguments will henceforth be referred to as the *thematic domain* of the verb ($\theta$-DOM).

There are basically two ways of viewing the $\theta$-DOM of a verb, according to whether we relate it to the eventuality argument of the verbal predicate, or to the semantics of the verb as a whole. In the first case, thematic entailments can be seen as restrictions on types of eventualities. For example there is a clear sense in which the participant roles contained within the $\theta$-DOM of a verb like *sell* (source, theme, goal) confine the referential scope of the eventuality variable of the verb to the set of all eventualities in which three individuals (or groups of individuals) interact in such a way the they can be respectively characterized as as source, theme and goal participants. This fact could be represented in terms of restricted event quantification as indicated in (4-74).

(4-74) $(\exists e : \exists x, y, z[source(e,x)] \wedge theme(e,y) \wedge [goal(e,z)])\, sell(e)$

From this vantage point, it would be quite natural to encode the thematic formulae contained in $\theta$-DOM of a verb as restrictions on the index variable of verb semantics. To accommodate this fact, I will allow the index attribute of a formula to be a complex structure consisting of an index variable and a sequence of thematic formulae which is the $\theta$-DOM of the formula:

(4-75) a TD7 *final version*

$$formula \Rightarrow \begin{bmatrix} \textbf{ind} & = & basic \sqcup complex\_ind \\ \textbf{pred} & = & basic \\ \textbf{args} & = & basic \sqcup arg\_list \end{bmatrix}$$

b TD9

$$complex\_ind \Rightarrow \begin{bmatrix} \textbf{var} & = & basic \\ \theta\textbf{-dom} & = & \theta\_seq \end{bmatrix}$$

The sequence of thematic formulae of the $\theta$-DOM (*theta_seq*) is encoded as a string form (cf. 4.1.1):

(4-76) TD10

$$\theta\text{-}seq \Rightarrow \Lambda \sqcup \langle formula \circ \theta\text{-}seq \rangle$$

For example, the $\theta$-DOM of a transitive verb like *hit* is:

$$\text{(4-77)} \quad \left\langle \begin{bmatrix} \textbf{ind} & = & \boxed{1} \\ \textbf{pred} & = & pat \\ \textbf{arg1} & = & \boxed{1} \\ \textbf{arg2} & = & [\,] \end{bmatrix} \circ \begin{bmatrix} \textbf{ind} & = & \boxed{1} \\ \textbf{pred} & = & agt \\ \textbf{arg1} & = & \boxed{1} \\ \textbf{arg2} & = & [\,] \end{bmatrix} \circ \Lambda \right\rangle$$

Given the identity axiom in (4-78) (see §4.1.1), we can rewrite (4-77) omitting reference to the empty string $\Lambda$ as shown in (4-79).

(4-78) The symbol $\Lambda$ is a string (i.e. the empty string), such that $\Lambda \circ \sigma = \sigma = \sigma \circ \Lambda$ for any element $\sigma$ of a sequence.

(4-79)
$$\left\langle \begin{bmatrix} \mathbf{ind} & = & \boxed{1} \\ \mathbf{pred} & = & pat \\ \mathbf{arg1} & = & \boxed{1} \\ \mathbf{arg2} & = & [\,] \end{bmatrix} \circ \begin{bmatrix} \mathbf{ind} & = & \boxed{1} \\ \mathbf{pred} & = & agt \\ \mathbf{arg1} & = & \boxed{1} \\ \mathbf{arg2} & = & [\,] \end{bmatrix} \right\rangle$$

The sign representation for the Japanese verb *arukimasu* in (4-74) can thus be reformulated as in (4-80) where the entailed agent role is encoded in the $\theta$-DOM attribute of the index; a linearized version of the verb semantics is given in (4-81).

(4-80) JAPANESE INTRANSITIVE VERB SIGN *final version*

$$\begin{bmatrix} \mathbf{phon} = arukimasu \\ \mathbf{catn} = sent \\ \mathbf{sem} = \begin{bmatrix} \mathbf{ind} = \begin{bmatrix} \mathbf{var} = \boxed{1} \\ \theta\text{-}\mathbf{dom} = \left\langle \begin{bmatrix} \mathbf{ind} & = & \boxed{1} \\ \mathbf{pred} & = & agt \\ \mathbf{arg1} & = & \boxed{1} \\ \mathbf{arg2} & = & [\,] \end{bmatrix} \right\rangle \end{bmatrix} \\ \mathbf{pred} = walk \\ \mathbf{args} = \boxed{1}e \end{bmatrix} \end{bmatrix}$$

(4-81) $[e_1 :< agt(e_1, X) >]walk(e_1)$

The use of string forms to encode thematic entailments allows us to capture hierarchical relations between thematic roles in terms of precedence,[8] without imposing a nested structure on sequences of thematic formulae.[9] The possibility of representing hierarchi-

[8] Recall that string formation is associative, but not commutative.

[9] A nested structure would result if the $\theta$-DOM were to be represented as a list, e.g.

(i) *a* $\theta$-DOM $\Rightarrow \theta\_list$

*b* $\theta\_list \rightarrow nil \sqcup \begin{bmatrix} \mathbf{1st} & = & formula \\ \mathbf{rest} & = & \theta\_list \end{bmatrix}$

Note that in this case, the selection an arbitrary formula from the $\theta$-DOM would require the introduction of a rather complex operation similar to *Functional Uncertainty* in LFG ([Kaplan & Zaenen 89], [Kaplan & Maxwell 88]), as shown in (ii) where the + sign indicates that there can be a path of attributes of arbitrary length, formed by one or more occurrences of the attribute **1st**, before the thematic formula which follows the equal sign is found.

(ii)
$$\begin{bmatrix} \mathbf{1st+} = \begin{bmatrix} \mathbf{ind} & = & \boxed{1} \\ \mathbf{pred} & = & agt \\ \mathbf{arg1} & = & \boxed{1} \\ \mathbf{arg2} & = & [\,] \end{bmatrix} \\ \mathbf{rest} = nil \end{bmatrix}$$

Our practice od encoding the $\theta$-DOM as a string avoids the complexity inherent to such an operation.

cal relations between thematic formulae will make it possible to develop a treatment of grammatical relations which adopts the basic insights of Dowty's approach to argument selection (see below). The lack of nesting in $\theta$-DOMs will be instrumental in providing a simple treatment of cases where the lack of correspondence between surface word order and the thematic/grammatical hierarchy cannot be accommodated through appeal to operations on the subcategorization frame of a verb (e.g. as by extraction, Functional Uncertainty, or by imposing partial ordering on the phonologies of the arguments of a verb). An example is provided below with respect to word order in Japanese (see also chapter 7).

From the viewpoint of the verb semantics as a whole, entailed roles can be seen as *expectations* about possible extensions of the semantics of the verbs with which they are associated. For example, the $\theta$-DOM of the verb in (4-80) indicates that a likely extension of the verb semantics involves combination with a thematic formula encoding an agent role. The association of the predicate *walk* with its subject will thus correspond to the satisfaction of such expectation, which can be characterized as the "discharging" of the thematic role contained in the $\theta$-DOM of the verb semantics — or, equivalently, as the reduction of the set of restrictions on event quantification. Where the $\theta$-DOM of *walks* consists of an agent role, the $\theta$-DOM for the sentence *John walks* will be empty.

(4-82) a "walks" $\begin{bmatrix} \textbf{var} = \boxed{1}\,e \\ \theta\textbf{-dom} = \left\langle \begin{bmatrix} \textbf{ind} = \boxed{1} \\ \textbf{pred} = agt \\ \textbf{arg1} = \boxed{1} \\ \textbf{arg2} = \text{OBJ} \end{bmatrix} \right\rangle \end{bmatrix}$

b "John walks" $\begin{bmatrix} \textbf{var} = e \\ \theta\textbf{-dom} = \Lambda \end{bmatrix}$

To render this second perspective, I will assume that a subject/object phrase instantiates an argument role in the $\theta$-DOM of the verb with which it combines. This argument role is token identical to the thematic formula introduced by the subject/object phrase. Consequently, any thematic information which is verb-specific (e.g. role type, selectional restrictions, etc.) will effectively add further information to, and thus place further constraints on, the thematic formula of the subject/object phrase. The "transmission" of these constraints is our notion of thematic marking. Following functional application, the instantiated thematic formula is removed from the $\theta$-DOM of the verb. The $\theta$-DOM of resulting formula is the $\theta$-DOM of the verb minus the removed thematic entailment. An intuitive representation of this process is given in the tree structure below for the Japanese sentence *John ga arukimasu* "John walks".

(4-83)

$$\Big[[e_1 : \Lambda][walk(e_1) \wedge agt(e_1, john_1)]\Big]_S$$

$$\Big[[e_1 : \Lambda][A_1 \wedge P_1(e_1, john_1)]\Big]_S \Big/ \Big[[e_1 :< P_1(e_1, john_1) >]A_1\Big]_S \qquad \Big[[e_1 :< agt(e_1, X) >]walk(e_1)\Big]_S$$

The treatment of predicate-argument association described above for Japanese can be summarized as follows:

(4-84)

1. In Japanese a verb forms a sentence of its own
2. The index of a verb sign contains a sequence of the "most salient" argument roles which the verb entails, i.e. the $\theta$-DOM
3. A subject/object phrase is a sentential adjunct sign which:
   - takes as argument a sentential sign and returns a sign of the same category type
   - combines an argument role with the semantics of the argument sentence
   - satisfies a thematic entailment of the argument sentential sign through removal of the thematic entailment from the $\theta$-DOM of the sentential sign
   - integrates the information of the removed thematic entailment with the information of the argument role which it combines with the argument sentence semantics
   - inherits the remaining thematic entailments of the argument sentential sign.

In the light of this analysis, subject and object phrases in Japanese are treated as optional, thematically bound adjuncts. From now on, I will use the term "quasi-adjuncts" to distinguish thematically bound adjuncts from "true adjuncts", i.e. adjuncts which do not satisfy a thematic entailments of the sign with which they combine. The revised sign for the subject phrase *John ga* shown in(4-85) provides a concrete example of how the set of operations in (4-84) is encoded in terms of structure sharing. Boxes and upper case subscripts indicate the main features of the sign which are responsible for this treatment of predicate-argument association.

(4-85) JAPANESE SUBJECT PHRASE *second version*

$$
\left[\begin{array}{lll}
\mathbf{phon} & = & \left[\begin{array}{lll} \mathbf{ord} & = & \mathrm{RC} \\ \mathbf{phon1} & = & \textit{John}^\frown\textit{ga} \\ \mathbf{phon2} & = & \boxed{1} \end{array}\right] \\
\mathbf{cat} & = & \left[\mathbf{catn} = \textit{sent}\right] \Big/ \left[\begin{array}{lll} \mathbf{phon} & = & \boxed{1} \\ \mathbf{catn} & = & \textit{sent} \\ \mathbf{sem} & = & \boxed{\left[\begin{array}{lll} \mathbf{ind} & = & \left[\begin{array}{lll} \mathbf{var} & = & \boxed{2} \\ \theta\text{-}\mathbf{dom} & = & \langle\boxed{3}\rangle_{A} \end{array}\right] \\ \mathbf{pred} & = & \boxed{5} \\ \mathbf{args} & = & \boxed{6} \end{array}\right]}_{B} \end{array}\right] \\
\mathbf{sem} & = & \left[\begin{array}{lll} \mathbf{ind} & = & \left[\begin{array}{lll} \mathbf{var} & = & \boxed{2} \\ \theta\text{-}\mathbf{dom} & = & \boxed{\mathrm{A}}_{C} \end{array}\right] \\ \mathbf{pred} & = & \textit{and} \\ \mathbf{arg1} & = & \boxed{\left[\begin{array}{lll} \mathbf{ind} & = & \boxed{2} \\ \mathbf{pred} & = & \boxed{5} \\ \mathbf{args} & = & \boxed{6} \end{array}\right]}_{D} \\ \mathbf{arg2} & = & \boxed{\boxed{3}\left[\begin{array}{lll} \mathbf{ind} & = & \boxed{2} \\ \mathbf{pred} & = & [\,] \\ \mathbf{arg1} & = & \boxed{2} \\ \mathbf{arg2} & = & \textit{john} \end{array}\right]}_{E} \end{array}\right]
\end{array}\right]
$$

- $A$ = active $\theta$-DOM
- $B$ = active semantics
- $C$ = result $\theta$-DOM
- $D$ = argument semantics minus $\theta$-DOM
- $E$ = thematic role introduced by subject phrase

The reader can easily verify that a single step of (forward) functional application relating the subject phrase in (4-85) and the verb sign in (4-80) will suffice to carry out all the processes in (4-84), thus giving rise to the sentential sign in (4-86).

$$
(4\text{-}86)\quad
\left[\begin{array}{lll}
\mathbf{phon} & = & \left[\begin{array}{lll} \mathbf{ord} & = & \mathrm{RC} \\ \mathbf{phon1} & = & \mathit{John}^\frown \mathit{ga} \\ \mathbf{phon2} & = & \mathit{arikimasu} \end{array}\right] \\
\mathbf{cat} & = & \mathit{sent} \\
\mathbf{sem} & = & \left[\begin{array}{lll}
\mathbf{ind} & = & \left[\begin{array}{lll} \mathbf{var} & = & \boxed{2} \\ \theta\text{-}\mathbf{dom} & = & \Lambda \end{array}\right] \\
\mathbf{pred} & = & \mathit{and} \\
\mathbf{arg1} & = & \left[\begin{array}{lll} \mathbf{ind} & = & \boxed{2}\, e \\ \mathbf{pred} & = & \mathit{walk} \\ \mathbf{args} & = & \boxed{2} \end{array}\right] \\
\mathbf{arg2} & = & \left[\begin{array}{lll} \mathbf{ind} & = & \boxed{2} \\ \mathbf{pred} & = & \mathit{agt} \\ \mathbf{arg1} & = & \boxed{2} \\ \mathbf{arg2} & = & \mathit{john} \end{array}\right]
\end{array}\right]
\end{array}\right]
$$

Note that in this case the result $\theta$-DOM is empty (i.e. $\Lambda$), since the original argument $\theta$-DOM (i.e. the $\theta$-DOM of the sentential sign in (4-80)) contains a single thematic entailment. Suppose, however, that the original argument $\theta$-DOM contained more than a single thematic entailment. This would be the case if we were to combine an object phrase with a transitive verb, as in the sentence below.

| | | | | | | |
|---|---|---|---|---|---|---|
| (4-87) | John | ga | Mary | o | but-ta | ([Kuno 73], p. 3) |
| | | nominative | | accusative | hit-past | |
| | | particle | | particle | | |
| | "John hit Mary" | | | | | |

As shown in (4-79), the $\theta$-DOM for the verb *hit* contains a patient and agent thematic entailments, in that order (the order, as will be discussed next, is imposed by the thematic hierarchy according to which grammatical relations are defined). Now, let us see what happens when the object *Mary-o* is combined with the verb *but-ta*. If we were to structure the object phrase as in (4-85), the unification of the active $\theta$-DOM (e.g. the $\theta$-DOM with subscript $A$) with the $\theta$-DOM of "hit" in (4-79) induced by functional application would fail. This is simply because the tag $\boxed{3}$ in (4-85) can only instantiate a single thematic formula, while the $\theta$-DOM of *hit* contains two such formulae:

$$
(4\text{-}88)\quad
\left\langle \left[\begin{array}{lll} \mathbf{ind} & = & \boxed{2} \\ \mathbf{pred} & = & [\,] \\ \mathbf{arg1} & = & \boxed{2} \\ \mathbf{arg2} & = & \mathit{mary} \end{array}\right] \right\rangle \sqcap \left\langle \left[\begin{array}{lll} \mathbf{ind} & = & \boxed{1} \\ \mathbf{pred} & = & \mathit{pat} \\ \mathbf{arg1} & = & \boxed{1} \\ \mathbf{arg2} & = & [\,] \end{array}\right] \circ \left[\begin{array}{lll} \mathbf{ind} & = & \boxed{1} \\ \mathbf{pred} & = & \mathit{agt} \\ \mathbf{arg1} & = & \boxed{1} \\ \mathbf{arg2} & = & [\,] \end{array}\right] \right\rangle = \perp
$$

This problem can be solved by adding a tag variable in the argument $\theta$-DOM of the object phrase, e.g.

$$\text{(4-89)} \quad \left\langle \begin{bmatrix} \mathbf{ind} & = & \boxed{2} \\ \mathbf{pred} & = & [\,] \\ \mathbf{arg1} & = & \boxed{2} \\ \mathbf{arg2} & = & \mathit{mary} \end{bmatrix} \circ \boxed{7} \right\rangle$$

Now the two $\theta$-DOMs will unify, and the combination of the object phrase with the verb will proceed regularly according to the characterization given in (4-84). We can then formulate a general template for subject/object phrases as shown in (4-90) where the argument $\theta$-DOM is enriched with the additional variable tag $\boxed{7}$.

(4-90) JAPANESE SUBJECT/OBJECT PHRASE TEMPLATE *first version*

$$\begin{bmatrix} \mathbf{phon} & = & \begin{bmatrix} \mathbf{ord} & = & \mathrm{RC} \\ \mathbf{phon1} & = & [\,] \\ \mathbf{phon2} & = & \boxed{1} \end{bmatrix} \\ \mathbf{cat} & = & \begin{bmatrix} \mathbf{catn} = \mathit{sent} \end{bmatrix} \Big/ \begin{bmatrix} \mathbf{phon} & = & \boxed{1} \\ \mathbf{catn} & = & \mathit{sent} \\ \mathbf{sem} & = & \boxed{\begin{bmatrix} \mathbf{ind} & = & \begin{bmatrix} \mathbf{var} & = & \boxed{2} \\ \theta\text{-}\mathbf{dom} & = & \langle \boxed{3} \circ \boxed{7} \rangle_A \end{bmatrix} \\ \mathbf{pred} & = & \boxed{5} \\ \mathbf{args} & = & \boxed{6} \end{bmatrix}}_B \end{bmatrix} \\ \mathbf{sem} & = & \begin{bmatrix} \mathbf{ind} & = & \begin{bmatrix} \mathbf{var} & = & \boxed{2} \\ \theta\text{-}\mathbf{dom} & = & \boxed{\langle \boxed{7} \rangle} \end{bmatrix}_C \\ \mathbf{pred} & = & \mathit{and} \\ \mathbf{arg1} & = & \boxed{\begin{bmatrix} \mathbf{ind} & = & \boxed{2} \\ \mathbf{pred} & = & \boxed{5} \\ \mathbf{args} & = & \boxed{6} \end{bmatrix}}_D \\ \mathbf{arg2} & = & \boxed{\boxed{3} \begin{bmatrix} \mathbf{ind} & = & \boxed{2} \\ \mathbf{pred} & = & [\,] \\ \mathbf{arg1} & = & \boxed{2} \\ \mathbf{arg2} & = & [\,] \end{bmatrix}}_E \end{bmatrix} \end{bmatrix}$$

- $A$ = active $\theta$-DOM
- $B$ = active semantics
- $C$ = result $\theta$-DOM
- $D$ = argument semantics minus $\theta$-DOM
- $E$ = thematic role introduced by subject/object phrase

Notice that if the argument $\theta$-DOM contains only one thematic entailment — as in the example shown earlier with the intransitive verb *arukimasu* — no problem arises. Given the identity axiom in (4-78), the $\theta$-DOM for the verb *arukimasu* is equivalent to a $\theta$-DOM where the final thematic entailment is preceded by the empty string:

$$\text{(4-91)}\quad \left\langle \begin{bmatrix} \mathbf{ind} & = & \boxed{2} \\ \mathbf{pred} & = & agt \\ \mathbf{arg1} & = & \boxed{2} \\ \mathbf{arg2} & = & [\,] \end{bmatrix} \right\rangle = \left\langle \begin{bmatrix} \mathbf{ind} & = & \boxed{2} \\ \mathbf{pred} & = & agt \\ \mathbf{arg1} & = & \boxed{2} \\ \mathbf{arg2} & = & [\,] \end{bmatrix} \circ \Lambda \right\rangle$$

Consequently, the unification of the active $\theta$-DOM of the subject phrase with the verb $\theta$-DOM will proceed as follows:

(4-92)

$$\left\langle \begin{bmatrix} \mathbf{ind} & = & \boxed{2} \\ \mathbf{pred} & = & [\,] \\ \mathbf{arg1} & = & \boxed{2} \\ \mathbf{arg2} & = & john \end{bmatrix} \circ \boxed{7} \right\rangle \sqcap \left\langle \begin{bmatrix} \mathbf{ind} & = & \boxed{2} \\ \mathbf{pred} & = & agt \\ \mathbf{arg1} & = & \boxed{2} \\ \mathbf{arg2} & = & [\,] \end{bmatrix} \circ \Lambda \right\rangle = \left\langle \begin{bmatrix} \mathbf{ind} & = & \boxed{2} \\ \mathbf{pred} & = & agt \\ \mathbf{arg1} & = & \boxed{2} \\ \mathbf{arg2} & = & john \end{bmatrix} \circ \Lambda \right\rangle = \left\langle \begin{bmatrix} \mathbf{ind} & = & \boxed{2} \\ \mathbf{pred} & = & agt \\ \mathbf{arg1} & = & \boxed{2} \\ \mathbf{arg2} & = & john \end{bmatrix} \right\rangle$$

The derivation for the intransitive sentence shown in (4-69) will therefore yield the correct result.

Consider next how this treatment of predicate argument association, and in particular the encoding of the $\theta$-DOM as a string form, can provide a natural account of word order in Japanese. It is well known that Japanese has relatively free word order, except for the constraint that verbs must appear in sentence-final position ([Kuno 73]). Given a ditransitive sentence such as (4-93), for example, the additional orderings in (4-93) will all be possible.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| (4-93) | John | *ga* | Mary | *ni* | hon | *o* | yatta |
| | | nom. | | dat. | book | acc. | gave |
| | "John gave Mary a book" | | | | | | |

(4-94) a John *ga* hon *o* Mary *ni* yatta
b Mary *ni* John *ga* hon *o* yatta
c Mary *ni* hon *o* John *ga* yatta
d hon *o* John *ga* Mary *ni* yatta
e hon *o* Mary *ni* John *ga* yatta

In the approach I have proposed, this freedom in word order follows from the fact that subject and object phrases are quasi-adjuncts which combine with a sentence through forward application to yield a sentence. Aside from the position of the verb, the only constraint which such a system enforces is that the $\theta$-DOM of the argument sentence must contain an argument role which is compatible with the role of the subject/object phrase. Restrictions arising from the position of such argument role in the $\theta$-DOM of the argument sentence are easily defeasible as long as the corresponding role in the active $\theta$-DOM of the object/subject phrase has variables on either side, as shown in (4-95) for the subject phrase *John ga*.

(4-95) JAPANESE SUBJECT PHRASE *final version*

$$\left[\begin{array}{ll}
\mathbf{phon} = & \begin{bmatrix} \mathbf{ord} = \mathrm{RC} \\ \mathbf{phon1} = \mathit{John}^\frown \mathit{ga} \\ \mathbf{phon2} = \boxed{1} \end{bmatrix} \\
\mathbf{cat} = & [\mathbf{catn} = \mathit{sent}] \,/ \begin{bmatrix} \mathbf{phon} = \boxed{1} \\ \mathbf{catn} = \mathit{sent} \\ \mathbf{sem} = \boxed{\begin{bmatrix} \mathbf{ind} = \begin{bmatrix} \mathbf{var} = \boxed{2} \\ \theta\text{-}\mathbf{dom} = \langle \boxed{8} \circ \boxed{3} \circ \boxed{7} \rangle_A \end{bmatrix} \\ \mathbf{pred} = \boxed{5} \\ \mathbf{args} = \boxed{6} \end{bmatrix}} \end{bmatrix}_B \\
\mathbf{sem} = & \begin{bmatrix} \mathbf{ind} = \begin{bmatrix} \mathbf{var} = \boxed{2} \\ \theta\text{-}\mathbf{dom} = \boxed{\langle \boxed{8} \circ \boxed{7} \rangle} \end{bmatrix}_C \\ \mathbf{pred} = \mathit{and} \\ \mathbf{arg1} = \boxed{\begin{bmatrix} \mathbf{ind} = \boxed{2} \\ \mathbf{pred} = \boxed{5} \\ \mathbf{args} = \boxed{6} \end{bmatrix}}_D \\ \mathbf{arg2} = \boxed{\boxed{3} \begin{bmatrix} \mathbf{ind} = \boxed{2} \\ \mathbf{pred} = \mathit{agt} \\ \mathbf{arg1} = \boxed{2} \\ \mathbf{arg2} = \mathit{John} \end{bmatrix}}_E \end{bmatrix}
\end{array}\right]$$

- $A$ = active $\theta$-DOM
- $B$ = active semantics
- $C$ = result $\theta$-DOM
- $D$ = argument semantics minus $\theta$-DOM
- $E$ = thematic role introduced by subject phrase

These variables, $\boxed{8}$ and $\boxed{7}$ in the active and result $\theta$-DOMs of (4-96), will make it possible to combine the sign in (4-95) with the sentential sign in (4-96) (the verb *yatta*) either before or after the theme and goal roles have been removed.

(4-96)

$$\begin{bmatrix} \texttt{phon} = \textit{yatta} \\ \texttt{cat} = \textit{sent} \\ \texttt{sem} = \begin{bmatrix} \texttt{ind} = \begin{bmatrix} \texttt{var} = \boxed{2} \\ \theta\texttt{-dom} = \left\langle \begin{bmatrix} \texttt{ind} = \boxed{2} \\ \texttt{pred} = \textit{goal} \\ \texttt{arg1} = \boxed{2} \\ \texttt{arg2} = [\,] \end{bmatrix} \circ \begin{bmatrix} \texttt{ind} = \boxed{2} \\ \texttt{pred} = \textit{theme} \\ \texttt{arg1} = \boxed{2} \\ \texttt{arg2} = [\,] \end{bmatrix} \circ \begin{bmatrix} \texttt{ind} = \boxed{2} \\ \texttt{pred} = \textit{agt} \\ \texttt{arg1} = \boxed{2} \\ \texttt{arg2} = [\,] \end{bmatrix} \right\rangle \end{bmatrix} \\ \texttt{pred} = \textit{give} \\ \texttt{arg1} = \boxed{2}\, e \end{bmatrix} \end{bmatrix}$$

This flexibility arises from two distinct factors:

- the identity axiom in (4-79)
- the possibility of using the same variable to instantiate an arbitrary number of thematic formulae preceding (following) the argument role, as granted by string unification

Consider, for example, the sentences in (4-94c) and (4-94e) where the subject and verb are adjacent. In both cases, this adjacency obtains if the subject is chosen as the first phrase to combine with the verb. This choice requires that the active $\theta$-DOM of the subject phrase in (4-95) unifies with the $\theta$-DOM of the verb sign in (4-96). This unification will yield as follows. First, the string-final variable $\boxed{7}$ in the active $\theta$-DOM of (4-95) instantiates the empty string $\Lambda$ in the $\theta$-DOM of the verb, and is thereafter "merged" with the preceding thematic formula as discussed above. Second, the string-initial variable $\boxed{8}$ in (4-95) instantiates both the goal and theme argument roles in the $\theta$-DOM of the verb. This instantiation is straightforward since string forms have a flat structure. The result of the unification of the active $\theta$-DOM of the subject phrase and the $\theta$-DOM of the verb alongside the substitution instances involved are given below.

(4-97)

$$\left\langle \boxed{8} \circ \boxed{3}\begin{bmatrix} \mathbf{ind} = \boxed{2} \\ \mathbf{pred} = agt \\ \mathbf{arg1} = \boxed{2} \\ \mathbf{arg2} = John \end{bmatrix} \circ \boxed{7} \right\rangle \sqcap \left\langle \begin{bmatrix} \mathbf{ind} = \boxed{2} \\ \mathbf{pred} = goal \\ \mathbf{arg1} = \boxed{2} \\ \mathbf{arg2} = [\,] \end{bmatrix} \circ \begin{bmatrix} \mathbf{ind} = \boxed{2} \\ \mathbf{pred} = theme \\ \mathbf{arg1} = \boxed{2} \\ \mathbf{arg2} = [\,] \end{bmatrix} \circ \begin{bmatrix} \mathbf{ind} = \boxed{2} \\ \mathbf{pred} = agt \\ \mathbf{arg1} = \boxed{2} \\ \mathbf{arg2} = [\,] \end{bmatrix} \right\rangle$$

$$= \left\langle \begin{bmatrix} \mathbf{ind} = \boxed{2} \\ \mathbf{pred} = goal \\ \mathbf{arg1} = \boxed{2} \\ \mathbf{arg2} = [\,] \end{bmatrix} \circ \begin{bmatrix} \mathbf{ind} = \boxed{2} \\ \mathbf{pred} = theme \\ \mathbf{arg1} = \boxed{2} \\ \mathbf{arg2} = [\,] \end{bmatrix} \circ \begin{bmatrix} \mathbf{ind} = \boxed{2} \\ \mathbf{pred} = agt \\ \mathbf{arg1} = \boxed{2} \\ \mathbf{arg2} = john \end{bmatrix} \right\rangle$$

where:

$$\boxed{8} / \begin{bmatrix} \mathbf{ind} = \boxed{2} \\ \mathbf{pred} = goal \\ \mathbf{arg1} = \boxed{2} \\ \mathbf{arg2} = [\,] \end{bmatrix} \circ \begin{bmatrix} \mathbf{ind} = \boxed{2} \\ \mathbf{pred} = theme \\ \mathbf{arg1} = \boxed{2} \\ \mathbf{arg2} = [\,] \end{bmatrix}$$

$$\boxed{7} / \Lambda$$

The general template for subject/object phrases in Japanese can thus be reformulated as in (4-98) where the argument role introduced by the subject/object phrase (i.e. the thematic formula indexed with the tag $\boxed{3}$) has variables on either side in the the active $\theta$-DOM.

(4-98) JAPANESE SUBJECT/OBJECT PHRASE TEMPLATE *final version*

$$\left[\begin{array}{ll}
\mathbf{phon} = & \left[\begin{array}{l} \mathbf{ord} = \mathrm{RC} \\ \mathbf{phon1} = [\,] \\ \mathbf{phon2} = \boxed{1} \end{array}\right] \\
\mathbf{cat} = & \left[\mathbf{catn} = \textit{sent}\right] / \left[\begin{array}{l} \mathbf{phon} = \boxed{1} \\ \mathbf{catn} = \textit{sent} \\ \mathbf{sem} = \boxed{\left[\begin{array}{l} \mathbf{ind} = \left[\begin{array}{l} \mathbf{var} = \boxed{2} \\ \theta\text{-}\mathbf{dom} = \langle \boxed{8} \circ \boxed{3} \circ \boxed{7} \rangle_{A} \end{array}\right] \\ \mathbf{pred} = \boxed{5} \\ \mathbf{args} = \boxed{6} \end{array}\right]}_{B} \end{array}\right] \\
\mathbf{sem} = & \left[\begin{array}{l} \mathbf{ind} = \left[\begin{array}{l} \mathbf{var} = \boxed{2} \\ \theta\text{-}\mathbf{dom} = \boxed{\langle \boxed{8} \circ \boxed{7} \rangle}_{C} \end{array}\right] \\ \mathbf{pred} = \textit{and} \\ \mathbf{arg1} = \boxed{\left[\begin{array}{l} \mathbf{ind} = \boxed{2} \\ \mathbf{pred} = \boxed{5} \\ \mathbf{args} = \boxed{6} \end{array}\right]}_{D} \\ \mathbf{arg2} = \boxed{\boxed{3} \left[\begin{array}{l} \mathbf{ind} = \boxed{2} \\ \mathbf{pred} = [\,] \\ \mathbf{arg1} = \boxed{2} \\ \mathbf{arg2} = [\,] \end{array}\right]}_{E} \end{array}\right]
\end{array}\right]$$

- $A$ = active $\theta$-DOM
- $B$ = active semantics
- $C$ = result $\theta$-DOM
- $D$ = argument semantics minus $\theta$-DOM
- $E$ = thematic role introduced by subject/object phrase

## Subcategorization

The augmentation of verb signs with a $\theta$-DOM makes it possible to represent information about obligatory arguments as constraints on the index variable of verbs, and therefore allows for a full characterization of properties of verbs concerning thematic assignment. Consequently, the omission of obligatory arguments in the argument structure of verbs no longer constitute a problem since information about these arguments is included in the $\theta$-DOM. For example, syntactic subcategorization for verbs can be directly related to the participant roles contained in the $\theta$-DOM as indicated in the sign below for the English verb *walk* where OBJ is a sort for non-temporal entities.

$$
(4\text{-}99)\quad
\begin{bmatrix}
\textbf{phon} = \begin{bmatrix} \textbf{ord} = \text{LC} \\ \textbf{phon1} = \textit{walk} \\ \textbf{phon2} = \boxed{1} \end{bmatrix} \\
\textbf{cat} = \begin{bmatrix} \textbf{catn} = \textit{sent} \end{bmatrix} \Big/ \begin{bmatrix} \textbf{phon} = \boxed{1} \\ \textbf{catn} = \textit{np} \\ \textbf{sem} = \boxed{2} \end{bmatrix} \\
\textbf{sem} = \begin{bmatrix}
\textbf{ind} = \begin{bmatrix} \textbf{var} = \boxed{3} \\ \theta\textbf{-dom} = \left\langle \boxed{2} \begin{bmatrix} \textbf{ind} = \boxed{3} \\ \textbf{pred} = \textit{agt} \\ \textbf{arg1} = \boxed{3} \\ \textbf{arg2} = \text{OBJ} \end{bmatrix} \right\rangle \end{bmatrix} \\
\textbf{pred} = \textit{walk} \\
\textbf{arg1} = \boxed{3}\, e
\end{bmatrix}
\end{bmatrix}
$$

**SD6**: OBJ $=_{def.}$ $\neg$*temporal*

In this case, the sign for noun phrases can be structured as a polymorphic type-raised complement — e.g. $X/(X/np)$ where $X$ instantiates the categories $s$, $s/np$, and $s/np/np$ — following the approach adopted by [Zeevat *et al.* 87].

$$
(4\text{-}100)\quad
\begin{bmatrix}
\textbf{phon} = \boxed{1} \\
\textbf{cat} = \boxed{2} \Big/ \boxed{\begin{bmatrix}
\textbf{phon} = \boxed{1} \\
\textbf{cat} = \boxed{2} \Big/ \boxed{\begin{bmatrix} \textbf{phon} = \textit{John} \\ \textbf{catn} = \textit{np} \\ \textbf{sem} = \boxed{3} \end{bmatrix}}_{B} \\
\textbf{sem} = \begin{bmatrix} \textbf{ind} = \begin{bmatrix} \textbf{var} = \boxed{4} \\ \theta\textbf{-dom} = \langle \boxed{3} \circ \boxed{5} \rangle \end{bmatrix} \\ \textbf{pred} = \boxed{6} \\ \textbf{args} = \boxed{7} \end{bmatrix}
\end{bmatrix}}_{A} \\
\textbf{sem} = \begin{bmatrix}
\textbf{ind} = \begin{bmatrix} \textbf{var} = \boxed{4} \\ \theta\textbf{-dom} = \langle \boxed{5} \rangle \end{bmatrix} \\
\textbf{pred} = \textit{and} \\
\textbf{arg1} = \begin{bmatrix} \textbf{ind} = \boxed{4} \\ \textbf{pred} = \boxed{6} \\ \textbf{args} = \boxed{7} \end{bmatrix} \\
\textbf{arg2} = \boxed{3} \begin{bmatrix} \textbf{ind} = \boxed{4} \\ \textbf{pred} = [\,] \\ \textbf{arg1} = \boxed{4} \\ \textbf{arg2} = \textit{John} \end{bmatrix}
\end{bmatrix}
\end{bmatrix}
$$

- $A$ = active verb sign
- $B$ = subcategorized NP sign

Likewise, the question of multiple entries for synonymous NPs expressing different thematic roles no longer constitutes a problem. As indicated in the sign for the noun phrase *John* in (4-100), specific information about role type (i.e. a constant value for the path **sem:arg2:pred** in (4-100)) need not be explicitly referenced in noun phrases since it can be retrieved from the information contained in the $\theta$-DOM of the verb with which the noun phrase combines. Notice in fact that the formula corresponding to the participant role introduced by the noun phrase (the value for the path **sem:arg2** in (4-100)) is indexed with the tag $\boxed{3}$ indicating that the formula as a whole is coinstantiated with the first member in the $\theta$-DOM of the active verb sign. The underspecification of the predicate for the thematic formula introduced by the NP ([ ] in (4-100)) will allow for different thematic instantiations. Moreover, because the raised NP in (4-100) is assigned a polymorphic category type[10] the NP could potentially combine with either an intransitive verb like the one in (4-99) or a transitive verb as in (4-101).

$$
(4\text{-}101)\quad
\begin{bmatrix}
\mathbf{phon} = \begin{bmatrix} \mathbf{ord} = \mathrm{LC} \\ \mathbf{phon1} = \begin{bmatrix} \mathbf{ord} = \mathrm{RC} \\ \mathbf{phon1} = \textit{kick} \\ \mathbf{phon2} = \boxed{2} \end{bmatrix} \\ \mathbf{phon2} = \boxed{1} \end{bmatrix} \\
\mathbf{cat} = \begin{bmatrix} \mathbf{catn} = \textit{sent} \end{bmatrix} \Big/ \begin{bmatrix} \mathbf{phon} = \boxed{1} \\ \mathbf{catn} = np \\ \mathbf{sem} = \boxed{3} \end{bmatrix} \Big/ \begin{bmatrix} \mathbf{phon} = \boxed{2} \\ \mathbf{catn} = np \\ \mathbf{sem} = \boxed{4} \end{bmatrix} \\
\mathbf{sem} = \begin{bmatrix} \mathbf{ind} = \begin{bmatrix} \mathbf{var} = \boxed{5} \\ \theta\mathbf{-dom} = \left\langle \boxed{4} \begin{bmatrix} \mathbf{ind} = \boxed{5} \\ \mathbf{pred} = \textit{pat} \\ \mathbf{arg1} = \boxed{5} \\ \mathbf{arg2} = \mathrm{OBJ} \end{bmatrix} \circ \boxed{3} \begin{bmatrix} \mathbf{ind} = \boxed{5} \\ \mathbf{pred} = \textit{agt} \\ \mathbf{arg1} = \boxed{5} \\ \mathbf{arg2} = \mathrm{OBJ} \end{bmatrix} \right\rangle \end{bmatrix} \\ \mathbf{pred} = \textit{kick} \\ \mathbf{arg1} = \boxed{5}\, e \end{bmatrix}
\end{bmatrix}
$$

In the first case, where the noun phrase functions as the subject of the resulting sentence, the value for thematic predicate contained in it ([ ] in (4-100)) will be coinstantiated with the the thematic predicate *agt* (agent) of the formula within the $\theta$-DOM of the sign for *walks* in (4-99), as indicated in the resulting sentential sign below.

[10] That is, all we know about the result category (i.e. the first occurrence of $\boxed{2}$ in (4-100)) is that it is identical to the result category of the active sign (the second occurrence of $\boxed{2}$); its value could then be either an atomic or complex category type (e.g. *sent* or $s/np$, $s/np/np$).

$$
(4\text{-}102)\quad
\begin{bmatrix}
\mathbf{phon} = \begin{bmatrix} \mathbf{ord} = \text{LC} \\ \mathbf{phon1} = \textit{walks} \\ \mathbf{phon2} = \textit{John} \end{bmatrix} \\
\mathbf{catn} = \textit{sent} \\
\mathbf{sem} = \begin{bmatrix}
\mathbf{ind} = \begin{bmatrix} \mathbf{var} = \boxed{4} \\ \theta\text{-}\mathbf{dom} = \Lambda \end{bmatrix} \\
\mathbf{pred} = \textit{and} \\
\mathbf{arg1} = \begin{bmatrix} \mathbf{ind} = \boxed{4} \\ \mathbf{pred} = \textit{walk} \\ \mathbf{args} = \boxed{4} \end{bmatrix} \\
\mathbf{arg2} = \begin{bmatrix} \mathbf{ind} = \boxed{2} \\ \mathbf{pred} = \textit{agt} \\ \mathbf{arg1} = \boxed{4} \\ \mathbf{arg2} = \textit{John} \end{bmatrix}
\end{bmatrix}
\end{bmatrix}
$$

In the second case, where the noun phrase combines with a transitive verb, the thematic predicate variable contained in the noun phrase will be coinstantiated with the thematic predicate *pat* (patient) of the first formula within the *θ*-DOM of the sign for *kick* in (4-101), as shown in the resulting verb phrase sign below.

$$
(4\text{-}103)\quad
\begin{bmatrix}
\mathbf{phon} = \begin{bmatrix} \mathbf{ord} = \text{LC} \\ \mathbf{phon1} = \begin{bmatrix} \mathbf{ord} = \text{RC} \\ \mathbf{phon1} = \textit{kick} \\ \mathbf{phon2} = \textit{John} \end{bmatrix} \\ \mathbf{phon2} = \boxed{1} \end{bmatrix} \\
\mathbf{cat} = \begin{bmatrix} \mathbf{catn} = \textit{sent} \end{bmatrix} \Big/ \begin{bmatrix} \mathbf{phon} = \boxed{1} \\ \mathbf{catn} = \textit{np} \\ \mathbf{sem} = \boxed{3} \end{bmatrix} \\
\mathbf{sem} = \begin{bmatrix}
\mathbf{ind} = \begin{bmatrix} \mathbf{var} = \boxed{5} \\ \theta\text{-}\mathbf{dom} = \left\langle \boxed{3} \begin{bmatrix} \mathbf{ind} = \boxed{5} \\ \mathbf{pred} = \textit{agt} \\ \mathbf{arg1} = \boxed{5} \\ \mathbf{arg2} = \text{OBJ} \end{bmatrix} \right\rangle \end{bmatrix} \\
\mathbf{pred} = \textit{and} \\
\mathbf{arg1} = \begin{bmatrix} \mathbf{ind} = \boxed{5} \\ \mathbf{pred} = \textit{kick} \\ \mathbf{args} = \boxed{5}\, e \end{bmatrix} \\
\mathbf{arg2} = \begin{bmatrix} \mathbf{ind} = \boxed{5} \\ \mathbf{pred} = \textit{pat} \\ \mathbf{arg1} = \boxed{5} \\ \mathbf{arg2} = \text{OBJ} \end{bmatrix}
\end{bmatrix}
\end{bmatrix}
$$

In brief, the notion of $\theta$-DOM and the conception of predicate argument association presented hitherto express the same type of generalizations about thematic assignment and subcategorization which are commonly thought of as derivative on the predicate argument structure of verbs. The main advantage of the approach proposed is that it allows for an explicit encoding of thematic relations, as available within a neo-Davidsonian system.

### 4.3.2 Role Content

In §3.4, I made the suggestion that definitions relative to the semantic content of role predicates within a neo-Davidsonian approach could be derived in terms of Dowty's proto-roles. The basic idea behind my suggestion expounded in (3-65), here repeated as (4-104), can be summarized as follows. First, Dowty's properties contributing to the definition of proto-roles are used to define the predicates *agentive strength* and *patientive strength* as relations between individuals:

(4-104) Let:

a $P^{agt}$ and $P^{pat}$ be the sets of 1-place predicates of individuals contributing to the proto-agent and proto-patient roles

b $\pi_1^{agt}, ..., \pi_n^{agt}$ the members of the power set $\Pi^{agt}$ of $P^{agt}$

c $\pi_1^{pat}, ..., \pi_n^{pat}$ the members of the power set $\Pi^{pat}$ of $P^{pat}$

d $\Pi^{\theta}$ the power set of $P^{agt} \cup P^{pat}$

e $>_{agt}$ the relation of *agentive strength* such that for any pair $Q, R \in \Pi^{\theta}$ if $Q >_{agt} R$ then the cardinality of the set of properties contributing to the proto-agent in $Q$, $\pi_i^{agt} \in Q$, is greater than the cardinality of the set of proto-agent relations in $R$ $\pi_j^{agt} \in R$

f $>_{pat}$ the relations of *patientive strength* such that for any pair $Q, R \in \Pi^{\theta}$ if $Q >_{pat} R$ then the cardinality of the set of properties contributing to the proto-patient in Q, $\pi_i^{pat} \in Q$, is greater than that of the set of proto-patient relations in R $\pi_j^{pat} \in R$.

Then, the proto-agent and proto-patient are defined as relations between eventualities and individuals. In doing so, the assignment of a value (i.e. proto-agent or proto-patient) to a given proto-role predicate is made to be sensitive to the thematic ranking of the individual object argument of the proto-role — measured in terms of agentive/patientive strength — with respect to a given eventuality (i.e. the eventuality argument of the proto-role), e.g.

(4-105) *P-agent Role*
For any eventuality $e$ and individual $x$ if $\theta(e,x)$ is the proto-agent participant of $e$ and $\delta$ a predicate of $e$, then there is a cluster of proto-agent properties $\pi_i^{agt}$ entailed by $\delta$ such that $\pi_i^{agt}(x)$ and there is no $\pi_j^{agt} >_{agt} \pi_i^{agt}$ such that for some individual $y$ distinct from $x$ and $\theta'$ distinct from or equal to $\theta$ if $\theta'(e,y)$ then $\pi_j^{agt}(y)$.

(4-106) *P-patient Role*
For any eventuality $e$ and individual $x$ if $\theta(e,x)$ is the proto-patient participant of $e$ and $\delta$ a predicate of $e$, then there is a cluster of proto-patient properties $\pi_i^{pat}$ entailed by $\delta$ such that $\pi_i^{pat}(x)$ and there is no $\pi_j^{pat} >_{pat} \pi_i^{pat}$ such that for some individual $y$ distinct from $x$ and $\theta'$ distinct from or equal to $\theta$ if $\theta'(e,y)$ then $\pi_j^{pat}(y)$.

We can now provide a unification-based specification of this treament which integrates the insights of the sort system described in §4.2.

First, Dowty's properties contributing to the proto-agent and proto-patient roles are included in the property set of our sort system, and declared as sorts as shown in (4-107). In doing so, I will omit reference to the property *incremental theme* (the import of this property for thematic classification will be structurally encoded in terms of transfer properties of role predicates, see chapter 6).

(4-107) a SET OF DEFINING PROPERTIES
female, neuter, singular, 1st (person), 2nd (person), temporal, stative, telic, volitional, sentient, causer, moving, changing, affected, stationary.

b PROTO-ROLE SORT DEFINITIONS

**SD7**: VOL $=_{def.}$ *volitional*
**SD8**: SEN $=_{def.}$ *sentient*
**SD9**: CAUS $=_{def.}$ *causer*
**SD10**: MOV $=_{def.}$ *moving*
**SD11**: CHA $=_{def.}$ *changing*
**SD12**: AFF $=_{def.}$ *affected*
**SD13**: STA $=_{def.}$ *stationary*

Further background constraints are also introduced to capture cooccurrence restrictions relative to the newly added properties, as shown in (4-108).[11]

[11] For ease of exposition, I will ignore background constraints which state cooccurence restrictions between proto-role sorts and other sorts.

(4-108) BACKGROUND CONSTRAINTS
BC7: SEN $\vee$ CAUS $\vee$ MOV $\vee$ AFF $\vee$ STA $\rightarrow$ $\neg$*temporal*
BC8: VOL $\rightarrow$ SEN
BC9: CHA $\rightarrow$ AFF

The first background constraint in (4-108) says that proto-role sorts all describe non-temporal entities, i.e. individual objects. BC8 and BC9 state that volitional individual objects are also sentient, and that individual objects which undergo change of state are causally affected by the event in which they occur.

Given the sort definitions and background constraints above, the set of all clusters of proto-agent and proto-patient properties is constructed as the set of consistent partial models resulting from all truth assignments to the two sets of sorts in (4-109) with respect to the background constraints in (4-108) — or, equivalently, as the set of propositional formulae which denote these partial models.[12]

(4-109) a *The set of proto-agent sorts*
{VOL, SEN, CAUS, MOV}
b *The set of proto-patient sorts*
{CHA, AFF, STA}

Having defined clusters of proto-role properties as partial models in the sort systems, the notions "agentive strength" and "patientive strength" can be redefined as relations between sets of truth values:

(4-110) given two partial models $\mu$ and $\mu'$, where $\mu$ and $\mu'$ are the denotations of object sorts which occur as arguments of thematic predicates,
a $\mu$ is more agentive that $\mu'$ if the set of truth values $T$ assigned to proto-agent sorts in $\mu$ is more numerous than that in $\mu'$
b $\mu$ is more patientive that $\mu'$ if the set of $T$s assigned to proto-patient sorts in $\mu$ is more numerous than that in $\mu'$

The determination of proto-agent and proto-patient role predicates can then be established for each choice of verb by comparing the object sorts of thematic formulae in the $\theta$-DOM of the verb.

Consider, for example, how the determination of the proto-patient argument of transitive verbs is implemented according to this approach. First, the set of clusters of proto-

[12]Recall that each sort, or the property it defines, is treated as a sentential constant within a full propositional calculus in the sort system.

patient properties is defined as the set of consistent partial models which result from all truth assignments to the set of proto-patient sorts — or, equivalently as the set of formulae denoting these partial models:[13]

(4-111) a $\textsc{cha} \wedge \textsc{aff} \wedge \textsc{sta} \equiv \left\{ \begin{bmatrix} \textsc{cha} \rightarrow T \\ \textsc{aff} \rightarrow T \\ \textsc{sta} \rightarrow T \end{bmatrix} \right\}$

b $\textsc{cha} \wedge \textsc{aff} \wedge \neg\textsc{sta} \equiv \left\{ \begin{bmatrix} \textsc{cha} \rightarrow T \\ \textsc{aff} \rightarrow T \\ \textsc{sta} \rightarrow F \end{bmatrix} \right\}$

c $\neg\textsc{cha} \wedge \textsc{aff} \wedge \textsc{sta} \equiv \left\{ \begin{bmatrix} \textsc{cha} \rightarrow F \\ \textsc{aff} \rightarrow T \\ \textsc{sta} \rightarrow T \end{bmatrix} \right\}$

d $\neg\textsc{cha} \wedge \textsc{aff} \wedge \neg\textsc{sta} \equiv \left\{ \begin{bmatrix} \textsc{cha} \rightarrow F \\ \textsc{aff} \rightarrow T \\ \textsc{sta} \rightarrow F \end{bmatrix} \right\}$

e $\neg\textsc{cha} \wedge \neg\textsc{aff} \wedge \textsc{sta} \equiv \left\{ \begin{bmatrix} \textsc{cha} \rightarrow F \\ \textsc{aff} \rightarrow F \\ \textsc{sta} \rightarrow T \end{bmatrix} \right\}$

f $\neg\textsc{cha} \wedge \neg\textsc{aff} \wedge \neg\textsc{sta} \equiv \left\{ \begin{bmatrix} \textsc{cha} \rightarrow F \\ \textsc{aff} \rightarrow F \\ \textsc{sta} \rightarrow F \end{bmatrix} \right\}$

Next, each formula denoting a consistent partial model is defined as a sort (the matching between subexample letters a-f and formulae in (4-112) is as in (4-111)):

(4-112) SORT DEFINITIONS FOR CLUSTERS OF PROTO-ROLE PROPERTIES
a **SD14**: PAT1 $=_{def.}$ $\textsc{cha} \wedge \textsc{aff} \wedge \textsc{sta}$
b **SD15**: PAT2 $=_{def.}$ $\textsc{cha} \wedge \textsc{aff} \wedge \neg\textsc{sta}$
c **SD16**: PAT3 $=_{def.}$ $\neg\textsc{cha} \wedge \textsc{aff} \wedge \textsc{sta}$
d **SD17**: PAT4 $=_{def.}$ $\neg\textsc{cha} \wedge \textsc{aff} \wedge \neg\textsc{sta}$
e **SD18**: PAT5 $=_{def.}$ $\neg\textsc{cha} \wedge \neg\textsc{aff} \wedge \textsc{sta}$
f **SD19**: PAT6 $=_{def.}$ $\neg\textsc{cha} \wedge \neg\textsc{aff} \wedge \neg\textsc{sta}$

Now, there is a clear sense in which the sorts PAT1-PAT6 are (partially) ordered with respect to the relation "patientive strength" defined in (4-110). For example, PAT1 is more patientive than PAT2-PAT6 in that it denotes a model where all proto-patient sorts are true (cf. (4-111a)), whereas in the models denoted by the sorts PAT2-PAT6 one or more proto-patient sorts are false. By the same token, PAT2 and PAT3 are more patientive

[13]Note that according to **BC9** partial models where the sort CHA is false and the sort AFF is true are not within the set of consistent partial models.

than PAT4-PAT6, and PAT4-PAT5 more patientive than PAT6. On the other hand, PAT2 and PAT3 do not differ with respect to "patientive strength" since they denote models where the same number of proto-patient sorts are true; the same holds of PAT4 and PAT5. The hierarchy in (4-113) gives an intuitive representation of the ordering of sorts PAT1-PAT6 relative to patientive strength.

(4-113) *Proto-Patient Hierarchy*

$$\text{PAT1} > \left\{ \begin{array}{c} \text{PAT2} \\ \text{PAT3} \end{array} \right\} > \left\{ \begin{array}{c} \text{PAT4} \\ \text{PAT5} \end{array} \right\} > \text{PAT6}$$

This ordering can be used to determine the proto-patient role as follows:

(4-114) *Proto-patient role*
The proto-patient of a verb is the role predicate of the verb $\theta$-DOM whose object argument is highest on the Proto-Patient Hierarchy

a *corollary*
If the object arguments of two role predicates within the $\theta$-DOM do not differ with respect to the Proto-Patient Hierarchy, then either role predicate can be proto-patient.

The proto-patient definition in (4-114) can be directly expressed in verb templates. For example, the template which establishes the general properties of transitive verbs will contain, alongside other specifications, information about its $\theta$-DOM which integrates the generalization in (4-114). This information can be given in terms of templates which constrain the range of possible transitive $\theta$-DOMs to those ones where the proto-patient role is predicated of the object argument which ranks highest on the Proto-Patient Hierarchy:

(4-115) **LCT2**

@TV_$\theta$-DOM1 $\Rightarrow$

$$\neg\left[\textbf{sem:ind:}\theta\textbf{-dom} = \left\langle \begin{bmatrix} \textbf{ind} = \boxed{1} \\ \textbf{pred} = \textit{p-pat} \\ \textbf{arg1} = \boxed{1}e \\ \textbf{arg2} = \text{PAT1} \end{bmatrix} \circ \begin{bmatrix} \textbf{ind} = \boxed{1} \\ \textbf{pred} = \textit{p-agt} \\ \textbf{arg1} = \boxed{1}e \\ \textbf{arg2} = \begin{bmatrix} \text{PAT2} \vee \text{PAT3} \\ \vee\text{PAT4}\vee \\ \text{PAT5} \vee \text{PAT6} \end{bmatrix} \end{bmatrix} \right\rangle\right]$$

**LCT3**

@TV_$\theta$-DOM2 $\Rightarrow$

$$\neg\left[\textbf{sem:ind:}\theta\textbf{-dom} = \left\langle \begin{bmatrix} \textbf{ind} = \boxed{1} \\ \textbf{pred} = \textit{p-pat} \\ \textbf{arg1} = \boxed{1}e \\ \textbf{arg2} = \left[\text{PAT2} \vee \text{PAT3}\right] \end{bmatrix} \circ \begin{bmatrix} \textbf{ind} = \boxed{1} \\ \textbf{pred} = \textit{p-agt} \\ \textbf{arg1} = \boxed{1}e \\ \textbf{arg2} = \begin{bmatrix} \text{PAT4} \vee \text{PAT5} \\ \vee\text{PAT6} \end{bmatrix} \end{bmatrix} \right\rangle\right]$$

**LCT4**

@TV_$\theta$-DOM3 $\Rightarrow$

$$\neg\left[\textbf{sem:ind:}\theta\textbf{-dom} = \left\langle \begin{bmatrix} \textbf{ind} = \boxed{1} \\ \textbf{pred} = \textit{p-pat} \\ \textbf{arg1} = \boxed{1}e \\ \textbf{arg2} = \left[\text{PAT5} \vee \text{PAT6}\right] \end{bmatrix} \circ \begin{bmatrix} \textbf{ind} = \boxed{1} \\ \textbf{pred} = \textit{p-agt} \\ \textbf{arg1} = \boxed{1}e \\ \textbf{arg2} = \text{PAT6} \end{bmatrix} \right\rangle\right]$$

The same method is used to define the proto-agent role of transitive verbs. Given the proto-agent sorts in (4-109a) and background constraints in (4-108b), the clusters of proto-agent properties and sorts which describe them are defined as in (4-116).

(4-116) a **SD19**: AGT1 $=_{def.}$ VOL $\wedge$ SEN $\wedge$ CAUS $\wedge$ MOV
b **SD20**: AGT2 $=_{def.}$ VOL $\wedge$ SEN $\wedge$ CAUS $\wedge$ $\neg$MOV
c **SD21**: AGT3 $=_{def.}$ VOL $\wedge$ SEN $\wedge$ $\neg$CAUS $\wedge$ MOV
d **SD22**: AGT4 $=_{def.}$ $\neg$VOL $\wedge$ SEN $\wedge$ CAUS $\wedge$ MOV
e **SD23**: AGT5 $=_{def.}$ VOL $\wedge$ SEN $\wedge$ $\neg$CAUS $\wedge$ $\neg$MOV
f **SD24**: AGT6 $=_{def.}$ $\neg$VOL $\wedge$ SEN $\wedge$ CAUS $\wedge$ $\neg$MOV
g **SD25**: AGT7 $=_{def.}$ $\neg$VOL $\wedge$ SEN $\wedge$ $\neg$CAUS $\wedge$ MOV
h **SD26**: AGT8 $=_{def.}$ $\neg$VOL $\wedge$ $\neg$SEN $\wedge$ CAUS $\wedge$ MOV
i **SD27**: AGT9 $=_{def.}$ $\neg$VOL $\wedge$ SEN $\wedge$ $\neg$CAUS $\wedge$ $\neg$MOV
j **SD28**: AGT10 $=_{def.}$ $\neg$VOL $\wedge$ $\neg$SEN $\wedge$ CAUS $\wedge$ $\neg$MOV
k **SD29**: AGT11 $=_{def.}$ $\neg$VOL $\wedge$ $\neg$SEN $\wedge$ $\neg$CAUS $\wedge$ MOV
l **SD30**: AGT12 $=_{def.}$ $\neg$VOL $\wedge$ $\neg$SEN $\wedge$ $\neg$CAUS $\wedge$ $\neg$MOV

Sorts AGT1-AGT12 are ordered by the relation of "agentive strength" (cf. (4-110)) as indicated below:

(4-117) *The Proto-Agent Hierarchy*

$$\textsc{agt}1 > \left\{\begin{matrix}\textsc{agt}2\\ \textsc{agt}3\\ \textsc{agt}4\end{matrix}\right\} > \left\{\begin{matrix}\textsc{agt}5\\ \textsc{agt}6\\ \textsc{agt}7\\ \textsc{agt}8\end{matrix}\right\} > \left\{\begin{matrix}\textsc{agt}9\\ \textsc{agt}10\\ \textsc{agt}11\end{matrix}\right\} > \textsc{agt}12$$

This ordering is used to define the proto-agent role as follows:

(4-118) *Proto-Agent role*
The proto-agent of a verb is the role predicate of the verb $\theta$-DOM whose object argument is highest on the Proto-Patient Hierarchy

a *corollary*
If the individual object arguments of two role predicates within the $\theta$-DOM do not differ with respect to the Proto-Agent Hierarchy, then either one role predicate can be proto-agent.

With transitive verbs, the definition of proto-agent above is implemented through the following template definitions which constrain transitive $\theta$-DOMs to those where the proto-agent role is predicated of the object sort which rank highest (or non-lowest):

(4-119) **LCT5**

@TV_$\theta$-DOM4 $\Rightarrow$

$$\neg\left[\textbf{sem:ind:}\theta\textbf{-dom} = \left\langle \begin{bmatrix} \textbf{ind} = \boxed{1} \\ \textbf{pred} = \textit{p-pat} \\ \textbf{arg1} = \boxed{1}e \\ \textbf{arg2} = \mathrm{AGT1} \end{bmatrix} \circ \begin{bmatrix} \textbf{ind} = \boxed{1} \\ \textbf{pred} = \textit{p-agt} \\ \textbf{arg1} = \boxed{1}e \\ \textbf{arg2} = \begin{bmatrix} \mathrm{AGT2} \vee \mathrm{AGT3} \vee \\ \mathrm{AGT4} \vee \mathrm{AGT5} \vee \\ \mathrm{AGT6} \vee \mathrm{AGT7} \vee \\ \mathrm{AGT8} \vee \mathrm{AGT9} \vee \\ \mathrm{AGT10} \vee \mathrm{AGT11} \vee \\ \mathrm{AGT12} \end{bmatrix} \end{bmatrix} \right\rangle\right]$$

**LCT6**

@TV_$\theta$-DOM5 $\Rightarrow$

$$\neg\left[\textbf{sem:ind:}\theta\textbf{-dom} = \left\langle \begin{bmatrix} \textbf{ind} = \boxed{1} \\ \textbf{pred} = \textit{p-pat} \\ \textbf{arg1} = \boxed{1}e \\ \textbf{arg2} = \begin{bmatrix} \mathrm{AGT2} \vee \mathrm{AGT3} \\ \vee \mathrm{AGT4} \end{bmatrix} \end{bmatrix} \circ \begin{bmatrix} \textbf{ind} = \boxed{1} \\ \textbf{pred} = \textit{p-agt} \\ \textbf{arg1} = \boxed{1}e \\ \textbf{arg2} = \begin{bmatrix} \mathrm{AGT5} \vee \mathrm{AGT6} \vee \\ \mathrm{AGT7} \vee \mathrm{AGT8} \vee \\ \mathrm{AGT9} \vee \mathrm{AGT10} \vee \\ \mathrm{AGT11} \vee \mathrm{AGT12} \end{bmatrix} \end{bmatrix} \right\rangle\right]$$

**LCT7**

@TV_$\theta$-DOM6 $\Rightarrow$

$$\neg\left[\textbf{sem:ind:}\theta\textbf{-dom} = \left\langle \begin{bmatrix} \textbf{ind} = \boxed{1} \\ \textbf{pred} = \textit{p-pat} \\ \textbf{arg1} = \boxed{1}e \\ \textbf{arg2} = \begin{bmatrix} \mathrm{AGT5} \vee \mathrm{AGT6} \vee \\ \mathrm{AGT7} \vee \mathrm{AGT8} \end{bmatrix} \end{bmatrix} \circ \begin{bmatrix} \textbf{ind} = \boxed{1} \\ \textbf{pred} = \textit{p-agt} \\ \textbf{arg1} = \boxed{1}e \\ \textbf{arg2} = \begin{bmatrix} \mathrm{AGT9} \vee \mathrm{AGT10} \vee \\ \mathrm{AGT11} \vee \mathrm{AGT12} \end{bmatrix} \end{bmatrix} \right\rangle\right]$$

**LCT8**

@TV_$\theta$-DOM7 $\Rightarrow$

$$\neg\left[\textbf{sem:ind:}\theta\textbf{-dom} = \left\langle \begin{bmatrix} \textbf{ind} = \boxed{1} \\ \textbf{pred} = \textit{p-pat} \\ \textbf{arg1} = \boxed{1}e \\ \textbf{arg2} = \begin{bmatrix} \mathrm{AGT9} \vee \mathrm{AGT10} \\ \vee \mathrm{AGT11} \end{bmatrix} \end{bmatrix} \circ \begin{bmatrix} \textbf{ind} = \boxed{1} \\ \textbf{pred} = \textit{p-agt} \\ \textbf{arg1} = \boxed{1}e \\ \textbf{arg2} = \mathrm{AGT12} \end{bmatrix} \right\rangle\right]$$

We can then define a (meta)template for transitive $\theta$-DOMs as the "generalization" (i.e. join) of templates definitions LCT2-LCT8, e.g.

(4-120) **LCT9**

@TV_$\theta$-DOM $\Rightarrow$

$$\begin{bmatrix} \text{@TV\_}\theta\text{-DOM1} \sqcup \\ \text{@TV\_}\theta\text{-DOM2} \sqcup \\ \text{@TV\_}\theta\text{-DOM3} \sqcup \\ \text{@TV\_}\theta\text{-DOM4} \sqcup \\ \text{@TV\_}\theta\text{-DOM5} \sqcup \\ \text{@TV\_}\theta\text{-DOM6} \sqcup \\ \text{@TV\_}\theta\text{-DOM7} \end{bmatrix}$$

LCT9 is included in the general template for transitive verbs, as shown below where the vertical dots stand in place of specifications concerning remaining attributes. This will ensue that the proto-agent and proto-patient roles of all transitive verbs comply with the definitions in (4-115) and (4-119).

(4-121) LCT10 *preliminary version*

$$\text{@TV} \Rightarrow \begin{bmatrix} \text{@TV\_}\theta\text{-DOM,} \\ \vdots \end{bmatrix}$$

With respect to intransitive verbs, it will suffice to say, for the moment, that the role predicate of the $\theta$-DOM of such verbs is a proto-agent role — but see chapter 6 for a more articulate proposal. With ditransitive verbs, the role predicate which is neither the highest on the Proto-Agent Hierarchy nor the highest on the Proto-Patient hierarchy is encoded as a prepositional predicate (as mentioned in §3.4).[14] The specification relative to such prepositional role predicate in encoded in lexical templates which introduce item-specific information (i.e. lexical item templates, cf. §4.2.2). For example, the specification **pred** = *to* in the lexical template below specifies that the prepositional role predicate for the verb *give* is *to*.

(4-122) LIT2

give :

$$\begin{bmatrix} \text{@DTV,} \\ \textbf{phon:phon1:phon1:phon1} = \textit{give} \\ \textbf{sem:pred} = \textit{give}, \\ \textbf{sem:ind:}\theta\textbf{-dom} = \langle [\textbf{pred} = \textit{to}] \circ [\textbf{pred} = \textit{p-pat}] \circ [\textbf{pred} = \textit{p-agt}] \rangle \end{bmatrix}$$

This way of introducing prepositional predicates gives a natural characterization of the idea that the prepositional predicate which is found with indirect and oblique object is inherently linked to the meaning of specific verbs.

The thematic relation between a matrix verb and its sentential complement (an infinitive VP or complementized sentence) will be encoded as a relation between eventualities and propositions. For example, the semantics for a verb phrase like *hears that John left* will be represented as a conjunctive formula where the first argument corresponds to the matrix verb semantics (*hears*), and second argument is a thematic formula with predicate *prop*, as shown in (4-123) both in feature-value and linearized notation. The *prop* role is a two-place relation whose first argument corresponds to the eventuality

[14] Here, I will not give a list of the template definitions for ditransitive $\theta$-DOMs which implements such characterization. However, the form of such templates can be easily deduced from the $\theta$-DOM templates for transitive verbs given above.

argument variable of the matrix verb and second argument is the semantics of the complement sentence (*that John left*).

(4-123)

$$
\text{a}\quad \textbf{sem} = \begin{bmatrix}
\textbf{ind} = \begin{bmatrix} \textbf{var} = \boxed{1} \\ \theta\textbf{-dom} = \left\langle \begin{bmatrix} \textbf{ind} = \boxed{1} \\ \textbf{pred} = \textit{p-agt} \\ \textbf{arg1} = \boxed{1} \\ \textbf{arg2} = \textsc{obj} \end{bmatrix} \right\rangle \end{bmatrix} \\
\textbf{pred} = \textit{and} \\
\textbf{arg1} = \begin{bmatrix} \textbf{ind} = \boxed{1} \\ \textbf{pred} = \textit{hear} \\ \textbf{args} = \boxed{1}e \end{bmatrix} \\
\textbf{arg2} = \begin{bmatrix} \textbf{ind} = \boxed{1} \\ \textbf{pred} = \textit{Prop} \\ \textbf{arg1} = \boxed{1} \\ \textbf{arg2} = \begin{bmatrix} \textbf{ind} = \boxed{2} \\ \textbf{pred} = \textit{and} \\ \textbf{arg1} = \begin{bmatrix} \textbf{ind} = \boxed{2} \\ \textbf{pred} = \textit{leave} \\ \textbf{args} = \boxed{2}e \end{bmatrix} \\ \textbf{arg2} = \begin{bmatrix} \textbf{ind} = \boxed{2} \\ \textbf{pred} = \textit{p-agt} \\ \textbf{arg1} = \boxed{2} \\ \textbf{arg2} = \textit{john} \end{bmatrix} \end{bmatrix} \end{bmatrix}
\end{bmatrix}
$$

$$\text{b}\quad [e_1 :< \textit{p-agt}(e_1, \textsc{obj}) >][\textit{hear}(e_1) \wedge \textit{prop}(e_1, [\textit{leave}(e_2) \wedge \textit{p-agt}(e_2, \textit{john})])]$$

The formulae in (4-123) express the idea that the verb *hear* assigns a ***propositional*** role to its complement sentence *that John left*, and that this role denotes the set of eventualities of *leaving* by *John* which function as a proposition with respect to some eventuality of hearing. As for other thematic roles, the propositional role appears in the thematic domain of verbs which subcategorize for a sentential complement such as *hear*, and is coinstantiated with the semantic attribute of a subcategorized complement of the verb as shown in (4-124).

(4-124)

$$
\begin{bmatrix}
\textbf{phon} = \begin{bmatrix} \textbf{ord} = \text{LC} \\ \textbf{phon1} = \begin{bmatrix} \textbf{ord} = \text{RC} \\ \textbf{phon1} = \textit{hears} \\ \textbf{phon2} = \boxed{2} \end{bmatrix} \\ \textbf{phon2} = \boxed{1} \end{bmatrix} \\
\textbf{cat} = \begin{bmatrix} \textbf{catn} = \textit{sent} \end{bmatrix} \Big/ \begin{bmatrix} \textbf{phon} = \boxed{1} \\ \textbf{catn} = \textit{np} \\ \textbf{sem} = \boxed{3} \end{bmatrix} \Big/ \begin{bmatrix} \textbf{phon} = \boxed{3} \\ \textbf{catn} = \textit{sent} \\ \textbf{sem} = \boxed{4} \end{bmatrix} \\
\textbf{sem} = \begin{bmatrix} \textbf{ind} = \begin{bmatrix} \textbf{var} = \boxed{5} \\ \theta\textbf{-dom} = \left\langle \boxed{4} \begin{bmatrix} \textbf{ind} = \boxed{5} \\ \textbf{pred} = \textit{prop} \\ \textbf{arg1} = \boxed{5} \\ \textbf{arg2} = [\,] \end{bmatrix} \circ \boxed{3} \begin{bmatrix} \textbf{ind} = \boxed{5} \\ \textbf{pred} = \textit{P-agt} \\ \textbf{arg1} = \boxed{5} \\ \textbf{arg2} = [\,] \end{bmatrix} \right\rangle \end{bmatrix} \\ \textbf{pred} = \textit{hear} \\ \textbf{arg1} = \boxed{5}\,e \end{bmatrix}
\end{bmatrix}
$$

In keeping with our treatment of subject and object phrases, sentential complements are treated as type-raised arguments (e.g. X/(X/sent))[15] which reduce the subcategorization list and $\theta$-DOM of their matrix verb, and combine it with a propositional role. The sign for the complementized sentence *that John left*, for example, is as described in (4-125).

[15]See [Klein 87] for a similar treatment of sentential complements within a slightly different approach to verb semantics.

$$
(4\text{-}125)\quad
\begin{bmatrix}
\textbf{phon} = \boxed{1} \\
\textbf{cat} = \boxed{2} \Big/ \begin{bmatrix}
\textbf{phon} = \boxed{1} \\
\textbf{cat} = \boxed{2} \Big/ \begin{bmatrix} \textbf{phon} = \textit{that John left} \\ \textbf{catn} = \textit{sent} \\ \textbf{sem} = \boxed{3} \end{bmatrix} \\
\textbf{sem} = \begin{bmatrix}
\textbf{ind} = \begin{bmatrix} \textbf{var} = \boxed{4} \\ \theta\textbf{-dom} = \langle \boxed{3} \circ \boxed{6} \rangle \end{bmatrix} \\
\textbf{pred} = \boxed{7} \\
\textbf{args} = \boxed{4}
\end{bmatrix}
\end{bmatrix} \\
\textbf{sem} = \begin{bmatrix}
\textbf{ind} = \begin{bmatrix} \textbf{var} = \boxed{4} \\ \theta\textbf{-dom} = \langle \boxed{6} \rangle \end{bmatrix} \\
\textbf{pred} = \textit{and} \\
\textbf{arg1} = \begin{bmatrix} \textbf{ind} = \boxed{4} \\ \textbf{pred} = \boxed{7} \\ \textbf{args} = \boxed{4} \end{bmatrix} \\
\textbf{arg2} = \boxed{3} \begin{bmatrix}
\textbf{ind} = \boxed{4} \\
\textbf{pred} = \textit{Prop} \\
\textbf{arg1} = \boxed{4} \\
\textbf{arg2} = \begin{bmatrix}
\textbf{ind} = \boxed{5} \\
\textbf{pred} = \textit{and} \\
\textbf{arg1} = \begin{array}{l} \textbf{ind} = \boxed{5} \\ \textbf{pred} = \textit{leave} \\ \textbf{args} = \boxed{5}\,\textit{e} \end{array} \\
\textbf{arg2} = \begin{array}{l} \textbf{ind} = \boxed{5} \\ \textbf{pred} = \textit{P-agt} \\ \textbf{arg1} = \boxed{5} \\ \textbf{arg2} = \textit{john} \end{array}
\end{bmatrix}
\end{bmatrix}
\end{bmatrix}
\end{bmatrix}
$$

The result of combining the two signs in (4-124) and (4-125) will be the VP sign in (4-126).

$$
\text{(4-126)}\quad
\begin{bmatrix}
\textbf{phon} = \begin{bmatrix}
\textbf{ord} = \textbf{LC} \\
\textbf{phon1} = \begin{bmatrix} \textbf{ord} = \textbf{RC} \\ \textbf{phon1} = \textit{hears} \\ \textbf{phon2} = \textit{that John left} \end{bmatrix} \\
\textbf{phon2} = \boxed{1}
\end{bmatrix} \\
\textbf{cat} = \begin{bmatrix} \textbf{catn} = \textit{sent} \end{bmatrix} \Big/ \begin{bmatrix} \textbf{phon} = \boxed{1} \\ \textbf{catn} = \textit{np} \\ \textbf{sem} = \boxed{3} \end{bmatrix} \\
\textbf{sem} = \begin{bmatrix}
\textbf{ind} = \begin{bmatrix} \textbf{var} = \boxed{4} \\ \theta\textbf{-dom} = \left\langle \boxed{3} \begin{bmatrix} \textbf{ind} = \boxed{4} \\ \textbf{pred} = \textit{P-agt} \\ \textbf{arg1} = \boxed{4} \\ \textbf{arg2} = [\,] \end{bmatrix} \right\rangle \end{bmatrix} \\
\textbf{pred} = \textit{and} \\
\textbf{arg1} = \begin{bmatrix} \textbf{ind} = \boxed{4} \\ \textbf{pred} = \textit{hear} \\ \textbf{args} = \boxed{4} \end{bmatrix} \\
\textbf{arg2} = \boxed{3} \begin{bmatrix}
\textbf{ind} = \boxed{4} \\
\textbf{pred} = \textit{Prop} \\
\textbf{arg1} = \boxed{4} \\
\textbf{arg2} = \begin{bmatrix}
\textbf{ind} = \boxed{5} \\
\textbf{pred} = \textit{and} \\
\textbf{arg1} = \begin{matrix} \textbf{ind} = \boxed{5} \\ \textbf{pred} = \textit{leave} \\ \textbf{args} = \boxed{5}\, e \end{matrix} \\
\textbf{arg2} = \begin{matrix} \textbf{ind} = \boxed{5} \\ \textbf{pred} = \textit{P-agt} \\ \textbf{arg1} = \boxed{5} \\ \textbf{arg2} = \textit{john} \end{matrix}
\end{bmatrix}
\end{bmatrix}
\end{bmatrix}
\end{bmatrix}
$$

### 4.3.3 Argument Selection

Having provided a specification of thematic marking, subcategorization and role content, my next objective is to show how syntactic and semantic properties of verb signs are interfaced to provide a specification of grammatical relations. The basic approach which I will pursue is one which relies on Dowty's theory of grammatical relations and argument selection (see §2.3). According to Dowty, grammatical relations arise from the functor-argument structure of predicates where argument are ordered according to thematic ranking. For example, the subject of a verb is the last argument to combine with the verb and corresponds, all else being equal, to the argument which has the greatest number of entailed proto-agent properties. (I shall, for the moment, ignore the effect of relation changing rules.) The direct object is the next argument to combine with the verb, and it is the argument that has the greatest number of entailed proto-patient properties. The indirect object is the first argument to combine with the verb, and it is the argument which fails to rank highest both with respect to entailed proto-agent and proto-patient properties. To reproduce the insights of Dowty's approach within the treatment of verb semantics and subcategorization developed hitherto, I will make the following assumptions:

(4-127) a The thematic formulae of a verb $\theta$-DOM are ordered according to thematic ranking: prepositional roles first, proto-patient roles next and proto-agent roles last.

b The order imposed on argument roles in the verb $\theta$-DOM is reflected in the subcategorization frame of the verb

(4-127a) can be easily implemented by requiring that all $\theta$-DOM templates relative to transitive and ditransitive predicates conform to the sequential order of thematic formulae in (4-128) (*prep* is a sort for prepositional predicates).

(4-128) a
$$\left[\textbf{sem:ind:}\theta\textbf{-dom} = \left\langle \begin{bmatrix} \textbf{ind} = \boxed{1} \\ \textbf{pred} = \textit{p-pat} \\ \textbf{arg1} = \boxed{1}\,e \\ \textbf{arg2} = \text{OBJ} \end{bmatrix} \circ \begin{bmatrix} \textbf{ind} = \boxed{1} \\ \textbf{pred} = \textit{p-agt} \\ \textbf{arg1} = \boxed{1}\,e \\ \textbf{arg2} = \text{OBJ} \end{bmatrix} \right\rangle \right]$$

b
$$\left[\textbf{sem:ind:}\theta\textbf{-dom} = \left\langle \begin{bmatrix} \textbf{ind} = \boxed{1} \\ \textbf{pred} = \textit{prep} \\ \textbf{arg1} = \boxed{1}\,e \\ \textbf{arg2} = \text{OBJ} \end{bmatrix} \circ \begin{bmatrix} \textbf{ind} = \boxed{1} \\ \textbf{pred} = \textit{p-pat} \\ \textbf{arg1} = \boxed{1}\,e \\ \textbf{arg2} = \text{OBJ} \end{bmatrix} \circ \begin{bmatrix} \textbf{ind} = \boxed{1} \\ \textbf{pred} = \textit{p-agt} \\ \textbf{arg1} = \boxed{1}\,e \\ \textbf{arg2} = \text{OBJ} \end{bmatrix} \right\rangle \right]$$

A characterization of the assumption in (4-127b) is given in terms of the following three constraints:

(4-129) a ROLE ASSOCIATION ($\theta$-ASSOC)
All syntactic arguments of a predicate must be linked to a unique role, and all entailed roles to a unique syntactic argument (subject to parametric variation)

b PROTO-AGENT ROLE REALIZATION (P-AGT REAL)
If the Proto-Agent role of a predicate is syntactically realized, then it must be linked to innermost active sign in the category structure of a verb sign

c PROTO-PATIENT ROLE REALIZATION (P-PAT REAL)
If the Proto-Patient role of a predicate is syntactically realized, then it must be linked to the innermost subcategorized NP immediately following the active sign linked to the Proto-Agent role, if there is one (subject to parametric variation)

The implementation of the constraints in (4-129) will lead to signs for transitive and ditransitive verbs such as those in (4-130) and (4-131) where the grammatical relations subject, object and indirect/oblique object are defined as follows:[16]

- the subject is the innermost active sign in the category structure of a verb
- the direct object is the next outer active sign in the category structure of a verb
- the indirect/oblique object is outermost active sign in the category structure of a verb which instantiates a prepositional predicate

[16]In Japanese, where subject and object phrases are not subcategorized for according to the analysis suggested above, grammatical relations could be derived from the ordering of roles inherent to the $\theta$-DOM of verbs, e.g.

- the subject is the quasi-adjunct which instantiates the innermost thematic formula of a verb $\theta$-DOM
- the direct object is the quasi-adjunct which instantiates the next outer thematic formula of a verb $\theta$-DOM
- the indirect/oblique object is the quasi-adjunct which instantiates the outermost prepositional role in the $\theta$-DOM of a verb

$$(4\text{-}130)\quad \begin{bmatrix} \mathbf{phon} & = & \begin{bmatrix} \mathbf{ord} & = & \textsc{lc} \\ \mathbf{phon1} & = & \begin{bmatrix} \mathbf{ord} & = & \textsc{rc} \\ \mathbf{phon1} & = & \textit{kick} \\ \mathbf{phon2} & = & \boxed{2} \end{bmatrix} \\ \mathbf{phon2} & = & \boxed{1} \end{bmatrix} \\ \mathbf{cat} & = & \begin{bmatrix} \mathbf{catn} = \textit{sent} \end{bmatrix} \Big/ \begin{bmatrix} \mathbf{phon} & = & \boxed{1} \\ \mathbf{catn} & = & \textit{np} \\ \mathbf{sem} & = & \boxed{3} \end{bmatrix} \Big/ \begin{bmatrix} \mathbf{phon} & = & \boxed{2} \\ \mathbf{catn} & = & \textit{np} \\ \mathbf{sem} & = & \boxed{4} \end{bmatrix} \\ \mathbf{sem} & = & \begin{bmatrix} \mathbf{ind} & = & \begin{bmatrix} \mathbf{var} & = & \boxed{5} \\ \theta\mathbf{\text{-}dom} & = & \left\langle \boxed{4} \begin{bmatrix} \mathbf{ind} & = & \boxed{5} \\ \mathbf{pred} & = & \textit{p-pat} \\ \mathbf{arg1} & = & \boxed{5} \\ \mathbf{arg2} & = & \textsc{obj} \end{bmatrix} \circ \boxed{3} \begin{bmatrix} \mathbf{ind} & = & \boxed{5} \\ \mathbf{pred} & = & \textit{p-agt} \\ \mathbf{arg1} & = & \boxed{5} \\ \mathbf{arg2} & = & \textsc{obj} \end{bmatrix} \right\rangle \end{bmatrix} \\ \mathbf{pred} & = & \textit{kick} \\ \mathbf{arg1} & = & \boxed{5}\,e \end{bmatrix} \end{bmatrix}$$

(4-131)

$$\begin{bmatrix} \mathbf{phon} & = & \begin{bmatrix} \mathbf{ord} & = & \textsc{lc} \\ \mathbf{phon1} & = & \begin{bmatrix} \mathbf{ord} & = & \textsc{rc} \\ \mathbf{phon1} & = & \begin{bmatrix} \mathbf{ord} & = & \textsc{rc} \\ \mathbf{phon1} & = & \textit{give} \\ \mathbf{phon2} & = & \boxed{2} \end{bmatrix} \\ \mathbf{phon2} & = & \boxed{3} \end{bmatrix} \\ \mathbf{phon2} & = & \boxed{1} \end{bmatrix} \\ \mathbf{cat} & = & \begin{bmatrix} \mathbf{catn} = \textit{sent} \end{bmatrix} \Big/ \begin{bmatrix} \mathbf{phon} & = & \boxed{1} \\ \mathbf{catn} & = & \textit{np} \\ \mathbf{sem} & = & \boxed{4} \end{bmatrix} \Big/ \begin{bmatrix} \mathbf{phon} & = & \boxed{2} \\ \mathbf{catn} & = & \textit{np} \\ \mathbf{sem} & = & \boxed{5} \end{bmatrix} \Big/ \begin{bmatrix} \mathbf{phon} & = & \boxed{3} \\ \mathbf{catn} & = & \begin{bmatrix} \mathbf{name} & = & \textit{np} \\ \mathbf{feats} & = & \begin{bmatrix} \mathbf{case} = \textit{to} \end{bmatrix} \end{bmatrix} \\ \mathbf{sem} & = & \boxed{6} \end{bmatrix} \\ \mathbf{sem} & = & \begin{bmatrix} \mathbf{ind} & = & \begin{bmatrix} \mathbf{var} & = & \boxed{5} \\ \theta\mathbf{\text{-}dom} & = & \left\langle \boxed{6} \begin{bmatrix} \mathbf{ind} & = & \boxed{7} \\ \mathbf{pred} & = & \textit{to} \\ \mathbf{arg1} & = & \boxed{7} \\ \mathbf{arg2} & = & \textsc{obj} \end{bmatrix} \circ \boxed{5} \begin{bmatrix} \mathbf{ind} & = & \boxed{7} \\ \mathbf{pred} & = & \textit{p-pat} \\ \mathbf{arg1} & = & \boxed{7} \\ \mathbf{arg2} & = & \textsc{obj} \end{bmatrix} \circ \boxed{4} \begin{bmatrix} \mathbf{ind} & = & \boxed{7} \\ \mathbf{pred} & = & \textit{p-agt} \\ \mathbf{arg1} & = & \boxed{7} \\ \mathbf{arg2} & = & \textsc{obj} \end{bmatrix} \right\rangle \end{bmatrix} \\ \mathbf{pred} & = & \textit{give} \\ \mathbf{arg1} & = & \boxed{7}\,e \end{bmatrix} \end{bmatrix}$$

An account of different realization patterns across languages can be given by parametrizing $\theta$-ASSOC, P-AGT REAL and P-PAT REAL. For example, the possibility of realizing either the proto-patient or prepositional role as a direct object in "double object" languages such as Kinyarwanda ([kimenyi 80]) — and to a lesser extent in English through "dative shift" — can be derived by weakening the P-PAT REAL. In syntactic ergative languages, where the subject is linked to the proto-patient role, the realization patterns in (4-132b-c) could be switched around. The "ergative" NP – the argument which realizes the proto-agent role — would be analyzed as direct object and the "absolutive" NP — the argument which realizes the proto-patient role — as subject (cf. [Schmerling 79], [Dowty 82a], [Dowty 87]). Alternatively, the ergative NP could be viewed as an oblique argument ([Wierzbicka 81], [Kiparsky 87], [Bresnan & Kanerva 88]). In this case, the ergative NP could be analyzed as an adjunct by assuming that proto-agent roles need not be syntactically realized. This is done by parametrizing ROLE ASSOCIATION in such a way that linking is not required of proto-agent roles, e.g.

(4-132) ROLE ASSOCIATION *ergative languages*
All syntactic arguments of a predicate must be linked to a unique role, and all entailed roles other than the proto-agent to a unique syntactic argument

The resulting analysis of ergative NPs would be similar to the analysis of subject/object phrases in Japanese as quasi-adjuncts (see above) and the treatment of passive and clitic dislocation which will be developed in chapters 5 and 7 (see [Sanfilippo in prep.]). ROLE ASSOCIATION is not operative in null anaphora languages such as Japanese where, according to the analysis presented above, subject and object phrases occur as quasi-adjuncts (e.g. they are not subcategorized).

At present, I shall assume that the three constraints in (4-129) are directly encoded in the template definitions of verbs. This can be done by establishing appropriate reentrancy relations between the thematic formulae of $\theta$-DOMs and the semantics of subcategorized NP signs in template definitions as indicated in (4-133) for transitive verbs (for ease of exposition, reference to morphosyntactic features is omitted).

(4-133) **LCT10** ***first version***

$$
@\mathrm{TV} \Rightarrow \left[\begin{array}{l}
@\mathrm{TV\_}\theta\text{-}\textsc{dom}, \\
\left[\begin{array}{lll}
\mathbf{phon} & = & \left[\begin{array}{lll}
\mathbf{ord} & = & \textsc{lc} \\
\mathbf{phon1} & = & \left[\begin{array}{lll}
\mathbf{ord} & = & \textsc{rc} \\
\mathbf{phon1} & = & [\,] \\
\mathbf{phon2} & = & \boxed{2}
\end{array}\right] \\
\mathbf{phon2} & = & \boxed{1}
\end{array}\right] \\
\mathbf{cat} & = & \left[\mathbf{catn} = \mathit{sent}\right] / \left[\begin{array}{lll}
\mathbf{phon} & = & \boxed{1} \\
\mathbf{catn} & = & \mathit{np} \\
\mathbf{sem} & = & \boxed{3}
\end{array}\right] / \left[\begin{array}{lll}
\mathbf{phon} & = & \boxed{2} \\
\mathbf{catn} & = & \mathit{np} \\
\mathbf{sem} & = & \boxed{4}
\end{array}\right] \\
\mathbf{sem} & = & \left[\begin{array}{lll}
\mathbf{ind} & = & \left[\begin{array}{lll}
\mathbf{var} & = & \boxed{5} \\
\theta\text{-}\mathbf{dom} & = & \left\langle \boxed{4}\left[\begin{array}{lll}
\mathbf{ind} & = & \boxed{5} \\
\mathbf{pred} & = & \mathit{p\text{-}pat} \\
\mathbf{arg1} & = & \boxed{5} \\
\mathbf{arg2} & = & \textsc{obj}
\end{array}\right] \circ \boxed{3}\left[\begin{array}{lll}
\mathbf{ind} & = & \boxed{5} \\
\mathbf{pred} & = & \mathit{p\text{-}agt} \\
\mathbf{arg1} & = & \boxed{5} \\
\mathbf{arg2} & = & \textsc{obj}
\end{array}\right] \right\rangle
\end{array}\right] \\
\mathbf{pred} & = & [\,] \\
\mathbf{arg1} & = & \boxed{5}\, e
\end{array}\right]
\end{array}\right]
\end{array}\right]
$$

This implementation provides a suitable characterization of argument selection; however, as I will argue in the next chapter, a more modular approach is needed to give a principled account of Relation Changing processes.

### Proto-Roles as Semantic Defaults

According to the definitions for role predicates presented above, the object sorts which determine proto-agent and proto-patient roles for each choice for verbs are always fully specified for the properties "volitional, sentient, moving, changing, affected, stationary".[17] This practice, however, preempts the possibility of treating proto-roles as semantic defaults. Consider, for example, the case of psychological predicates such as *please, worry, annoy, frighten, surprise,* etc. discussed in §2.3.2. As Dowty observes, the "experiencer" and "stimulus" arguments of these verbs have equal number of proto-agent properties, but may differ with respect to proto-patient properties in that the experiencer is understood as undergoing change when its governing verb is not stative. The attribution of the property "undergoing change of state" qualifies the experiencer as a better proto-patient. Consequently, the experiencer of such verbs is realized as object while the stimulus surfaces as subject. This realization pattern persists even when the verb is

[17]This follows from the inclusion of template definitions for $\theta$-DOMs in verb templates.

not understood as involving change of state. Therefore, the relevance of "change of state" with respect to argument selection in this case is its potential, rather the effective, occurrence. To conclude this chapter, I would like to suggest how the relevance of semantic defaults in the determination of proto-roles could be characterized in the UCG system presented in §4.2.

My suggestion relies on the introduction of non-monotonic inheritance. The need for a non-monotonic mode of inheritance has long been recognized within unification-based grammar frameworks as attested by the introduction of "constraint equations" in LFG ([Bresnan 82]), "priority unification" in FUG, "overwriting" in PATR-II ([Shieber 86]) and "default feature specifications" in GPSG ([Gazdar *et al.*]). Here, I will follow a recent proposal by [Bouma 90] where non-monotonic inheritance is implemented in terms of "default unification". According to Bouma, default unification is an operation which takes two feature structures as arguments, representing default and non-default information respectively. The resulting feature structure is subsumed by the non-default feature structure, but not necessarily by the default feature structure. This result is obtained by removing all default information which may lead to unification failure. The notion of default unification adopted in this thesis differs from Bouma's proposal in that it is defined only for atomic values and propositional formulae corresponding to sort descriptions. I will also allow default unification to operate on pairs of default values; in this case default unification will succeed only if the two default values are compatible, and the result will be a default value (i.e. the unification of the two defaults). (4-134) provide an informal characterization of this notion of default unification with respect to sorts (the default unification of atomic feature structures will be discussed in chapter 6).

(4-134) DEFAULT UNIFICATION (for sorts)

- a If $\alpha$ is a propositional constant or its negation, then $\{\text{DEF}, \alpha\}$ is a default sort specification.
- b If $A$ and $B$ are sorts and $a_1 \wedge, ..., \wedge a_n$, $b_1 \wedge, ..., \wedge b_n$ the formulae they define, then:

  $A \sqcap B = RID(a_1 \wedge, ..., \wedge a_n \wedge b_1 \wedge, ..., \wedge b_n)$ where $RID$ is an operation which for each pair $a_i, b_i$ of a formula, where $a_i$ is a propositional constant or its negation and $b_i$ a default sort specification, removes $b_i$ if $a_i \wedge b_i$ is inconsistent.

Default specifications can be used to define clusters of proto-role properties as well as to encode proto-role sorts in verbs signs. For example, the proto-patient sorts CHA and AFF relative to the experiencer role of verbs such as *please* will be encoded as default sorts:

(4-135) LIT3
please :

$$\left[\begin{array}{l} \text{@TV}, \\ \text{@TV\_}\theta\text{-DOM}, \\ \textbf{phon:phon1:phon1} = \textit{please}, \\ \textbf{sem:pred} = \textit{please}, \\ \textbf{sem:ind:}\theta\textbf{-dom} = \left\langle \begin{bmatrix} \textbf{ind} = \boxed{1} \\ \textbf{pred} = \textit{p-pat} \\ \textbf{arg1} = \boxed{1} \\ \textbf{arg2} = \begin{bmatrix} \{\text{DEF,CHA}\} \wedge \\ \{\text{DEF,AFF}\} \end{bmatrix} \end{bmatrix} \circ \begin{bmatrix} \textbf{ind} = \boxed{1} \\ \textbf{pred} = \textit{p-agt} \\ \textbf{arg1} = \boxed{1} \\ \textbf{arg2} = \begin{bmatrix} \neg\text{CHA} \wedge \\ \neg\text{AFF} \end{bmatrix} \end{bmatrix} \right\rangle \end{array}\right]$$

$\theta$-DOM templates can all be stated in terms of default sort specifications by encoding the sorts which forms clusters of proto-role properties as default sort specifications, e.g.

(4-136) SORT DEFINITIONS FOR CLUSTERS OF PROTO-ROLE PROPERTIES
a **SD14**: PAT1 $=_{def.}$ $\{\text{DEF,CHA}\} \wedge \{\text{DEF,AFF}\} \wedge \{\text{DEF,STA}\}$
b **SD15**: PAT2 $=_{def.}$ $\{\text{DEF,CHA}\} \wedge \{\text{DEF,AFF}\} \wedge \{\text{DEF,}\neg\text{STA}\}$
c **SD16**: PAT3 $=_{def.}$ $\{\text{DEF,}\neg\text{CHA}\} \wedge \{\text{DEF,AFF}\} \wedge \{\text{DEF,STA}\}$
d **SD17**: PAT4 $=_{def.}$ $\{\text{DEF,}\neg\text{CHA}\} \wedge \{\text{DEF,AFF}\} \wedge \{\text{DEF,}\neg\text{STA}\}$
e **SD18**: PAT5 $=_{def.}$ $\{\text{DEF,}\neg\text{CHA}\} \wedge \{\text{DEF,}\neg\text{AFF}\} \wedge \{\text{DEF,STA}\}$
f **SD19**: PAT6 $=_{def.}$ $\{\text{DEF,}\neg\text{CHA}\} \wedge \{\text{DEF,}\neg\text{AFF}\} \wedge \{\text{DEF,}\neg\text{STA}\}$

The operation of checking constraints on the $\theta$-DOM of individual verbs is carried out in two stages. First, a copy of the verb $\theta$-DOM is made where all proto-role sorts (or their negation) are encoded as default sort specifications, as shown in (4-137) for the verb template in (4-135).

$$(4\text{-}137) \quad \left\langle \begin{bmatrix} \textbf{ind} = \boxed{1} \\ \textbf{pred} = \textit{p-pat} \\ \textbf{arg1} = \boxed{1} \\ \textbf{arg2} = [\{\text{DEF.CHA}\} \wedge \{\text{DEF,AFF}\}] \end{bmatrix} \circ \begin{bmatrix} \textbf{ind} = \boxed{1} \\ \textbf{pred} = \textit{p-agt} \\ \textbf{arg1} = \boxed{1} \\ \textbf{arg2} = [\{\text{DEF,}\neg\text{CHA}\} \wedge \{\text{DEF,}\neg \mathit{AFF}\}] \end{bmatrix} \right\rangle$$

The resulting $\theta$-DOM is checked against the template for transitive $\theta$-DOMs where proto-role sorts are all encoded as default sort specifications as indicated in (4-136). This practice makes it possible to determine proto-roles on the basis of defaults. For example, the $\theta$-DOM for *please* in (4-137) meets the default constraints expressed by the template for transitive $\theta$-DOMs as the default proto-patient properties associated with the *p-pat* role are more than those associated with the *p-agt* role. However, the $\theta$-DOM in (4-138) will be rejected because the object argument of the *p-agt* role has more proto-patient properties than the object argument of the *p-pat* role, even though these values can potentially be changed through unification with non-default sort specifications. This is simply because, default sort specifications cannot overwrite each other.

$$(4\text{-}138)\quad \left\langle \begin{bmatrix} \textbf{ind} & = & \boxed{1} \\ \textbf{pred} & = & \textit{p-pat} \\ \textbf{arg1} & = & \boxed{1} \\ \textbf{arg2} & = & \left[\{\text{DEF}, \neg\text{CHA}\} \wedge \{\text{DEF}, \neg \mathit{AFF}\}\right] \end{bmatrix} \circ \begin{bmatrix} \textbf{ind} & = & \boxed{1} \\ \textbf{pred} & = & \textit{p-agt} \\ \textbf{arg1} & = & \boxed{1} \\ \textbf{arg2} & = & \{\text{DEF}, \text{CHA}\} \wedge \{\text{DEF}, \text{AFF}\} \end{bmatrix} \right\rangle$$

If the verb $\theta$-DOM is recognized as well-formed with respect to $\theta$-DOM constraints, the sort specifications which were changed into defaults are reassigned their original non-default specification. This is done by unifying the copy made out of the original $\theta$-DOM with the original $\theta$-DOM (e.g. the $\theta$-DOM of the verb template in (4-135) with the $\theta$-DOM in (4-137)).

## 4.4 Summary

The main purpose of this chapter was to show how a UCG specification of neo-Davidsonian verb semantics and predicate-argument association could be developed that provides an account of grammatical relations and argument selection (e.g. lexicalization of grammatical functions). As a way of concluding, I would like to highlight some of the basic notions underlying the approach developed in the chapter, and give a paramount idea of how these notions will be instrumental in shaping the orientation which will be pursued in the remaining chapters.

It is now generally recognized that the approach to verb semantics pioneered by [Parsons 80] provides a natural encoding of thematic information within a model-theoretic framework. The naturalness of such encoding results from the central role which thematic relations play with respect to the association of verbs and their grammatical arguments in the derivation of sentences. Within a Neo-Davidsonian specification of verb semantics, verbs denote properties of eventualities and thematic roles relations between eventualities and individuals. Thematic relations thus provide an indispensable layer of semantic interpretation to combine verb and noun phrase meanings into sentence meanings. However, as [Dowty 89] rightly observes, a conception of verb semantics and predicate-argument association of this type raises a number of questions with respect to how subcategorization and in particular the argument/adjunct distinction are to be encoded. In addition, given the unclear status of roles such as agent, goal, theme, etc., it would be desirable to replace traditional thematic taxonomies with a more reliable method of thematic classification. Ultimately, the viability of a neo-Davidsonian approach can be said to be crucially dependent on the possibility of providing:

- a specification of thematic assignment properties of verbs
- an adequate account of the distinction between arguments and adjuncts
- a method for deriving subcategorization from thematic assignment properties of verbs
- a reliable thematic classification

The attainment of these goals is necessary to capture generalization about argument selection and realization.

My point of departure was to adopt a conception of verb meaning where the thematic assignment properties of a verb could be derived from the set of necessary entailments of the verb within the model-theoretic approach to lexical meaning envisaged by Carlson. The basic idea underlying my proposal was that only those thematic entailments which contribute to maximizing lexical differentiation with the least deployment of definitions are chosen for inclusion within the thematic domain of a verb. My next step was to include the thematic domain of a verb within the index attribute of the UCG formula corresponding to the semantic representation of the verb. This practice was intended to give a twofold characterization of thematic entailments as:

- restrictions on the eventuality variable of the verbal predicate, and
- an indication of the possible extensions of the semantics of the verbs with which they are associated.

The association of a verb with its subject and object constituents is interpreted as a removal of thematic entailments which licenses sentence formation. The removal of thematic entailments is inherently ordered because the domain of thematic entailments of a verb is represented as an ordered sequence of formulae. In languages where subject and object phrases occur as arguments — rather than quasi-arguments as in Japanese — this ordering is reflected in the subcategorization frame through ROLE ASSOCIATION, PROTO-AGENT REALIZATION and PROTO-PATIENT REALIZATION. These three constraints enforce a regime of reentrancy between the semantics attribute of subcategorized signs and the sequence of formulae in the thematic domain of a verb which is equivalent to Dowty's account of grammatical relations ([Dowty 82a], [Dowty 82b]) and argument selection ([Dowty 87]). Generalizations concerning argument selection were captured by providing a unification-based specification of Dowty's prototype approach to thematic information within the neo-Davidsonian treatment of verb semantics developed throughout the chapter. In addition, I suggested that the characterization of proto-roles as semantic defaults could be attained by introducing a restricted mode of non-monotonic inheritance within the sort system.

# Chapter 5

# Argument Selection and Relation Changing: an Integrated Approach

The association of entailed roles with subcategorized positions provides an initial specification of grammatical relations. This initial specification may then be subject to modifications through relation changing operations. As was discussed in chapter 2, relation changing operations may involve either word or phrase formation processes. Current approaches to morphosyntax can be roughly classified in three categories according to whether they favour a syntactic approach ([Dowty 82a, Dowty 82b, Baker 88]), a lexicalist one ([Bresnan 82, Bresnan & Kanerva 88]), or a mixture of the two ([Williams 81a, Zubizarreta 85, Di Sciullo & Williams 87]). Our general criticism of these approaches was that the choice of level of linguistic description for morphosyntactic analysis they each promote is ultimately dictated by theory internal reasoning. In particular, none of these three approaches may justify the choice of level for morphosyntactic analysis on the basis of phonological properties of the input. In addition, we saw that several problems arise with respect to restrictions on morphosyntactic interactions. For example, it appears manifest that in the general case the problem of predicting which rule interactions are possible cannot be characterized in terms of levels of grammatical representations, contrary to the coanalysis approach pursued by Di Sciullo & Williams and Zubizarreta. This is simply because constraints on morphosyntactic interactions apply regardless of morphophonological considerations (i.e. whether the relation changing processes involved are carried out through word or phrase formation operations). Moreover, the attempt to give a syntactic characterization across morphosyntactic classes cannot provide a suitable solution to the problem. As was shown in chapter 2, attempts to do so (e.g. [Baker 88]) frameworks rely on a treatment of word formation which is hardly plausible both on psychological or computational grounds. Last but not least, none of these approaches incorporates a treatment of verb semantics where thematic information can be represented in a non-trivial manner. Admittedly, Dowty's Montagovian framework attempts to give a semantic characterization of thematic roles. Unfortunately, within the theory of predicate-argument association adopted by Dowty, thematic roles cannot be naturally represented "on-line", and ultimately may only be able to encode restrictions on morphosyntactic interactions through fairly baroque mechanisms (see §3.3.1).

In short, two basic questions are at stake here:

- At which level of grammatical representation should generalizations about relation changing rules be captured?
- How can these generalizations be stated in such a way that the semantic contribution of thematic information can be suitably incorporated?

The goal of this chapter is to show how the approach to grammatical relations, argument selection and thematic roles developed in the previous chapter yields a model of morphosyntactic processing which provides a natural answer to these questions. The basic idea which I will pursue in achieving this goal is to build a unified characterization of morphosyntactic processes which cuts across levels of grammatical representation, and where direct access to thematic information in semantic representation is possible at levels of both word and phrase formation. The chapter contains two major sections. In the first section, I will develop an approach to morphosyntactic processing where restrictions on GR-changing can be expressed in terms of argument selection principles. In the second section, I will show how the regime of constraints relative to this approach provides a natural characterization of morphosyntactic interactions.

## 5.1 A Sign-Based Approach to Morphosyntactic Processing

One of the most appealing features of a sign-based grammar formalism is that different kinds of linguistic information can be efficiently integrated in such a way that at any stage of a derivation, phonological, syntactic and semantic information can be easily accessed. We have already seen in the last chapter that simultaneous access to syntactic and semantic information is instrumental in modelling argument selection. Recall that the assignment of grammatical relations is obtained by establishing a one-to-one correspondence between subcategorized signs and thematic entailments. This correspondence is effectively established by interleaving subcategorization and thematic information in the category structure of verb signs. More precisely, the semantic attribute of each active sign in the category structure of a verb is assigned as value a distinct thematic entailment in such a way that the innermost active sign is linked to the proto-agent role, the next outer (if any) to the proto-patient, and the outermost (with ditransitives) to a prepositional role, as shown in (5-1) for the verb *sell.* This set of assignments leads to the following definitions for grammatical relations:

- the subject is the innermost active sign in the category structure of a verb
- the direct object is the next outer active sign in the category structure of a verb
- the indirect/oblique object is outermost active sign in the category structure of a verb which instantiates a prepositional predicate

(5-1)

$$\begin{bmatrix} \mathbf{cat} = \begin{bmatrix}\mathbf{catn} = \mathit{sent}\end{bmatrix} / \begin{bmatrix}\mathbf{catn} = \mathit{np} \\ \mathbf{sem} = \boxed{1}\end{bmatrix} / \begin{bmatrix}\mathbf{catn} = \mathit{np} \\ \mathbf{sem} = \boxed{2}\end{bmatrix} / \begin{bmatrix}\mathbf{catn} = \mathit{np} \\ \mathbf{sem} = \boxed{3}\end{bmatrix} \\ \mathbf{sem} = \begin{bmatrix} \mathbf{ind{:}\theta\text{-}dom} = \begin{bmatrix}\langle \boxed{3}\begin{bmatrix}\mathbf{pred} = \mathit{to}\end{bmatrix} \circ \boxed{2}\begin{bmatrix}\mathbf{pred} = \mathit{p\text{-}pat}\end{bmatrix} \circ \boxed{1}\begin{bmatrix}\mathbf{pred} = \mathit{p\text{-}agt}\end{bmatrix}\rangle\end{bmatrix} \\ \mathbf{pred} = \mathit{sell} \\ \mathbf{arg1} = \mathit{e} \end{bmatrix} \end{bmatrix}$$

The goal of this section is to show how morphosyntactic processing can be modelled through a small set of primitive operations which modify the initial assignment of grammatical relations. The basic idea which I am going to exploit in modelling morphosyntactic processing is that thematic information is as important for argument selection as it is for selection change. While this is certainly not a novel claim, the ways and means by which I intend to fashion the contribution of thematic information to GR-changing differ from those of previous approaches in some major regards. First of all, my account is going to rest on the assumption that the form and function of thematic information is intimately related to a formal characterization of verb semantics; consequently, my approach will have a robust semantic foundation. Secondly, the system presented so far allows syntactic and semantic information to be interleaved, and this makes it possible to check thematic information on-line at both the levels of word and phrase formation; access to thematic information is therefore going to be highly facilitated. An additional property of the approach which I will present is that restrictions on morphosyntactic rules can effectively be expressed in a totally declarative fashion alongside the argument selection constraints discussed in §4.3.

### 5.1.1 Argument Selection: A Modular Approach

So far the only morphosyntactic operations which we have encountered — ROLE ASSOCIATION, PROTO-AGENT ROLE REALIZATION and PROTO-PATIENT ROLE REALIZATION — concern argument selection. ROLE ASSOCIATION ($\theta$-ASSOC) establishes a biunique relation between syntactic arguments and thematic roles according to language-specific conventions.

(5-2) ROLE ASSOCIATION ($\theta$-ASSOC)
All syntactic arguments of a predicate must be linked to a unique role, and all roles to a unique syntactic argument (subject to parametric variation)

PROTO-AGENT ROLE REALIZATION (P-AGT REAL) and PROTO-PATIENT ROLE REALIZATION (P-PAT REAL) constrain the linking of roles to subcategorized arguments so that the ordering of role entailment as encoded in the $\theta$-DOM of a verb — i.e. *prep-role* < *p-pat* < *p-agt* — is reflected in the category structure of the verb.

(5-3) a PROTO-AGENT ROLE REALIZATION (P-AGT REAL)
If the Proto-Agent role of a predicate is syntactically realized, then it must be linked to innermost active sign in the category structure of a verb sign

b PROTO-PATIENT ROLE REALIZATION (P-PAT REAL)
If the Proto-Patient role of a predicate is syntactically realized, then it must be linked to the innermost subcategorized NP immediately following the active sign linked to the Proto-Agent, if there is one (subject to parametric variation)

In the previous chapter, I assumed that $\theta$-ASSOC, P-AGT REAL and P-PAT REAL are encoded in the template definitions of verbs by establishing appropriate reentrancy relations between the thematic formulae of $\theta$-DOMs and the semantics of subcategorized NP signs in template definitions, as indicated by the tags $\boxed{4}$, $\boxed{3}$ in the template for English transitive verbs below.

(5-4) LCT10 *first version*

$$
@\mathrm{TV} \Rightarrow \begin{bmatrix}
\text{@TV\_}\theta\text{-DOM}, & \\
\textbf{phon} = \boxed{1}{}^\frown[\,]^\frown\boxed{2} & \\
\textbf{cat} = \begin{bmatrix}\textbf{catn} = \textit{sent}\end{bmatrix} / \begin{bmatrix}\textbf{phon} = \boxed{1} \\ \textbf{catn} = \textit{np} \\ \textbf{sem} = \boxed{3}\end{bmatrix} / \begin{bmatrix}\textbf{phon} = \boxed{2} \\ \textbf{catn} = \textit{np} \\ \textbf{sem} = \boxed{4}\end{bmatrix} & \\
\textbf{sem} = \begin{bmatrix}
\textbf{ind} = \begin{bmatrix}
\textbf{var} = \boxed{5} \\
\theta\textbf{-dom} = \left\langle \boxed{4}\begin{bmatrix}\textbf{ind} = \boxed{5} \\ \textbf{pred} = \textit{p-pat} \\ \textbf{arg1} = \boxed{5} \\ \textbf{arg2} = \text{OBJ}\end{bmatrix} \circ \boxed{3}\begin{bmatrix}\textbf{ind} = \boxed{5} \\ \textbf{pred} = \textit{p-agt} \\ \textbf{arg1} = \boxed{5} \\ \textbf{arg2} = \text{OBJ}\end{bmatrix} \right\rangle
\end{bmatrix} \\
\textbf{pred} = [\,] \\
\textbf{arg1} = \boxed{5}\,e
\end{bmatrix} &
\end{bmatrix}
$$

According to this encoding, constraints on argument selection are effectively merged into a single set of reentrancies, although notionally they are conceptualized as distinct constraints. As long as no other constraints on the syntactic realization of roles are considered, this is a desirable practice to follow since $\theta$-ASSOC, P-AGT REAL and P-PAT REAL yield a single configuration for each verb template. For example, the relations of structure sharing between the subcategorized NP signs and thematic entailments of the template definition in (5-4) are the only ones permitted by $\theta$-ASSOC, P-AGT REAL and P-PAT REAL for transitive verbs. The set of reentrancies relative to these relations of structure sharing can thus be fixed once for all in the template.

When we take into account GR-changing, however, this encoding of argument selection constraints is far too simplistic. Consider for example the passivization of transitive verbs. Because the realization of the p-agt and p-pat roles is already fully specified in the template for transitive verbs, as shown in (5-4), passive must be formalized as an operation which destructively changes the initial assignment of grammatical relations. There are at least two reasons to avoid such a treatment. First, an analysis of GR-change which is based on non-monotonic operations is not in keeping with the general spirit of unification grammar, according to which grammatical processes are most naturally characterized as information-preserving operations. Second, a non-monotonic treatment of morphosyntactic processes is hard to constrain and is thus unsuitable to provide an explanatory account. A first element of arbitrariness, for example, derives from the fact that within a non-monotonic treatment of GR changing the initial assignment of grammatical relations is defeasible. Therefore, constraints on morphosyntactic rules have to be stated independently of argument selection principles. A second element of arbitrariness is induced by the possibility of subjecting each assignment of grammatical relations resulting from GR-changing to yet another morphosyntactic rule, as in the case of rule interactions. Because a priori any assignment of grammatical relations is defeasible, whether emerging from argument selection or through GR-changing, there is no way of providing a natural characterization of the range of possible morphosyntactic operations which are found across languages.

I think that within a unification-based approach, it is best to regard morphosyntactic rules as operations which add constraints on argument selection in a declarative fashion, rather than as destructive operations which reset fully specified configurations of grammatical relations (e.g. as induced by $\theta$-ASSOC, P-AGT REAL and P-PAT REAL).[1] Within an approach of this kind, restrictions on morphosyntactic rules follow from the interaction of functional specifications introduced by morphosyntactic rules with argument selection principles (i.e. $\theta$-ASSOC, P-AGT REAL and P-PAT REAL).[2] Because this interaction is information-preserving — i.e. it is realized through unification — no independent constraints on GR changing are needed aside from argument selection principles and the

[1]This approach is germane in spirit to the Lexical Mapping Theory of LFG, see §2.2.

[2]In languages such as Japanese where $\theta$-ASSOC is not operative — i.e. thematic entailments are not linked to subcategorized signs in the category structure of verbs according to the approach described in §4 3 — GR-changing can be characterized in terms of operations which modify the order of thematic entailments in the $\theta$-DOM of verbs, where necessary. Alternatively, GR-changing rules could be formalized as operations which introduce subcategorized arguments and link them to a thematic entailment. For example, passive could be formulated as an operation which introduces a subcategorized NP sign in the category structure of the verb and links it to the proto-patient role.

functional specifications introduced by morphosyntactic rules. In other words, the syntactic realization of thematic roles is determined by the incremental accretion of linking specifications contributed by argument selection constraints and morphosyntactic rules. Most importantly, the range of admissible morphosyntactic rules can be defined as the set of GR-changing operations which are compatible with the instantiations specified by argument selection constraints. Let us see how such an approach can be integrated with the UCG framework developed in chapter 4.

To begin with, I will encode argument selection constraints as distinct templates. The $\theta$-ASSOC template for (English) transitive verbs in (5-5) provides a first example of this approach. According to (5-2), $\theta$-ASSOC states that there is a one-to-one relationship between thematic entailments and subcategorized sign, but does not specify which subcategorized sign is linked to which role. This partial characterization is reflected in (5-5) where the category attribute of a transitive verb sign which obeys $\theta$-ASSOC is defined as a disjunction of two category structures: in the first disjunct, the subject (i.e. the innermost active sign in the category structure of the verb) is linked to the p-agt role and the object (the outermost active sign) to the p-pat role; in the second disjunct, the inverse linking configuration obtains.

(5-5) **LCT11**

@TV_$\theta$-ASSOC$\Rightarrow$

$$\left[\begin{array}{l} \mathbf{cat} = \left[\begin{array}{l} [\mathbf{catn} = \mathit{sent}] \Big/ \left[\begin{array}{l}\mathbf{catn} = \mathit{np}\\ \mathbf{sem} = \boxed{1}\end{array}\right] \Big/ \left[\begin{array}{l}\mathbf{catn} = \mathit{np}\\ \mathbf{sem} = \boxed{2}\end{array}\right] \sqcup \\ \\ [\mathbf{catn} = \mathit{sent}] \Big/ \left[\begin{array}{l}\mathbf{catn} = \mathit{np}\\ \mathbf{sem} = \boxed{2}\end{array}\right] \Big/ \left[\begin{array}{l}\mathbf{catn} = \mathit{np}\\ \mathbf{sem} = \boxed{1}\end{array}\right] \end{array}\right] \\ \\ \mathbf{sem{:}ind{:}}\theta\mathbf{\text{-}dom} = \left\langle \boxed{2}\,[\mathbf{pred} = \mathit{p\text{-}agt}] \circ \boxed{1}\,[\mathbf{pred} = \mathit{p\text{-}agt}] \right\rangle \end{array}\right]$$

P-AGT REAL and P-PAT REAL are encoded as templates which impose further constraints on linking. The P-AGT REAL template states that the p-agt cannot be lexicalized as object or indirect/oblique object,[3] and the P-PAT REAL template rules out the syntactic realization of the p-pat role as indirect/oblique object, as shown in (5-6) where the template definitions below are introduced to simplify notation.

[3] As will be discussed later, passive *by*-phrases are treated as syntactic adjuncts.

- $@\textsc{p-agt} \Rightarrow \begin{bmatrix} \textbf{ind} & = & \boxed{1} \\ \textbf{pred} & = & \textit{p-agt} \\ \textbf{arg1} & = & \boxed{1} \\ \textbf{arg2} & = & \textsc{obj} \end{bmatrix}$

- $@\textsc{p-pat} \Rightarrow \begin{bmatrix} \textbf{ind} & = & \boxed{1} \\ \textbf{pred} & = & \textit{p-pat} \\ \textbf{arg1} & = & \boxed{1} \\ \textbf{arg2} & = & \textsc{obj} \end{bmatrix}$

(5-6) **LCT12**

$$@\textsc{p-agt real} \Rightarrow$$
$$\left[\left[\textbf{cat} = \begin{bmatrix} [\textbf{catn} = \textit{sent}] / \begin{bmatrix}\textbf{catn} = \textit{np} \\ \textbf{sem} = [\,]\end{bmatrix} / \begin{bmatrix}\textbf{catn} = \textit{np} \\ \textbf{sem} = @\textsc{p-agt}\end{bmatrix} \sqcup \\ [\textbf{catn} = \textit{sent}] / \begin{bmatrix}\textbf{catn} = \textit{np} \\ \textbf{sem} = [\,]\end{bmatrix} / \begin{bmatrix}\textbf{catn} = \textit{np} \\ \textbf{sem} = @\textsc{p-agt}\end{bmatrix} / \begin{bmatrix}\textbf{catn} = \textit{np} \\ \textbf{sem} = [\,]\end{bmatrix} \sqcup \\ [\textbf{catn} = \textit{sent}] / \begin{bmatrix}\textbf{catn} = \textit{np} \\ \textbf{sem} = [\,]\end{bmatrix} / \begin{bmatrix}\textbf{catn} = \textit{np} \\ \textbf{sem} = [\,]\end{bmatrix} / \begin{bmatrix}\textbf{catn} = \textit{np} \\ \textbf{sem} = @\textsc{p-agt}\end{bmatrix} \end{bmatrix}\right] \Rightarrow \bot\right]$$

(5-7) **LCT13**

$$@\textsc{p-pat real} \Rightarrow$$
$$\left[\left[[\textbf{catn} = \textit{sent}] / \begin{bmatrix}\textbf{catn} = \textit{np} \\ \textbf{sem} = [\,]\end{bmatrix} / \begin{bmatrix}\textbf{catn} = \textit{np} \\ \textbf{sem} = [\,]\end{bmatrix} / \begin{bmatrix}\textbf{catn} = \textit{np} \\ \textbf{sem} = @\textsc{p-pat}\end{bmatrix}\right] \Rightarrow \bot\right]$$

For example, in absence of additional linking specifications — i.e. constraints induced by GR-changing rules — one of the two category structures specified by $\theta$-ASSOC for transitive verbs, i.e. the one where the p-agt role is linked to the direct object in (5-5), is filtered out through the constraints enforced by the P-AGT REAL template in (5-6). The diagram below gives an informal characterization of this process. The first entry in (5-8) shows the sign structure which $\theta$-ASSOC yields for transitive verbs; subsequent entries indicate the result of incrementally incorporating further argument selection constraints into this structure.

$$\text{(5-8)}\quad \theta\text{-ASSOC}\quad \begin{bmatrix} \mathbf{cat} = \begin{bmatrix} \begin{bmatrix}\mathbf{catn} = \textit{sent}\end{bmatrix} / \begin{bmatrix}\mathbf{catn} = \textit{np} \\ \mathbf{sem} = @\text{P-AGT}\end{bmatrix} / \begin{bmatrix}\mathbf{catn} = \textit{np} \\ \mathbf{sem} = @\text{P-PAT}\end{bmatrix} \sqcup \\ \begin{bmatrix}\mathbf{catn} = \textit{sent}\end{bmatrix} / \begin{bmatrix}\mathbf{catn} = \textit{np} \\ \mathbf{sem} = @\text{P-PAT}\end{bmatrix} / \begin{bmatrix}\mathbf{catn} = \textit{np} \\ \mathbf{sem} = @\text{P-AGT}\end{bmatrix} \end{bmatrix} \end{bmatrix}$$

$$\text{P-AGT REAL}\quad \begin{bmatrix} \mathbf{cat} = \begin{bmatrix}\mathbf{catn} = \textit{sent}\end{bmatrix} / \begin{bmatrix}\mathbf{catn} = \textit{np} \\ \mathbf{sem} = @\text{P-AGT}\end{bmatrix} / \begin{bmatrix}\mathbf{catn} = \textit{np} \\ \mathbf{sem} = @\text{P-PAT}\end{bmatrix} \end{bmatrix}$$

P-PAT REAL (same as above)

This more modular approach to argument selection is realized by encoding P-AGT REAL and *p-pat* in lexical rules, and $\theta$-ASSOC in verb templates. The template for transitive verbs shown earlier in (4-131) and (5-4), for example, is now reformulated by removing all linking specifications relative to P-AGT REAL and P-PAT REAL, as shown in (5-9) where the set notation is used as an abbreviation for the disjunction of category structures in (5-5).

(5-9) LCT10 *final version*

$$@\text{TV} \Rightarrow \begin{bmatrix} @\text{TV\_}\theta\text{-DOM}, \\ \mathbf{phon} = \boxed{1}{}^\frown[\,]^\frown\boxed{2} \\ \mathbf{cat} = \begin{bmatrix}\mathbf{catn} = \textit{sent}\end{bmatrix} / \left\{ \begin{bmatrix}\mathbf{phon} = \boxed{1} \\ \mathbf{catn} = \textit{np} \\ \mathbf{sem} = \boxed{3}\end{bmatrix}, \begin{bmatrix}\mathbf{phon} = \boxed{2} \\ \mathbf{catn} = \textit{np} \\ \mathbf{sem} = \boxed{4}\end{bmatrix} \right\} \\ \mathbf{sem} = \begin{bmatrix} \mathbf{ind} = \begin{bmatrix}\mathbf{var} = \boxed{5} \\ \theta\text{-}\mathbf{dom} = \langle \boxed{4} \circ \boxed{3} \rangle\end{bmatrix} \\ \mathbf{pred} = [\,] \\ \mathbf{arg1} = \boxed{5}\,e \end{bmatrix} \end{bmatrix}$$

The P-AGT REAL and P-PAT REAL templates are encoded as well-formedness constraints on lexical rules which take verb signs as input and give as output verb signs whose category structure is well-formed with respect to role realization constraints. After a verb is processed through a lexical rule, a copy of the resulting verb sign is passed as input to yet another lexical rule (where possible) and a second copy is matched against *Realization Constraint Templates* which check the category structure of the sign for compatibility with the P-AGT REAL and P-PAT REAL:

Verb, Lexical Rule → Verbl

Verbl, Lexical Rulel → Verb2 | Verbl, *Real. Constr. Temp.* → Verbl

... | Verb2, *Real. Constr. Temp.* → Verb2

*Realization Constraint Templates* are structured in the form of lexical rules, as shown below for verbs which take NP complements.[4]

(5-10)

rule = REALIZATION CONSTRAINT TEMPLATE

$$\texttt{in} = \left[\ \texttt{cat} = \boxed{1}\left[\begin{array}{l}[\texttt{catn} = \textit{sent}]/[\texttt{catn} = \textit{np}] \sqcup \\ [\texttt{catn} = \textit{sent}]/[\texttt{catn} = \textit{np}]/[\texttt{catn} = \textit{np}] \sqcup \\ [\texttt{catn} = \textit{sent}]/[\texttt{catn} = \textit{np}]/[\texttt{catn} = \textit{np}]/[\texttt{catn} = \textit{np}]\end{array}\right]\ \right]$$

$$\texttt{out} = \left[\begin{array}{l}\text{@P-AGT REAL,} \\ \text{@P-PAT REAL,} \\ \texttt{cat} = \boxed{1}\end{array}\right]$$

With respect to the category structure of verbs, GR-changing rules are encoded as linking constraints on $\theta$-ASSOC. These constraints are implemented in the form of information-preserving operations which take as input the sign structures generated by verb templates or other lexical rules. Because verb templates encode $\theta$-ASSOC constraints, it follows that only operations whose input is compatible with the output of $\theta$-ASSOC are allowed. Each operation, as well as any set of compatible operations, can forms a lexical rule as long as its output is well-formed according to role realization constraints, i.e. as encoded by *Realization Constraint Templates*. Consequently, the range of operations allowed is restricted to those which are compatible with argument selection principles: $\theta$-ASSOC as well as P-AGT REAL and P-PAT REAL.

[4]Additional Realization Constrain Templates are needed for verbs which take VP complements, where the P-AGT REAL and P-PAT REAL are also to be checked to the category structure of the subcategorized VP sign.

**Argument Satisfaction and $\theta$-Entailment Closure**

**Passive: P-Agt Argument Satisfaction** Within the approach to GR-changing rules sketched above, passive can be formalized in terms of an operation which satisfies the outermost syntactic argument of verbs which is linked to a p-agt role.

(5-11) **rule** = PASSIVE *generalized version*

$$\textbf{in} = \left[ \textbf{cat} = \boxed{1} \Big/ \begin{bmatrix} \textbf{catn} = np \\ \textbf{sem} = @\text{P-AGT} \end{bmatrix} \right]$$

$$\textbf{out} = \left[ \textbf{cat} = \boxed{1} \right]$$

As for all GR-changing rules, this operation succeeds only if the output is well-formed according to *Realization Constraint Templates*, e.g. (5-10). The operation which leads to the satisfaction of the p-agt argument in the passive rule above constrains $\theta$-ASSOC in two major ways. First, it restricts the range of input category structures, as specified by $\theta$-ASSOC, to those where the p-agt role is linked to the outermost active sign. Second, it reduces the valency of the input category structure through satisfaction of the subcategorized sign which is linked to the the p-agt role. Given the transitive verb sign induced by $\theta$-ASSOC in (5-5) as input to the passive rule in (5-11), for example, the result of p-agt argument satisfaction is the sign in (5-12) where the p-pat role is lexicalized as subject. This role realization is well-formed according to argument selection constraints since P-AGT REAL and P-PAT REAL allow the proto-patient to be lexicalized as subject as long as the proto-agent is syntactically unexpressed.

(5-12) $$\left[ \textbf{cat} = \left[ \textbf{catn} = sent \right] \Big/ \begin{bmatrix} \textbf{catn} = np \\ \textbf{sem} = @\text{P-PAT} \end{bmatrix} \right]$$

In other words, passive can be viewed as a complex operation which

- eliminates the argument selection choices induced by $\theta$-ASSOC where the p-agt is realized as subject, e.g.
  $\textbf{cat} = \left[ \textbf{catn} = sent \right] \Big/ \begin{bmatrix} \textbf{catn} = np \\ \textbf{sem} = @\text{P-AGT} \end{bmatrix} \Big/ \begin{bmatrix} \textbf{catn} = np \\ \textbf{sem} = @\text{P-PAT} \end{bmatrix}$ (cf. (5-5))
- "rescues" the argument selection choice induced by $\theta$-ASSOC where the p-pat is lexicalized as subject (e.g. the second disjunct in the category attribute of the sign in (5-5)) by "delinking" the p-agt role.

Additional operations on the category and phonology of the input sign include the introduction of passive morphology and the morphosyntactic feature "pas" (short for "passive"), removal of the phonology of the initial subject, and reordering of the verb phonology. A detailed version of the passive rule in (5-11) is given below; the rule is meant for English transitive verbs as input, but could easily be generalized to ditransitives and extended to other languages by underspecifying word order information.

(5-13)

$$\mathtt{rule} = \textsc{passive}\ \textit{English}$$

$$\mathtt{in} = \begin{bmatrix} \mathtt{phon} = \boxed{1}\frown\boxed{2}\frown\boxed{3} \\ \mathtt{cat} = \begin{bmatrix} \mathtt{name} = \textit{sent} \\ \mathtt{feats} = \begin{bmatrix} \mathtt{voice} = \boxed{4} \end{bmatrix} \end{bmatrix} \Big/ \begin{bmatrix} \mathtt{phon} = \boxed{3} \\ \mathtt{catn} = \textit{np} \\ \mathtt{sem} = @\text{P-PAT} \end{bmatrix} \Big/ \begin{bmatrix} \mathtt{phon} = \boxed{1} \\ \mathtt{catn} = \textit{np} \\ \mathtt{sem} = @\text{P-AGT} \end{bmatrix} \\ \mathtt{sem} = \boxed{5} \end{bmatrix}$$

$$\mathtt{out} = \begin{bmatrix} \mathtt{phon} = \boxed{3}\frown\textit{passive}(\boxed{2}) \\ \mathtt{cat} = \begin{bmatrix} \mathtt{name} = \textit{sent} \\ \mathtt{feats} = \begin{bmatrix} \mathtt{voice} = \boxed{4}\textit{pas} \end{bmatrix} \end{bmatrix} \Big/ \begin{bmatrix} \mathtt{phon} = \boxed{3} \\ \mathtt{catn} = \textit{np} \\ \mathtt{sem} = @\text{P-PAT} \end{bmatrix} \\ \mathtt{sem} = \boxed{5} \end{bmatrix}$$

According to this treatment of passive, the proto-agent role which is de-linked through argument satisfaction is still encoded in the $\theta$-DOM of the verb in the form of an "undischarged" thematic entailment, as shown in (5-14) for the passive verb *eaten*.

(5-14) PASSIVE VERB

$$\begin{bmatrix} \mathtt{phon} = \boxed{1}\frown\textit{eaten} \\ \mathtt{cat} = \begin{bmatrix} \mathtt{name} = \textit{sent} \\ \mathtt{feats} = \begin{bmatrix} \mathtt{voice} = \textit{pas} \end{bmatrix} \end{bmatrix} \Big/ \begin{bmatrix} \mathtt{phon} = \boxed{1} \\ \mathtt{catn} = \textit{np} \\ \mathtt{sem} = \boxed{2} \end{bmatrix} \\ \mathtt{sem} = \begin{bmatrix} \mathtt{ind{:}}\theta\mathtt{\text{-}dom} = \langle \boxed{2}@\text{P-PAT} \circ @\text{P-AGT} \rangle \\ \mathtt{pred} = \textit{eat} \\ \mathtt{arg1} = \textit{e} \end{bmatrix} \end{bmatrix}$$

Following [Bresnan 78, Jackendoff 87, Grimshaw 88, Bresnan & Moshi 89], I will assume that the proto-agent role of passive verbs is expressed as an optional, thematically bound adjunct. This analysis is motivated by the fact that the agent phrase which realizes the p-agt role of passive verbs exhibits syntactic properties which are akin to those of adjuncts. Optionality is perhaps the most perspicuous property of agent phrases which points towards this direction, but more subtle arguments can be found. Consider the following example from Italian concerning control of infinitival adjuncts.

It is well known that the controller of "Consecutive *da* + Infinitive" adjunct clauses in Italian coincides, in most cases, with the subject of the matrix verb ([Perlmutter 84]), e.g.

| | | | | | |
|---|---|---|---|---|---|
| (5-15) | a | Giorgio | ha rimproverato | Maria | tante volte |
| | | Giorgio | has scolded | Maria | so many times |

*da sentirsi in colpa*
so as to feel guilty
"Giorgio scolded Maria so many times that $\left\{\begin{array}{c}\textbf{he}\\ \textbf{*she}\end{array}\right\}$ felt guilty"

| | | | | | |
|---|---|---|---|---|---|
| | b | Giorgio | ha telefonato | a Maria | tante volte |
| | | Giorgio | has telephoned | to Maria | so many times |

*da arrabbiarsi*
so as to anger-self
"Giorgio phoned Maria so many times that $\left\{\begin{array}{c}\textbf{he}\\ \textbf{*she}\end{array}\right\}$ got angry"

However, this control pattern is inverted with verbs such as *piacere* "please" where the indirect object controls the adjunct infinitive:

| | | | | | |
|---|---|---|---|---|---|
| (5-16) | a | A Carlo | Maria | piace | *da impazzire* |
| | | To Carlo | Maria | is pleasing | so as to go crazy |

Maria pleases Carlo so much that $\left\{\begin{array}{c}\textbf{he}\\ \textbf{*she}\end{array}\right\}$ could go crazy

The possibility of a control shift in this case can be related to the fact that the experiencer argument of psychological verbs is generally the most prominent role with respect to anaphoric relations, as discussed in §3.1.[5] This strongly suggests that control of consecutive *da*+infinitive adjunct clauses is thematically governed.[6] On the assumption that the agent phrase of passive constructions is an argument, we would thus expect the passive version of the sentence in (5-15b) to maintain the same control pattern. As (5-17) shows, however, this is not so: the agent phrase may not control the adjunct infinitive.

| | | | | | |
|---|---|---|---|---|---|
| (5-17) | Maria | fu rimproverata | da Giorgio | tante volte | *da sentirsi in colpa* |
| | Maria | was scolded | by Giorgio | so many times | so as to feel guilty |

"Giorgio scolded Maria so many times that $\left\{\begin{array}{c}\text{she}\\ \text{*he}\end{array}\right\}$ felt guilty"

By contrast, the controller shift in (5-17) is unproblemetic if the agent phrase is analyzed as an adjunct; adjunct phrases may not act as controllers in consecutive *da*+infinitive constructions, e.g.

[5] Note, however, that the controller shift induced by *piacere* in consecutive *da* + Infinitive constructions cannot be stated simply in terms of the role experiencer, as in the anaphora cases discussed in §3.1. Further qualifications are needed since no controller shift is possible with psychological verbs such as *preoccupare*, as shown in (i) where the object NP cannot control the adjunct infinitive even though it realizes an experiencer role.

| | | | | | |
|---|---|---|---|---|---|
| (i) | *Le difficoltà finanziarie | preoccupavano | tanto | Mario | *da ammalarsi* |
| | the financial difficulties | preoccupied | so much | Mario | to get himself sick |

A semantic factor which is responsible for the contrast between *piacere* and *preoccupare* is the possibility of attributing volitionality to the stimulus argument (see [Zaenen 89] for a similar contrast in Dutch). The verb *piacere*, for example, may not entail volitionality for their stimulus argument: the Italian sentence in (ii) cannot be used to describe a situation in which Maria intentionally does something to please Carlo.

| | | | |
|---|---|---|---|
| (ii) | A Carlo | Maria | piace |
| | to Carlo | Maria | is-pleasing |
| | "Carlo likes Maria" | | |

The stimulus argument of *preoccupare*, on the other hand, can be volitional: (iii) can in fact be used to describe a situation in which Carlo intentionally does something to amuse/worry his parents.

(iii) Carlo diverte/preoccupa i genitori
"Carlo amuses/worries his parents"

[6] A different view is held by [Perlmutter 84] who proposes that the controller in "consecutive *da* + Infinitive" constructions must be a "working 1", i.e. a *term* relation (initial/final subject and direct/indirect object) which is also an initial subject. Perlmutter's account is purely syntactic since it relies on the assumption that the syntactic functionality of arguments is independent of semantic factors. However, notice that the determination of which argument of a verb qualifies as working 1 is verb-specific and would therefore be best characterized according to semantic criteria. For example, the contrast between (5-15b) and (5-16) implies that *piacere* and *telefonare* differ with respect to their indirect object argument position. This contrast is a fact of lexical semantics, regardless of what we make of it in syntactic terms.

| | | | | |
|---|---|---|---|---|
| (5-18) | La moglie di Giorgio | ha telefonato | a Maria | tante volte |
| | the wife of Giorgio | has telephoned | to Maria | so many times |
| | *da arrabbiarsi* | | | |
| | so as to anger-self | | | |

"Giorgio$_i$'s wife$_j$ phoned Maria so many times that $\left\{\begin{matrix}\textbf{she}_j \\ {}^*\textbf{he}_i\end{matrix}\right\}$ got angry"

The analysis of the agent phrase as a thematically bound adjunct is akin in spirit to the treatment of Japanese subject and object phrases as quasi-adjuncts described in §4.3. Such a treatment allows us to establish thematic boundedness independently of subcategorization through instantiation and removal of thematic entailments driven by an adjunction mode of syntactic combination. According to this approach, the agent phrase can be structured as a VP modifier — e.g. $(S/NP)/S/NP$ — which saturates the proto-agent entailment of the (passive) verb with which it combines. As in the case of subject and object quasi-adjuncts, this process involves two crucial operations: removal of the proto-agent entailment from the thematic domain of the verb, and integration of the removed entailment with the semantics of the verb. The tree structure below provides an informal characterization of the process as a whole for the passive VP *was hit by John*.

$$\Big[[e_1 :< p\text{-}pat(e_1, X_1) >][hit(e_1) \wedge p\text{-}agt(e, john)]\Big]_{S/NP}$$

$$\Big[[e_1 :< \Theta_1 >][A_1 \wedge p\text{-}agt(e_1, john)]\Big]_{S/NP} \Big/ \Big[[e_1 :< \Theta_1 \circ p\text{-}agt(e_1, john) >]A_1\Big]_{S/NP}$$

$$\Big[[e_1 :< p\text{-}pat(e_1, X_2) \circ p\text{-}agt(e_1, X_1) >]hit(e_1)\Big]_{S/NP}$$

$$\Big[[e_1 :< p\text{-}pat(e_1, X_2) \circ p\text{-}agt(e_1, X_1) >]hit(e_1)\Big]_{S/NP/NP}$$

A detailed characterization of the agent phrase is given in (5-19) for the English *by*-phrase *by John*; as in previous examples, boxes and upper case subscripts are used to flesh out the major component of the sign.

(5-19)

AGENT *by*-PHRASE

$$
\begin{bmatrix}
\textbf{phon} = \boxed{1}\frown by \frown John \\
\textbf{cat} = \boxed{8} / \underbrace{\boxed{\begin{bmatrix}
\textbf{phon} = \boxed{1}\begin{bmatrix} \textbf{ord} = \mathrm{LC} \\ \textbf{phon1} = [\,] \\ \textbf{phon2} = \boxed{2} \end{bmatrix} \\
\textbf{cat} = \boxed{8}\begin{bmatrix} \textbf{catn} = sent \end{bmatrix} / \begin{bmatrix} \textbf{phon} = \boxed{2} \\ \textbf{catn} = np \\ \textbf{sem} = \boxed{5} \end{bmatrix} \\
\textbf{sem} = \begin{bmatrix} \textbf{ind} = \begin{bmatrix} \textbf{var} = \boxed{4} \\ \theta\textbf{-dom} = \left\langle \boxed{5} \circ \boxed{3} @\mathrm{P\text{-}AGT} \right\rangle \end{bmatrix} \\ \textbf{pred} = \boxed{6} \\ \textbf{args} = \boxed{7} \end{bmatrix}
\end{bmatrix}}}_{\mathrm{A}} \\
\textbf{sem} = \begin{bmatrix}
\textbf{ind} = \begin{bmatrix} \textbf{var} = \boxed{4} \\ \theta\textbf{-dom} = \langle \boxed{5} \rangle \end{bmatrix} \\
\textbf{pred} = and \\
\textbf{arg1} = \underbrace{\boxed{\begin{bmatrix} \textbf{ind} = \boxed{4} \\ \textbf{pred} = \boxed{6} \\ \textbf{args} = \boxed{7} \end{bmatrix}}}_{\mathrm{B}} \\
\textbf{arg2} = \boxed{3}\begin{bmatrix} \textbf{ind} = \boxed{4} \\ \textbf{pred} = p\text{-}agt \\ \textbf{arg1} = \boxed{4} \\ \textbf{arg2} = john \end{bmatrix}
\end{bmatrix}
\end{bmatrix}
$$

A = Argument verb phrase
$\boxed{3}$ = Thematic formula introduced by the agent phrase
B = Semantics of argument verb phrase

The combination of agent phrases and passive verbs proceeds through functional application, as usual. The result of combining the agent phrase in (5-19) with the passive verb in (5-15), for example, will be the verb phrase sign in (5-20)

$$
(5\text{-}20)\quad
\begin{bmatrix}
\textbf{phon} = \boxed{2}{}^\frown \textit{eaten}{}^\frown \textit{by}{}^\frown \textit{John} \\
\textbf{cat} = \begin{bmatrix}\textbf{catn} = \textit{sent}\end{bmatrix} \Big/ \begin{bmatrix}\textbf{phon} = \boxed{2} \\ \textbf{catn} = \textit{np} \\ \textbf{sem} = \boxed{5}\end{bmatrix} \\
\textbf{sem} = \begin{bmatrix}
\textbf{ind} = \begin{bmatrix}\textbf{var} = \boxed{4} \\ \theta\textbf{-dom} = \langle \boxed{5}@\textsc{p-pat} \rangle\end{bmatrix} \\
\textbf{pred} = \textit{and} \\
\textbf{arg1} = \begin{bmatrix}\textbf{ind} = \boxed{4} \\ \textbf{pred} = \textit{eat} \\ \textbf{args} = \boxed{4}\end{bmatrix} \\
\textbf{arg2} = \begin{bmatrix}\textbf{ind} = \boxed{4} \\ \textbf{pred} = \textit{p-agt} \\ \textbf{arg1} = \boxed{4} \\ \textbf{arg2} = \textit{john}\end{bmatrix}
\end{bmatrix}
\end{bmatrix}
$$

Since the thematic dependency between the passive verb and the by-phrase can be established without having to rely on subcategorization, the assumption that there are two passive rules — i.e. agentive and agentless passive — can be dispensed with. Such an assumption is only needed if the agent phrase is analyzed as a subcategorized argument. It should also be pointed out that this treatment induces a simplification of argument selection principles. According to Dowty, for example, the fact that the agent phrase is always understood as expressing the role encoded by the initial subject means that a proto-agent role can be syntactically realized as an oblique argument. Our treatment of the agent phrase as a thematically bound adjunct allows us to dispense with such a conclusion. It is therefore possible to maintain that whenever the proto-agent role is realized as a subcategorized argument it can only be subject.

**Middle/Inchoative Formation: P-Agt Argument Satisfaction and $\theta$-Entailment Closure** The operation of p-agt argument satisfaction discussed above is also instrumental in giving an account of middle/inchoative formation. The basic difference between passive and middle/inchoative formation is that with middles and inchoatives removal of the p-agt argument from the category structure of the verb is associated with "closure" of the p-agt entailment. By closure, I mean that the thematic entailment in question is bound to a constant (e.g. existentially quantified) in such a way that it becomes syntactically inexpressible. A few words of clarification at this point are in order. The practice suggested here to express both middle and inchoative formation in terms of closure of the p-agt entailment contrasts with the accounts of [Fiengo 80, Keyser & Roeper 84] and others where it is held that middles differ from inchoatives in having an implied but unexpressed agent. For example, [Fiengo 80] makes the following observations:

> ...in middles and passives there is a subject either stated or implied; in "the car was sold" it is implied that there was an agent of the sale, and in "foreign cars sell easily" the same is true. The sentences "the milk spilled" and "the milk was spilled", or "the tomato ripened" and "the tomato was ripened" seem to contrast in this respect, the "intransitives" implying no agent.

I think that the contrast which Fiengo is alluding to is essentially orthogonal to the middle-inchoative distinction. Pair of sentences such as "the butter melted" vs. "butter melts easily" differ in that the former refers to an event which is indexically bound, while the latter has generic reference. This difference, however, seems to have little to do with the assignment of an interpretation to the sentences which requires or dispenses with an implied agent. For example, the sentence "ivy grows easily" carries no implication of a covert agent just as "the ivy grew all over the fence" does not. On the other hand, both "foreign cars sell easily" and "Joe's MG sold for two thousand pounds" imply the existence of an agent participant since no event of selling can be carried out without a seller. I think what is going on here is that verbs such as *grow* have two distinct word meanings according to whether they are understood as entailing an agent and theme participants or just a theme participant, e.g.

(5-21) a $\forall e \Box[grow(e) \rightarrow \exists x, y[agt(e,x) \wedge theme(e,y)]]$
b $\forall e \Box[grow(e) \rightarrow \exists y[theme(e,y)]]$

The two meanings are related in that the use of *grow* which carries the implication of two participant roles entails the use of *grow* which only has one implied role, but not vice versa: e.g.

(5-22) $\forall x, y, e[[grow(e) \wedge agt(e,x) \wedge theme(e,y)] \rightarrow [grow(e) \wedge theme(e,y)]]$

Consequently, no causative-inchoative alternation needs to be assumed to relate pairs of sentences such as "John spilled the milk" and "the milk spilled" where the latter sentence is understood as implying no covert agent: the two instances of the verb correspond to distinct word meanings. The same holds for causative-middle pairs such as "John grew ivy in his garden" and "the ivy grew all over the fence". However, where intransitive sentences are understood as having an implied agent as in "foreign cars sell easily" and "Joe's MG sold for two thousand pounds" suppression of the syntactic argument which realizes the theme role — as induced by the causative-middle and causative-inchoative alternations — is clearly involved. The distinction between middles and inchoatives is therefore best characterized in terms of generic/indexical reference, rather than as presence vs. absence of an implied, covert agent.

Here, I will not address the question of how to represent generic reference; consequently, only the lexical rule relative to causative-inchoative alternations is discussed. The closure of the p-agt entailment which together with satisfaction of the p-agt argument provides a characterization of inchoative formation can be expressed by introducing a value, e.g. *some*, which blocks all possible instantiations for the individual variable of the p-agt role. For the present purpose, *some* can be viewed as an individual constant whose extensions are undetermined. As shown in (5-23), the inchoative rule is essentially as the passive rule discussed above, except that the individual variable of the p-agt role is instantiated with the constant *some*.

(5-23)

rule = INCHOATIVE *English*

$$\text{in} = \left[\begin{array}{lll}\textbf{phon} & = & \boxed{1}\frown\boxed{2}\frown\boxed{3} \\ \textbf{cat} & = & \left[\textbf{catn} = \textit{sent}\right] \Big/ \left[\begin{array}{lll}\textbf{phon} & = & \boxed{3} \\ \textbf{catn} & = & \textit{np} \\ \textbf{sem} & = & \text{@P-PAT}\end{array}\right] \Big/ \left[\begin{array}{lll}\textbf{phon} & = & \boxed{1} \\ \textbf{catn} & = & \textit{np} \\ \textbf{sem} & = & \left[\begin{array}{lll}\textbf{pred} & = & \textit{p-agt} \\ \textbf{arg1} & = & \textit{e} \\ \textbf{arg2} & = & \textit{some}\end{array}\right]\end{array}\right] \\ \textbf{sem} & = & \boxed{4}\end{array}\right]$$

$$\text{out} = \left[\begin{array}{lll}\textbf{phon} & = & \boxed{3}\frown\boxed{2} \\ \textbf{cat} & = & \left[\textbf{catn} = \textit{sent}\right] \Big/ \left[\begin{array}{lll}\textbf{phon} & = & \boxed{3} \\ \textbf{catn} & = & \textit{np} \\ \textbf{sem} & = & \text{@P-PAT}\end{array}\right] \\ \textbf{sem} & = & \boxed{4}\end{array}\right]$$

According to the lexical rule above, the sign for an inchoative verb such as *break* in "the glass broke" is:

(5-24) INCHOATIVE VERB

$$\left[\begin{array}{lll}\textbf{phon} & = & \boxed{1}\frown\textit{break} \\ \textbf{cat} & = & \left[\textbf{catn} = \textit{sent}\right] \Big/ \left[\begin{array}{lll}\textbf{phon} & = & \boxed{1} \\ \textbf{catn} & = & \textit{np} \\ \textbf{sem} & = & \boxed{2}\end{array}\right] \\ \textbf{sem} & = & \left[\begin{array}{l}\textbf{ind:}\theta\textbf{-dom} = \left\langle \boxed{2}\,\text{@P-PAT} \circ \left[\begin{array}{lll}\textbf{pred} & = & \textit{p-agt} \\ \textbf{arg1} & = & \boxed{3} \\ \textbf{arg2} & = & \textit{some}\end{array}\right]\right\rangle \\ \textbf{pred} = \textit{eat} \\ \textbf{arg1} = \boxed{3}\,\textit{e}\end{array}\right]\end{array}\right]$$

The same rule formulation can be used to provide a characterization of inchoatives in Romance by introducing inchoative morphology in the output phonology of the verb (e.g. the clitic *si*/*se*, see examples in §2.1 and below). Since a thematic entailment whose individual argument instantiates the constant *some* is no longer available for syntactic realization — e.g. there is no nominal predicate in the lexicon whose individual object argument can instantiate such a constant — it follows that the p-agt role of an inchoative verb will remain unexpressed. In particular, such role may not be realized as a thematically bound adjunct (i.e. a quasi-argument) through intervention of an agent phrase[7] or a dislocated NP (see chapter7). We can therefore easily account for the ungrammaticality of sentences such as those in (5-25).

(5-25) a *The glass has broken by John

b *La neve si è sciolta dal sole
the snow INCH melted by the sun
*"The snow melted by the sun"

c *Il sole, la neve si è sciolta
the sun the snow INCH melted

**Reflexivization: P-Agt Argument Satisfaction and $\theta$-Binding** The inchoative rule described above can be minimally modified to yield a treatment of reflexivization in Romance. The modification needed consists in replacing $\theta$-entailment closure with "$\theta$-entailment binding". $\theta$-entailment binding (henceforth $\theta$-binding) allows the individual argument variable of the removed p-agt argument to be equated with the individual argument variable of either the p-pat role or the prepositional role (if there is one). For example, the result of combining the reflexive morpheme *si* with the transitive verb *radere* "to shave" in Italian is:

(5-26) REFLEXIVE VERB (*Italian*)

$$
\begin{bmatrix}
\textbf{phon} = \boxed{1}{}^\frown \textit{rader+si} \\
\textbf{cat} = \begin{bmatrix}\textbf{catn} = \textit{sent}\end{bmatrix} \Big/ \begin{bmatrix}\textbf{phon} = \boxed{1} \\ \textbf{catn} = \textit{np} \\ \textbf{sem} = \boxed{2}\end{bmatrix} \\
\textbf{sem} = \begin{bmatrix}
\textbf{ind:}\boldsymbol{\theta}\textbf{-dom} = \left\langle \boxed{2} \begin{bmatrix}\textbf{pred} = \textit{p-agt} \\ \textbf{arg1} = \boxed{3} \\ \textbf{arg2} = \boxed{4}\end{bmatrix} \circ \begin{bmatrix}\textbf{pred} = \textit{p-agt} \\ \textbf{arg1} = \boxed{3} \\ \textbf{arg2} = \boxed{4}\end{bmatrix} \right\rangle \\
\textbf{pred} = \textit{eat} \\
\textbf{arg1} = \boxed{3}\,e
\end{bmatrix}
\end{bmatrix}
$$

This result is obtained by defining the rule for reflexive formation in terms of the two basic operations and p-agt argument satisfaction and p-agt $\theta$-binding, as shown in (5-27) for non-finite verbs (the plus sign indicates a morpheme boundary).

[7] The impossibility of combining an agent phrase with an inchoative (or middle) verb follows also from imcompatibility concerning the feature "voice".

(5-27)

rule = REFLEXIVE (*Italian*)

$$
\texttt{in} = \left[\begin{array}{lll}
\texttt{phon} & = & \boxed{1}\frown\boxed{2}\frown\boxed{3} \\
\texttt{cat} & = & \left[\begin{array}{lll} \texttt{name} & = & \textit{sent} \\ \texttt{feats} & = & \left[\texttt{vform} = \textit{nfin}\right] \end{array}\right] / \boxed{4} / \left[\begin{array}{lll} \texttt{phon} & = & \boxed{1} \\ \texttt{catn} & = & \textit{np} \\ \texttt{sem} & = & \left[\begin{array}{lll} \texttt{ind} & = & [\,] \\ \texttt{pred} & = & \textit{p-agt} \\ \texttt{arg1} & = & [\,] \\ \texttt{arg2} & = & \boxed{5} \end{array}\right] \end{array}\right] \\
\texttt{sem} & = & \boxed{6}
\end{array}\right]
$$

$$
\texttt{out} = \left[\begin{array}{lll}
\texttt{phon} & = & \boxed{3}\frown\boxed{2} + \textit{si} \\
\texttt{cat} & = & \left[\begin{array}{lll} \texttt{name} & = & \textit{sent} \\ \texttt{feats} & = & \left[\texttt{vform} = \textit{nfin}\right] \end{array}\right] / \boxed{4} \left[\begin{array}{lll} \texttt{phon} & = & \boxed{3} \\ \texttt{catn} & = & \textit{np} \\ \texttt{sem} & = & \left[\begin{array}{lll} \texttt{ind} & = & [\,] \\ \texttt{pred} & = & \textit{p-pat} \\ \texttt{arg1} & = & [\,] \\ \texttt{arg2} & = & \boxed{5} \end{array}\right] \end{array}\right] \\
\texttt{sem} & = & \boxed{6}
\end{array}\right]
$$

The characterization of reflexivization in Italian as an operation which satisfies the p-agt argument is validated by the fact that the subject position of a reflexive verbs exhibits the same behaviour as the subject position of inchoative and passive verbs with respect to *ne*-cliticization, past participle agreement, absolute participial formation and reduced relatives. As has often been pointed out, these four processes may only affect an argument position which is compatible with a p-pat specification.[8] For example, *ne*-cliticization — an operation through which the partitive or adnominal (e.g. possessive) phrase contained in an argument NP is realized as the clitic *ne* — may affect the object of a transitive verb as well as the subject of a passive, inchoative or reflexive verb as shown in (5-28).

[8] E.g. a deep or initial object, see [Belletti & Rizzi 81], [Burzio 86], [Rosen 84].

| | | | | | |
|---|---|---|---|---|---|
| (5-28) | a | Due amici | ne | comprarono | tre |
| | | two fireds | of-them | bought | three |
| | | "Two friends bought three of them" | | | |
| | b | Ne | sono stati invitati | due | |
| | | of-them | were invited | two | |
| | | "Two of them were invited" | | | |
| | c | Se | ne | sono aperte | molte |
| | | INCH | of-them | opened | many |
| | | "Many of them have opened" | | | |
| | d | Se | ne | sono uccisi | due |
| | | REFL | of-them | killed | two |
| | | "Two of them killed themselves" | | | |

However, the attempt to apply *ne*-cliticization to the subject of a transitive or unergative verb results into ungrammaticality (unaccusatives will be discussed in chapter 6).

| | | | | | |
|---|---|---|---|---|---|
| (5-29) | a | *Ne | comprarono | tre case | due |
| | | of-them | bought | three houses | two |
| | b | *Ne | parlarono | due | di politica |
| | | of them | spoke | two | about politics |

Analogous distributional patterns are found with respect to participial absolutes. A participial absolute is a clausal adjunct consisting of a past participle plus a noun phrase which has no coreference linkage to the main clause (see [Rosen 84]), e.g.

(5-30) Vinta la squadra avversaria, scoppiarono gli applausi
"Having the competing team been defeated, applause broke out"

Crucially the nominal which follows a transitive participial cannot be understood as the subject of the active form of the transitive. Note in fact that the adjunct clause in (5-30) cannot be translated as in (5-31) where the past participle is given an active reading, and the nominal associated with it is understood as the agent actant.

(5-31) The competing team having won, ...

Following the same pattern as *ne*-cliticization, participial absolute formation is possible with passives (cf. (5-31)), reflexives and inchoatives (cf. (5-32)), but not with unergatives (cf. (5-33)).

(5-32) a Uccisosi il dittatore, i ribelli esultarono
"The dictator having killed himself, the rebels exulted"

b Rarefattesi le nubi, il sole tornò a risplendere
"The clouds having rarefied, the sun shone again"

(5-33) *Parlato l'imputato, il processo si concluse
"The defendant having spoken, the trial ended"

We may then conclude that the argument position which is syntactically realized in participial absolutes corresponds to a p-pat argument, as was observed in the case of *ne*-cliticization.

Additional evidence supporting the idea the subject of reflexives exhibits object functionality, and is therefore best characterized as the syntactic realization of a proto-agent role, is provided by past participle agreement and reduced relatives. It is well known that in Italian a transitive past participle agrees in gender and number with its direct object just in case the object is realized as an object clitic.[9]

(5-34) a La polizia ha { arrestato / *arrestata / *arrestati } tutti
the-FEM,SING police-FEM,SING has { arrested / *arrested-FEM,SING / arrested-MASC,PL } everybody-MASC,PL
"The police arrested everybody"

b La polizia li ha arrestati
the police them-MASC,PL has arrested-MASC,PL
"The police arrested them"

A passive, inchoative or reflexive past participle obligatorily agrees with its subject.

[9]The following table shows the basic patterns of number and gender agreement in Italian for nouns and adjectives. In past participles, the masculine ending is used as the unmarked inflectional affix when no agreement is at stake.

| Gender | Number | |
|---|---|---|
| | Singular | Plural |
| Masculine | -o | -i |
| Feminine | -a | -e |
| Masculine/Feminine | -e | -i |

(5-35) a Olga fu $\left\{\begin{array}{l}\text{arrestata}\\ \text{*arrestato}\end{array}\right\}$ tre anni fa

Olga-FEM,SING was $\left\{\begin{array}{l}\text{arrested-FEM,SING}\\ \text{*arrested}\end{array}\right\}$ three years ago

"Olga was arrested three years ago"

b Olga si è $\left\{\begin{array}{l}\text{accusata}\\ \text{*accusato}\end{array}\right\}$

Olga REFL has $\left\{\begin{array}{l}\text{accused-FEM,SING}\\ \text{*accused}\end{array}\right\}$

"Olga accused herself"

c La neve si è $\left\{\begin{array}{l}\text{sciolta}\\ \text{*sciolto}\end{array}\right\}$

The-FEM,SING snow-FEM,SING INCH has $\left\{\begin{array}{l}\text{melted-FEM,SING}\\ \text{*melted}\end{array}\right\}$

"The snow melted"

Past participle agreement is not possible with unergatives.

(5-36) Olga ha $\left\{\begin{array}{l}\text{parlato}\\ \text{*parlata}\end{array}\right\}$

Olga has $\left\{\begin{array}{l}\text{spoken}\\ \text{*spoken-FEM,SING}\end{array}\right\}$

"Olga spoke"

Consider last the case of reduced relative formation. Reduced relatives with transitive verbs are only allowed if relativization involves the object position.

(5-37) a Il poliziotto arrestato era un complice
"The policeman (who was) arrested was an accomplice"

b *Il poliziotto arrestato il criminale era un complice
"The policeman (who) arrested the criminal was an accomplice"

Reduced relatives are possible with passive (cf. (5-37a)), reflexive (cf. (5-38a)) and inchoative (cf. (5-38b)) verbs, but not with unergatives (cf. (5-38c)).

(5-38) a Il poliziotto costituitosi ieri ...
"The policeman (who) turned himself in yesterday ..."

b Il bicchiere rottosi ieri ...
"The glass broken yesterday ..."

c *Il poliziotto parlato al commissario ...
"The policeman (who has) spoken to the DA ..."

The data just reviewed show that the subject position of inchoative, passive and reflexive verbs corresponds to a proto-patient argument, just as the object of a transitive verb does. Therefore the characterization of reflexivization in Romance as an operations which satisfies the argument of a verb which is linked to the p-agt role appears to be highly motivated just as in inchoative and passive formation.

**Argument Satisfaction and Cliticization** The operation of argument satisfaction can also be extended to roles other than the p-agt to give a treatment of object cliticization in Romance. Some relevant examples are given in (5-39); in each case a full object NP has been replaced by an object clitic.

(5-39) a Maria lo vedrà domani
"Maria will see him(CLITIC) tomorrow"
b Carlo non gli ha ancora scritto
"Carlo has not written to-him(CLITIC) yet"

In this case the argument removed is one which is either linked to a proto-patient or prepositional role. As with passive, I will assume that the de-linked thematic role remains in the $\theta$-DOM of the verb. This treatment is motivated by the fact that the thematic roles linked to argument positions which are satisfied through cliticization can be syntactically realized as dislocated phrases (see chapter 7):

(5-40) a Carlo, Maria lo vedrà domani
"Carlo, Maria will see him(CLITIC) tomorrow"
b A Gianni, Carlo non gli ha ancora scritto
"To Gianni, Carlo has not written to-him(CLITIC) yet"

The treatment of object cliticization that I have proposed makes it possible to treat the sentence initial objects in (5-40) as *quasi-arguments* (i.e. a thematically bound adjunct) and it provides a unified treatment of pronominal clitics in Romance. (See chapter 7 for further details.)

### 5.1.2 Complex Predicate Formation

The kinds of morphosyntactic processes I have considered hitherto operate on roles which are already encoded in the input predicate. Next, I would like to consider a different range of processes where the initial cohort of arguments associated with the input predicate is augmented with new ones. There are basically two types of natural language phenomena which fit this description and which have been discussed to a considerable degree in the linguistic literature: applicatives (see [Baker 88, Alsina & Mchombo 88, Bresnan & Moshi 89]), and complex predicate formation ([Rizzi 78, Aissen & Perlmutter 83, Burzio 86]). For the purpose of this thesis I will only take into account complex predicates.

A complex predicate is a verbal complex consisting of two or more basic predicates which from a syntactic point of view act as a single clausal element (e.g. a single V-node in a phrase structure oriented formalism). For example, it is well-known that in Italian a clitic must be adjacent to its governing verb, e.g.

(5-41) a Carlo odia scriverle
"Carlo hates to-write-to-her(CLITIC)"
b *Carlo le odia scrivere
"Carlo to-her(CLITIC) hates to-write"

However, with verbal complexes consisting of a causative, aspectual or modal verb followed by an infinitive, a clitic may cross predicate boundaries as shown in (5-42)-(5-44) — a phenomenon usually referred to as *clitic climbing* in the literature. This indicates that the verbal complexes in question behave syntactically as a single verb.

(5-42) a Carlo fece scriverle
"Carlo made someone write-to-her(CLITIC)"
b Carlo le fece scrivere
"Carlo to-her(CLITIC) made someone write"

(5-43) a Carlo cominciò a scriverle
"Carlo began to write-to-her(CLITIC)"
b Carlo le cominciò a scrivere
"Carlo to-her(CLITIC) began to write"

(5-44) a Carlo volle scriverle
"Carlo wanted to write-to-her(CLITIC)"
b Carlo le volle scrivere
"Carlo to-her(CLITIC) wanted to write"

The (syntactic) monoclausal nature of complex predicates is perhaps more perspicuous in languages where the constituents of a complex predicate form a single word. In Eskimo, for example, complex predicates may be formed combining a simple predicate with verbal suffixes corresponding to modal, aspectual and causative verbs as shown in (5-45) (data adapted from [Grimshaw & Mester 85]).

(5-45) a angutik tiki-guma-vuk
man-ABS arrive-want-3SG(SUBJ)
"The man wants to arrive"

b pi-gia-ttuk
do-begin-3SG(SUBJ)
"He begins to do"

c mikilli-ti-vauk
become smaller-make-3SG(SUBJ)/3SG(OBJ)
"He makes it smaller"

The relation between the members of a complex predicate can effectively be stated in terms of subcategorization and thematic entailment. Consider, for instance, the complex predicate in (5-46).

(5-46) vuole vedere
"wants to watch"

Even though the two verbs form a single verbal complex, there is a clear sense in which semantically the modal verb and the following infinitive have distinct meanings which are compositionally combined. It is quite reasonable to assume that the relation between the modal and the infinitive is not unlike the kind of semantic relationship which is established under complementation in syntactically biclausal structures. The difference between complex predicates and biclausal complemented structures (e.g. (5-41a)) can be essentially captured at the syntactic level in terms of argument inheritance: aside from relationships established through control, the main verb of a biclausal structure may not inherit any of the arguments of its complement verb, while the main verb of a complex predicate may do so. This explains why in (5-42) clitic climbing is possible while in (5-41) it is not. Recall that cliticization involves argument satisfaction, so that only if the first predicate of verbal complex inherits the object of a lower predicate is clitic climbing possible.

In standard categorial grammar, complex predicate formation can be easily expressed through the rule of functional compositions described below.

(5-47) FUNCTIONAL COMPOSITION
A principal function over Y, of category X/Y or X\Y and interpretation F, amy combine with an adjacent subsidiary function into Y of category Y/Z or Y\Z and interpretation G. The result is their syntactic and semantic composition, a function from Z into X of category X/Z or X\Z which bears the interpretation $\lambda x[F(Gx)]$. [Steedman 87]

For example, given the assignment of category types and interpretations to expressions in (5-48), the complex predicate in (5-46) will be generated through the rule of *forward composition* as shown in (5-49). In this case, composition allows the complex predicate to inherit the outermost argument NP of the complement verb.

(5-48) vuole:= (S/NP)/S/NP
vedere:= S/NP/NP

(5-49) Forward Composition
$X/Z{:}F \quad Y/Z{:}G \rightarrow X/Z{:}\lambda z[F(Gz)]$

$$\dfrac{\dfrac{\text{vuole}}{(S/NP)/S/NP{:}\lambda P, x[want(x, Px)]} \qquad \dfrac{\text{vedere}}{S/NP/NP{:}\lambda y, x[see(x, y)]}}{S/NP/NP{:}\lambda z[\lambda x[want(x, see(x, z))]]}$$

My account of complex predicate formation incorporates the basic insights of this approach, although it does not make direct use of functional composition. The basic idea is to encode those features of functional composition which are crucial to the treatment of complex predicates into lexical rules or verb signs — according to whether a complex predicate involves word or phrase formation. This encoding is obtained in terms of three operations: *predicate composition, argument inheritance* and *control.*

*Predicate composition* has the effect of combining two predicates which stand in a functor-argument relation in such a way that the thematic entailments of the argument predicate are passed on to the θ-DOM of the functor predicate. The inheritance of thematic entailments will be discussed in details in chapter 7. At present, it will suffice to say that role inheritance is restricted to θ-DOM of entailed argument roles (e.g. complements but not adjuncts). In keeping with the treament of clausal complements presented in §4.3.3, the argument verb member of a complex predicate is semantically encoded as a propositional role which occurs as a thematic entailment in the θ-DOM of the functor predicate. For example, the semantic representation for each of the predicates forming the verbal complex in (5-46) is as in (5-50) where the template definition for propositional thematic formulae defined below is introduced to simplify notation (for ease of exposition, detailed categorial information is temporarily omitted; see below for details).

$$\bullet\ @\textsc{prop} \Rightarrow \begin{bmatrix} \textbf{ind} = \boxed{1} \\ \textbf{pred} = \textit{prop} \\ \textbf{arg1} = \boxed{1} \\ \textbf{arg2} = \begin{bmatrix} \textbf{ind} = [\,] \\ \textbf{pred} = [\,] \\ \textbf{args} = [\,] \end{bmatrix} \end{bmatrix}$$

(5-50) a MATRIX VERB SEMANTICS

$$\textbf{sem} = \begin{bmatrix} \textbf{ind} = \begin{bmatrix} \textbf{var} = \boxed{1} \\ \theta\textbf{-dom} = \langle @\textsc{prop} \circ @\textsc{p-agt} \rangle \end{bmatrix} \\ \textbf{pred} = \textit{want} \\ \textbf{arg1} = \boxed{1}e \end{bmatrix}$$

b COMPLEMENT VERB SEMANTICS

$$\textbf{sem} = \begin{bmatrix} \textbf{ind} = \boxed{1} \\ \textbf{pred} = \textit{prop} \\ \textbf{arg1} = \boxed{1} \\ \textbf{arg2} = \begin{bmatrix} \textbf{ind} = \begin{bmatrix} \textbf{var} = \boxed{2} \\ \theta\textbf{-dom} = \langle @\textsc{p-pat} \circ @\textsc{p-agt} \rangle \end{bmatrix} \\ \textbf{pred} = \textit{see} \\ \textbf{arg1} = \boxed{2}e \end{bmatrix} \end{bmatrix}$$

Predicate composition allows the two predicates to combine so as to yield the semantic structure in (5-51) where

- the propositional role has been removed from the $\theta$-DOM of the matrix predicate and combined with its semantics
- the thematic entailments of the complement predicate are transferred to the $\theta$-DOM of the matrix predicate.

(5-51)

$$\mathbf{sem} = \left[\begin{array}{lll}
\mathbf{ind} & = & \left[\begin{array}{l}\mathbf{var} = \boxed{1} \\ \theta\text{-}\mathbf{dom} = \langle @\text{P-PAT} \circ @\text{P-AGT} \circ @\text{P-AGT} \rangle \end{array}\right] \\
\mathbf{pred} & = & \mathit{and} \\
\mathbf{arg1} & = & \left[\begin{array}{lll}\mathbf{ind} & = & \boxed{1} \\ \mathbf{pred} & = & \mathit{want} \\ \mathbf{arg1} & = & \boxed{1}e \end{array}\right] \\
\mathbf{arg2} & = & \left[\begin{array}{lll}\mathbf{ind} & = & \boxed{1} \\ \mathbf{pred} & = & \mathit{prop} \\ \mathbf{arg1} & = & \boxed{1} \\ \mathbf{arg2} & = & \left[\begin{array}{lll}\mathbf{ind} & = & \boxed{2} \\ \mathbf{pred} & = & \mathit{see} \\ \mathbf{arg1} & = & \boxed{2}e \end{array}\right] \end{array}\right]
\end{array}\right]$$

The tree structure in (5-52) provides an exemplification of this process as a whole using linear representations for the semantic structures of matrix, argument and result predicates.

(5-52)

$$[e_1 :< @\text{P-PAT} \circ @\text{P-AGT}_2 \circ @\text{P-AGT}_1 >][\mathit{want}(e_1) \wedge \mathit{prop}(e_1, \mathit{see}(e_2))]$$

$$[e_1 :< @\text{PROP} \circ @\text{P-AGT}_1 >]\mathit{want}(e_1)$$

$$[e_1 :< @\text{P-PAT} \circ @\text{P-AGT}_2 >]\mathit{prop}(e_1, \mathit{see}(e_2))$$

*Argument inheritance* is an operation on pairs of category structures through which the functor predicate of a verbal complex takes over the arguments of the complement predicate. The resulting category structure is treated as a new predicate from a syntactic point of view, and must conform to argument selection principles. This is basically why complex predicates are syntactically classified as monoclausal. For example, *argument inheritance* will make it possible to combine the categories of the two verb signs corresponding to the matrix and complement verbs of the complex predicate *vuole vedere* "wants to see" into a single category structure as shown in (5-53).

(5-53)

$$\left[\mathbf{catn} = \mathit{sent}\right] \Big/ \begin{bmatrix}\mathbf{catn} = \mathit{np}\\ \mathbf{sem} = \text{@P-AGT}\end{bmatrix} \Big/ \begin{bmatrix}\mathbf{catn} = \mathit{np}\\ \mathbf{sem} = \text{@P-AGT}\end{bmatrix} \Big/ \begin{bmatrix}\mathbf{catn} = \mathit{np}\\ \mathbf{sem} = \text{@P-PAT}\end{bmatrix}$$

$$\left[\mathbf{catn} = \mathit{sent}\right] \Big/ \begin{bmatrix}\mathbf{catn} = \mathit{np}\\ \mathbf{sem} = \text{@P-AGT}\end{bmatrix} \Big/ \begin{bmatrix}\mathbf{cat} = \left[\mathbf{catn} = \mathit{sent}\right] \big/ \left[\mathbf{catn} = \mathit{np}\right]\\ \mathbf{sem} = \text{@PROP}\end{bmatrix}$$

$$\begin{bmatrix}\mathbf{cat} = \left[\mathbf{catn} = \mathit{sent}\right] \Big/ \begin{bmatrix}\mathbf{catn} = \mathit{np}\\ \mathbf{sem} = \text{@P-AGT}\end{bmatrix} \Big/ \begin{bmatrix}\mathbf{catn} = \mathit{np}\\ \mathbf{sem} = \text{@P-PAT}\end{bmatrix}\\ \mathbf{sem} = \text{@PROP}\end{bmatrix}$$

The integration of the results of *predicate composition* and *argument inheritance* for the derivation of the complex predicate under analysis (i.e. the semantic structure in (5-51) and the top category structure in (5-53)) is given in (5-54).

(5-54)

$$\begin{bmatrix}
\mathbf{cat} = \left[\mathbf{catn} = \mathit{sent}\right] \Big/ \begin{bmatrix}\mathbf{catn} = \mathit{np}\\ \mathbf{sem} = \boxed{3}\end{bmatrix} \Big/ \begin{bmatrix}\mathbf{catn} = \mathit{np}\\ \mathbf{sem} = \boxed{4}\end{bmatrix} \Big/ \begin{bmatrix}\mathbf{catn} = \mathit{np}\\ \mathbf{sem} = \boxed{5}\end{bmatrix}\\
\mathbf{sem} = \begin{bmatrix}
\mathbf{ind} = \begin{bmatrix}\mathbf{var} = \boxed{1}\\ \theta\text{-}\mathbf{dom} = \left\langle \boxed{5}\text{@P-PAT} \circ \boxed{4}\text{@P-AGT} \circ \boxed{3}\text{@P-AGT}\right\rangle\end{bmatrix}\\
\mathbf{pred} = \mathit{and}\\
\mathbf{arg1} = \begin{bmatrix}\mathbf{ind} = \boxed{1}\\ \mathbf{pred} = \mathit{want}\\ \mathbf{arg1} = \boxed{1}e\end{bmatrix}\\
\mathbf{arg2} = \begin{bmatrix}\mathbf{ind} = \boxed{1}\\ \mathbf{pred} = \mathit{prop}\\ \mathbf{arg1} = \boxed{1}\\ \mathbf{arg2} = \begin{bmatrix}\mathbf{ind} = \boxed{2}\\ \mathbf{pred} = \mathit{see}\\ \mathbf{arg1} = \boxed{2}e\end{bmatrix}\end{bmatrix}
\end{bmatrix}
\end{bmatrix}$$

According to argument selection principles, this structure is not well-formed since the category structure encodes two proto-agent arguments, and therefore it violates the uniqueness requirement of $\theta$-ASSOC:[10]

(5-55) ROLE ASSOCIATION ($\theta$-ASSOC)
All syntactic arguments of a predicate must be linked to a *unique* role, and all roles to a *unique* syntactic argument.

Ill-formedness derives from the fact that the category formed through *argument inheritance* counts as a single category structure and as such it is subject to argument selection principles. As in the case of passive, inchoative and reflexive formation, there is the possibility of removing the "offending" argument from the category structure of the verb so as rescue the entire derivation. In the case of complex predicate formation this is done through *control.*

*Control* is an operation which combines argument satisfaction, $\theta$-binding and "$\theta$-satisfaction". The properties of argument satisfaction and $\theta$-binding have already been discussed with reference to the passive, inchoative, reflexive and cliticization rules above. In the context of complex predicate formation, argument satisfaction makes it possible to remove one of the two subcategorized signs which are linked to a proto-agent role in (5-55); $\theta$-binding allows us to bind the individual variable of the removed p-agt argument to the individual variable of the p-agt argument which remains encoded in the category structure of the verb. This binding corresponds to the assignment of a controller for the unexpressed subject of a clausal complement as usually understood. I will not address here the issue of how the controlling role is chosen, although the integration the basic insights of thematically based theories of control (e.g. [Jackendoff 72], [Sag & Pollard 88]) should be fairly straightforward within the present system. The result of applying argument satisfaction and $\theta$-binding to the sign structure in (5-54) is:

[10] The ill-formedness of the category structure in (5-54) is also due to government constraints (i.e. assignment of morphological/abstract case). Because a non-finite verb is generally unable to govern its subject, the subject argument which the modal inherits from the complement predicate — a non-finite verb — will be caseless/ungoverned and therefore unable to be consumed through functional application. This is why when the argument verb is a passive as in (i) below the argument subject must be removed from the category structure of the modal even though argument inheritance in this case complies with $\theta$-ASSOC (i.e. the inherited complement subject is linked to a p-pat role rather than a p-agt as in (5-54)).

(i) Carlo vuole essere chiamato alle 8
Carlo wants to be called at 8

(5-56)

$$
\begin{bmatrix}
\mathbf{cat} = \begin{bmatrix}\mathbf{catn} = \mathit{sent}\end{bmatrix} \Big/ \begin{bmatrix}\mathbf{catn} = \mathit{np} \\ \mathbf{sem} = \boxed{3}\end{bmatrix} \Big/ \begin{bmatrix}\mathbf{catn} = \mathit{np} \\ \mathbf{sem} = \boxed{5}\end{bmatrix} \\
\mathbf{sem} = \begin{bmatrix}
\mathbf{ind} = \begin{bmatrix}
\mathbf{var} = \boxed{1} \\
\theta\text{-}\mathbf{dom} = \left\langle \boxed{5}@\text{P-PAT} \circ \begin{bmatrix}\mathbf{ind} = \boxed{2} \\ \mathbf{pred} = \mathit{p\text{-}agt} \\ \mathbf{arg1} = \boxed{2} \\ \mathbf{arg2} = \boxed{6}\end{bmatrix} \circ \boxed{3} \begin{bmatrix}\mathbf{ind} = \boxed{1} \\ \mathbf{pred} = \mathit{p\text{-}agt} \\ \mathbf{arg1} = \boxed{1} \\ \mathbf{arg2} = \boxed{6}\end{bmatrix} \right\rangle
\end{bmatrix} \\
\mathbf{pred} = \mathit{and} \\
\mathbf{arg1} = \begin{bmatrix}\mathbf{ind} = \boxed{1} \\ \mathbf{pred} = \mathit{want} \\ \mathbf{arg1} = \boxed{1}\,e\end{bmatrix} \\
\mathbf{arg2} = \begin{bmatrix}\mathbf{ind} = \boxed{1} \\ \mathbf{pred} = \mathit{prop} \\ \mathbf{arg1} = \boxed{1} \\ \mathbf{arg2} = \begin{bmatrix}\mathbf{ind} = \boxed{2} \\ \mathbf{pred} = \mathit{see} \\ \mathbf{arg1} = \boxed{2}\,e\end{bmatrix}\end{bmatrix}
\end{bmatrix}
\end{bmatrix}
$$

The de-linked thematic entailment is then removed from the $\theta$-DOM and combined with the semantics of the complex predicate through $\theta$-satisfaction as shown below:

(5-57)

$$
\begin{bmatrix}
\textbf{cat} = \begin{bmatrix}\textbf{catn} = \textit{sent}\end{bmatrix} \Big/ \begin{bmatrix}\textbf{catn} = \textit{np} \\ \textbf{sem} = \boxed{3}\end{bmatrix} \Big/ \begin{bmatrix}\textbf{catn} = \textit{np} \\ \textbf{sem} = \boxed{5}\end{bmatrix} \\
\textbf{sem} = \begin{bmatrix}
\textbf{ind} = \begin{bmatrix}
\textbf{var} = \boxed{1} \\
\theta\textbf{-dom} = \left\langle \boxed{5}@\text{P-PAT} \circ \boxed{3} \begin{bmatrix}\textbf{ind} = \boxed{1} \\ \textbf{pred} = \textit{p-agt} \\ \textbf{arg1} = \boxed{1} \\ \textbf{arg2} = \boxed{6}\end{bmatrix} \right\rangle
\end{bmatrix} \\
\textbf{pred} = \textit{and} \\
\textbf{arg1} = \begin{bmatrix}
\textbf{ind} = \boxed{1} \\
\textbf{pred} = \textit{and} \\
\textbf{arg1} = \begin{bmatrix}\textbf{ind} = \boxed{1} \\ \textbf{pred} = \textit{want} \\ \textbf{arg1} = \boxed{1}\,e\end{bmatrix} \\
\textbf{arg2} = \begin{bmatrix}\textbf{ind} = \boxed{1} \\ \textbf{pred} = \textit{prop} \\ \textbf{arg1} = \boxed{1} \\ \textbf{arg2} = \begin{bmatrix}\textbf{pred} = \textit{see}\end{bmatrix}\end{bmatrix}
\end{bmatrix} \\
\textbf{arg2} = \begin{bmatrix}\textbf{ind} = \boxed{2} \\ \textbf{pred} = \textit{p-agt} \\ \textbf{arg1} = \boxed{2} \\ \textbf{arg2} = \boxed{6}\end{bmatrix}
\end{bmatrix}
\end{bmatrix}
$$

The combined effect of *predicate composition*, *argument inheritance* and *control* resulting in a predicate complex such as the one in (5-57) can be either expressed through lexical rules, or encoded in verb signs. In the Eskimo case discussed above, for example, complex predicate formation is best expressed as a lexical rule since complex predicates involve word formation. An illustrative example is given below with respect to the rule which adds the modal verb suffix *-guma-* to Eskimo verbs, as in (5-45a) here repeated as (5-58) (for ease of exposition phonological details are omitted).

(5-58) angutik tiki-guma-vuk
man-ABS arrive-want-3SG(SUBJ)
"The man wants to arrive"

(5-59) **rule** = -GUMA- AFFIXATION (*Eskimo*)

$$
\textbf{in} = \begin{bmatrix}
\textbf{cat} = \begin{bmatrix}\textbf{catn} = \textit{sent}\end{bmatrix} \Big/ \begin{bmatrix}\textbf{catn} = \textit{np} \\ \textbf{sem} = \boxed{1}\begin{bmatrix}\textbf{arg2} = \boxed{2}\end{bmatrix}\end{bmatrix} \left( / \; \boxed{6} \right) \\
\textbf{sem} = \begin{bmatrix}\textbf{ind}{:}\theta\textbf{-dom} = \langle \boxed{3} \circ \boxed{1} \rangle \\ \textbf{pred} = \textit{prop} \\ \textbf{arg2} = \boxed{4}\end{bmatrix}
\end{bmatrix}
$$

$$
\textbf{out} = \begin{bmatrix}
\textbf{cat} = \begin{bmatrix}\textbf{catn} = \textit{sent}\end{bmatrix} \Big/ \begin{bmatrix}\textbf{catn} = \textit{np} \\ \textbf{sem} = \boxed{5}\begin{bmatrix}\textbf{arg2} = \boxed{2}\end{bmatrix}\end{bmatrix} \left( / \; \boxed{6} \right) \\
\textbf{sem} = \begin{bmatrix}\textbf{ind}{:}\theta\textbf{-dom} = \langle \boxed{3} \circ \boxed{5}\text{@P-AGT} \rangle \\ \textbf{pred} = \textit{and} \\ \textbf{arg1} = \begin{bmatrix}\textbf{pred} = \textit{and} \\ \textbf{arg1} = \begin{bmatrix}\textbf{pred} = \textit{want}\end{bmatrix} \\ \textbf{arg2} = \begin{bmatrix}\textbf{pred} = \textit{prop} \\ \textbf{arg2} = \boxed{4}\end{bmatrix}\end{bmatrix} \\ \textbf{arg2} = \boxed{1}\end{bmatrix}
\end{bmatrix}
$$

The rule takes as input a verb sign whose semantics corresponds to a propositional argument role, e.g.

(5-60) $[e_1 :< p\text{-}agt(e_2, X) >]prop(e_1, arrive(e_2))$

The parentheses which delimit the outermost categorial slash and any following material in the input template indicate, informally, that the rule applies to verbs of variable syntactic valency (e.g. intransitives as well as transitives). In the output template of the rule, the semantics of the input verb is combined with the semantics of the affixal modal predicate *want*. At the same time, the thematic entailments of the input predicate except the role linked to the subject are inherited by the $\theta$-DOM of the ouput sign (this is indicated with the tag $\boxed{3}$ in the rule above).[11] These two operations correspond to

[11] An additional tag should be added to the input and output $\theta$-DOMs of the rule on the right side of the subject role ($\boxed{1}$) to allow the output predicate to inherit de-linked thematic entailments of the input predicate, as in the case where the input predicate is a passive verb; e.g.

(i)
$$
\begin{bmatrix}
\textbf{cat} = \begin{bmatrix}\textbf{name} = \textit{sent} \\ \textbf{feats} = \begin{bmatrix}\textbf{voice} = \textit{pas}\end{bmatrix}\end{bmatrix} \Big/ \begin{bmatrix}\textbf{catn} = \textit{np} \\ \textbf{sem} = \boxed{1}\end{bmatrix} \begin{bmatrix}\textbf{catn} = \textit{np} \\ \textbf{sem} = \boxed{3}\end{bmatrix} \\
\begin{bmatrix}\textbf{ind}{:}\theta\textbf{-dom} = \langle \boxed{3}\text{@TO} \circ \boxed{1}\text{@P-PAT} \circ \text{@P-AGT} \rangle \\ \textbf{pred} = \textit{give} \\ \textbf{arg1} = \textit{e}\end{bmatrix}
\end{bmatrix}
$$

("@TO" is a template name for prepositional thematic formulae)

Where no de-linked thematic entailments occur on the left side of the subject role, this added tag would instantiate the empty string and would be merged with the preceding thematic formula by virtue of the *predicate composition.* The modal predicate introduces a proto-agent argument role, e.g. the subject of the modal with semantics $\boxed{5}$ in the output sign, whose individual argument variable $\boxed{2}$ binds the argument variable of the input subject role $\boxed{1}$. In the output template, this role is combined with the semantics of the verb, and the subcategorized sign to which it is linked in the input sign is removed. These three operations correspond to *control.* Finally, any subcategorized sign of the input verb — except the subject argument which has been removed through argument satisfaction — are inherited by the ouput sign, as indicated by the tag $\boxed{6}$. This last operation corresponds to *argument inheritance.*

Where complex predicates involve phrase formation, *predicate composition*, *argument inheritance* and *control* are encoded in the sign of the functor predicate. In this case, complex predicate formation is carried out through functional application. For example, the sign for the modal verb *volere* "want" in Italian is:[12]

(5-61)

$$
\left[\begin{array}{ll}
\textbf{cat} = & [\textbf{catn} = \textit{sent}] \,/\, \left[\begin{array}{l}\textbf{catn} = \textit{np}\\ \textbf{sem} = \boxed{1}[\textbf{arg2} = \boxed{2}]\end{array}\right] \\
& (/\boxed{3}) \\
& /\ \boxed{\left[\begin{array}{l} \textbf{cat} = [\textbf{catn} = \textit{sent}]/\left[\begin{array}{l}\textbf{catn} = \textit{np}\\ \textbf{sem} = \boxed{4}\end{array}\right] (/\ \boxed{3}) \\ \textbf{sem} = \boxed{5}[\textbf{ind}:\theta\textbf{-dom} = \langle \boxed{6} \circ \boxed{4}\rangle]\end{array}\right]}_{\mathrm{A}} \\
\textbf{sem} = & \left[\begin{array}{l} \textbf{ind}:\theta\textbf{-dom} = \langle \boxed{5}@\text{PROP} \circ \boxed{6} \circ \boxed{1}@\text{P-AGT}\rangle \\ \textbf{pred} = \textit{and} \\ \textbf{arg1} = [\textbf{pred} = \textit{want}] \\ \textbf{arg2} = \boxed{4}[\textbf{arg2} = \boxed{2}]\end{array}\right]
\end{array}\right]
$$

A = Active sign (complement verb of modal)

A comparison of the sign above with the lexical rule in (5-60) will reveal striking similarities. Notice, for example, that the active sign of the modal in (5-61) is essentially the same as the input template of the rule in (5-60). The only substantial difference concerns *predicate composition.* Note that only when complex predicate formation is

identity axiom for string unification described in §4.2 and §4.3. The same observation applies to the sign in (5-61), where the additional tag would be placed in the argument and result $\theta$-DOMs.

[12]See previous footnote and §6.3.3 for further details concerning role inheritance.

carried out though lexical rule as in (5-60) is the semantics of the input/complement predicate ( $\boxed{1}$ in both (5-60) and (5-61)) combined with the semantics of the modal verb. The semantics of the modal verb in (5-61) is instead combined with the semantics of the complement verb through functional application. This is done by structuring clausal complements as type-raised arguments, in the manner specified in §4.3.2. For example the sign for the infinitive *vedere* is as shown below where:

- TV_Cat abbreviates $\left[\mathbf{catn} = \mathit{sent}\right] \Big/ \begin{bmatrix} \mathbf{phon} = [\,] \\ \mathbf{catn} = \mathit{np} \\ \mathbf{sem} = [\,] \end{bmatrix} \Big/ \begin{bmatrix} \mathbf{phon} = [\,] \\ \mathbf{catn} = \mathit{np} \\ \mathbf{sem} = [\,] \end{bmatrix}$

$$
(5\text{-}62) \quad
\begin{bmatrix}
\mathbf{cat} = \boxed{1} \Bigg/ \begin{bmatrix}
\mathbf{cat} = \boxed{1} \Bigg/ \begin{bmatrix}
\mathbf{cat} = \text{TV\_Cat} \\
\mathbf{sem} = \boxed{2} \begin{bmatrix}
\mathbf{ind{:}\theta\text{-}dom} = \langle @\text{P-PAT} \circ @\text{P-AGT} \rangle \\
\mathbf{pred} = \boxed{4}\,\mathit{see} \\
\mathbf{arg1} = \boxed{3}\,e
\end{bmatrix}
\end{bmatrix} \\
\mathbf{sem} = \begin{bmatrix}
\mathbf{ind{:}\theta\text{-}dom} = \langle \boxed{2} \circ \boxed{5} \rangle \\
\mathbf{pred} = \boxed{6} \\
\mathbf{args} = \boxed{7}
\end{bmatrix}
\end{bmatrix} \\
\mathbf{sem} = \begin{bmatrix}
\mathbf{ind{:}\theta\text{-}dom} = \langle \boxed{5} \rangle \\
\mathbf{pred} = \mathit{and} \\
\mathbf{arg1} = \begin{bmatrix}
\mathbf{ind} = \boxed{8} \\
\mathbf{pred} = \boxed{6} \\
\mathbf{arg1} = \boxed{7}
\end{bmatrix} \\
\mathbf{arg2} = \begin{bmatrix}
\mathbf{ind} = \boxed{8} \\
\mathbf{pred} = \mathit{prop} \\
\mathbf{arg1} = \boxed{8} \\
\mathbf{arg2} = \begin{bmatrix}
\mathbf{ind} = \boxed{3} \\
\mathbf{pred} = \boxed{4} \\
\mathbf{arg1} = \boxed{3}
\end{bmatrix}
\end{bmatrix}
\end{bmatrix}
\end{bmatrix}
$$

Through the rule of (forward) functional application the two signs in (5-61) and (5-62) will yield the complex predicate in (5-57). The tree structure below gives a an informal characterization of the process as a whole using linear notation for semantic formulae (each $\Theta$ variable instantiates a single thematic formula).

$$\Big[\,[e_1 :< @\text{P-PAT}_1 \circ @\text{P-AGT}_1 >][\mathit{want}(e_1) \wedge @\text{P-AGT}_2 \wedge \mathit{prop}(e_1, \mathit{see}(e_2))]\,\Big]_{\mathrm{S/NP/NP}}$$

$$\Big[\,[e_1 < \boxed{4} \circ \boxed{3} \circ @\text{P-AGT}_1 >][\mathit{want}(e_1) \wedge \Theta_1]\,\Big]_{\mathrm{S/NP(/C_1)}} \Big/ \Big[\,\underbrace{[e_1 :< \boxed{3} \circ \Theta_1 >]\mathit{prop}(e_1, A_1)}_{\boxed{4}}\,\Big]_{\mathrm{S/NP(/C_1)}}$$

$$\Big[\,[e_1 :< \boxed{2} >][A_2 \wedge \boxed{1}]\,\Big]_{\mathrm{X}} \Big/ \Big[\,\Big[\,[e_1 :< \Theta \circ \boxed{2} >]A_2\,\Big]_{\mathrm{X}} \Big/ \Big[\,[e_1 :< @\text{P-PAT}_1 \circ @\text{P-AGT}_2 >]\underbrace{\mathit{prop}(e_1, \mathit{see}(e_2))}_{\boxed{1}}\,\Big]_{\mathrm{TV}}\,\Big]_{\mathrm{X/TV}}$$

## 5.2 On Causative Formation and Rule Interaction

The basic idea developed in the previous section was that argument selection principles concerning role realization can be factored out from the initial assignment of grammatical relations (i.e. default association of syntactic argument positions with thematic entailments of verb meanings), and encoded as constraints on morphosyntactic operations. The resulting approach is one where the range of morphosyntactic processes which are found in natural languages (e.g. passive and middle/inchoative formation, reflexivization, complex predicate formation and so on) are viewed as clusters of elementary operations on predicate structures such as argument satisfaction, $\theta$-entailment closure, $\theta$-binding, predicate composition, argument inheritance and $\theta$-satisfaction. (Of course, I assume that there are only a small number of elementary morphosyntactic operations, although whether the six types discussed so far suffice to provide a characterization of the whole range of morphosyntactic processes which are found across languages remains an empirical question.) In principle, these operations are free to interact so as to generate a variety of category structure configurations for each choice of predicate (or predicates, in the case of predicate composition). In practice, however, only a restricted number of interactions will result in admissible morphosyntactic derivations once the resulting category structure configurations are screened through argument selection constraints (i.e. $\theta$-ASSOC, P-AGT REAL and P-PAT REAL). This screening process is carried out in two stages. First, the range of admissible verb signs is constrained through template definitions in such a way that only predicates which comply with $\theta$-ASSOC have access to lexical rules. Second, the output of each morphosyntactic derivation involving one or more lexical rules is checked against *Realization Constraints Templates* which enforce restrictions relative to the syntactic encoding of proto-roles as subject, object and indirect object. This approach ensures that the range of morphosyntactic processes admissible in natural language corresponds to the set of clusters of elementary operations which modify predicate structures according to argument selection constraints. In addition, the clusters of operations in this set — where each cluster corresponds to a morphosyntactic process, i.e. passive, middle/inchoative etc. — can freely interact so as to *feed* one another as long as the requirements of each morphosyntactic process are met, and the final ouput is well-formed with respect to role realization constraints. Therefore, rule interactions are also constrained in terms of argument selection principles. In this section, I will show how this approach to GR-changing provides a natural account for a variety of phenomena concerning causative formation, and the interaction of causative with other morphosyntactic processes.

### 5.2.1 Causative Formation

It is well known that one of the basic parameters along which we can classify causative formation across languages concerns the syntactic realization of the *causee* participant, e.g. the subject of the complement verb.[13] English and Italian provide an illustrative example of this pattern. As shown in (5-63), the subject of a transitive which the causative verb takes as complement is realized as a direct object in English, while in Italian it surfaces as an indirect object.

| | | | | | |
|---|---|---|---|---|---|
| (5-63) | Mario | fece | comprare | il giornale | a lui |
| | Mario | made | to buy | the newspaper | to him |
| | "Mario made him buy the newspaper" | | | | |

Incidentally, this pattern is also observed in languages with affixal causatives, as the data in (5-64) from Chichewa and Chimwiini show; hence, it would be desirable to develop an account where the contrast regarding the syntactic realization of the *causee* participant can be explained independently of restrictions on word and phrase formation.

| | | | | | | |
|---|---|---|---|---|---|---|
| (5-64) | a | *Chichewa* | | | | |
| | | Anyani | a-na-meny-ets-a | ana | kwa buluzi | |
| | | baboons | SBJP-AGR-hit-CAUSE-ASP | children | to lizard | |
| | | "The baboons made the lizard hit the children" | | | | [Baker 88] |
| | b | *Chimwiini* | | | | |
| | | Mwa:limu | Ø-wa-andik-ish-ize | wa:na | xati | |
| | | teacher | SP-OP-write-CAUSE-ASP | children | letter | |
| | | "The teacher made the children write a letter" | | | | [Abasheik 79] |

[13] Cf. [Comrie 76], [Baker 88]; see also §2.1.

Within the approach to morphosyntactic processing developed in the previous section, the contrast in question can be stated in terms of argument inheritance. The basic idea is that in Italian/Chichewa causatives — henceforth *type 1* — the causative verb inherits all the arguments of its complement verb, while in English/Chimwiini causatives — henceforth *type 2* — only the complement subject is inherited. The difference is somewhat reminiscent of the the contrasts in Italian between verbs which allows for *clitic climbing* and verbs which do not as discussed in the previous section with respect to complex predicate formation.

**Type 1 Languages** Suppose, for example, we were to characterize the causative morpheme in Chichewa as an object control predicate (akin to *persuade*) which has the same properties of modals with respect to complex predicate formation:

- *Predicate Composition*

  When the semantics of the causative and its complement verb combine, the propositional role in the $\theta$-DOM of the causative verb is removed and the thematic entailments of the complement verb are transfered to the $\theta$-DOM of the causative verb

- *Argument Inheritance*

  The syntactic arguments of the complement verb become arguments of the matrix verb

- *Control*

  The individual argument variable of the complement subject is bound to that of the matrix object ($\theta$-binding); the semantics of the complement subject is combined with the matrix and complement verbs ($\theta$-satisfaction), and the complement subject sign is removed from the category structure of the result (argument satisfaction).

The tree structure below exemplifies this treatment of causative constructions by providing an informal derivation for the verbal complex *-meny-ets-* "make hit" (cf. (5-64a)).

$$\left[\left[e_1 : \left\langle \begin{array}{c} to(e_1,X_1)\circ \\ p\text{-}pat(e_2,X_2)\circ \\ p\text{-}agt(e_1,X_3)\end{array}\right\rangle\right][cause(e_1)\wedge prop(e_1,hit(e_2))\wedge p\text{-}agt(e_2,X_1)]\right]_{S/NP/NP/NP}$$

$$\left[\left[e_1 : \left\langle \begin{array}{c}[e_1 :< \boxed{1}\circ p\text{-}agt(e_2,X_1) >]A\circ \\ to(e_1,X_1)\circ\boxed{1}\circ p\text{-}agt(e_1,X_3)\end{array}\right\rangle\right]cause(e_1)\right]_{(S/NP/NP(/X))/S/NP(/X)}$$

$$\left[[e_1 :< p\text{-}pat(e_2,X_2)\circ p\text{-}agt(e_2,X_1) >]hit(e_2)\right]_{S/NP/NP}$$

Leaving aside details concerning phonology and the inheritance of thematic entailments,[14] a first characterization of the lexical rule for causative formation resulting from this analysis can be given as in (5-65) where the parentheses around the tag $\boxed{3}$ indicate that there can be arguments in the complement verb other than the subject.

(5-65)

rule = CAUSATIVE IN CHICHEWA *first version*

$$\texttt{in} = \left[\begin{array}{l}\textbf{cat} = \left[\textbf{catn} = sent\right] \Big/ \left[\begin{array}{l}\textbf{catn} = np\\ \textbf{sem} = \boxed{2}\left[\textbf{arg2} = \boxed{1}\right]\end{array}\right] \left(/\ \boxed{3}\right)\\ \textbf{sem} = \left[\begin{array}{l}\textbf{pred} = \boxed{4}\\ \textbf{args} = \boxed{5}\end{array}\right]\end{array}\right]$$

$$\texttt{out} = \left[\begin{array}{l}\textbf{cat} = \left[\textbf{catn} = sent\right] \Big/ \left[\begin{array}{l}\textbf{catn} = np\\ \textbf{sem} = \text{@P-AGT}\end{array}\right] \Big/ \left[\begin{array}{l}\textbf{catn} = np\\ \textbf{sem} = \left[\textbf{arg2} = \boxed{1}\right]\end{array}\right] \left(/\ \boxed{3}\right)\\ \textbf{sem} = \left[\begin{array}{l}\textbf{pred} = and\\ \textbf{arg1} = \left[\begin{array}{l}\textbf{pred} = and\\ \textbf{arg1} = \left[\begin{array}{l}\textbf{pred} = cause\\ \textbf{arg1} = e\end{array}\right]\\ \textbf{arg2} = \left[\begin{array}{l}\textbf{pred} = \boxed{4}\\ \textbf{arg1} = \boxed{5}\end{array}\right]\end{array}\right]\\ \textbf{arg2} = \boxed{2}\end{array}\right]\end{array}\right]$$

If the input verb to the rule is intransitive (with category type sent/np) as in the complex predicate *-sek-ets-* "make laugh" in (5-67b) , no arguments will be inherited (i.e. the option of instantiating the tag $\boxed{3}$ is not taken). In this case, the category of

[14]The reader is referred to the discussion on complex predicate formation provided in §5.1.2 for details concerning these issues.

the output verbal complex will be of type 'sent/np/np', as shown in (5-66), and the NP which binds the the complement subject will be treated as the object of a transitive (the p-pat instantiation is supported by ***Realization Constraint Templates***, cf. (5-10)). This is because the category structure of a complex predicate counts as a single predicate with respect to argument selection constraints (see §5.1.2).

(5-66) $$\left[ \textbf{cat} = \left[ \textbf{catn} = \textit{sent} \right] / \begin{bmatrix} \textbf{catn} = \textit{np} \\ \textbf{sem} = @\text{P-AGT} \end{bmatrix} / \begin{bmatrix} \textbf{catn} = \textit{np} \\ \textbf{sem} = @\text{P-PAT} \end{bmatrix} \right]$$

This is a desirable consequence, since the contrast between *type 1* and *type 2* languages concerning the syntactic realization of the complement subject is essentially restricted to contexts where the complement verb is transitive. As the Italian and Chichewa examples below indicate, the subject of an intransitive which the causative verb takes as complement is realized as a direct object (this realization pattern is also found in *type 2* languages).

(5-67) a Carlo ha fatto ridere tutti
"Carlo made everybody laugh"

b Buluzi a-na-wa-sek-ets-a ana
lizard SP-PAST-OP-laugh-CAUSE-ASP children
"The lizard made the children laugh"

If the complement verb is transitive (with category type sent/np/np), the tag $\boxed{3}$ in (5-65) instantiates an object NP. In this case, ***argument inheritance*** will give rise to a ditransitive category structure for the resulting causative verbal complex. For example, the category attribute for the causative verbal complex *-meny-ets-* "make hit" in (5-64a) will be:

(5-68) $$\left[ \begin{array}{l} \textbf{cat} = \left[ \textbf{catn} = \textit{sent} \right] / \begin{bmatrix} \textbf{catn} = \textit{np} \\ \textbf{sem} = @\text{P-AGT} \end{bmatrix} \\ \qquad\qquad\qquad\qquad / \begin{bmatrix} \textbf{catn} = \textit{np} \\ \textbf{sem} = \left[ \textbf{arg2} = \boxed{1} \right] \end{bmatrix} \\ \qquad\qquad\qquad\qquad / \begin{bmatrix} \textbf{catn} = \textit{np} \\ \textbf{sem} = @\text{P-PAT} \end{bmatrix} \end{array} \right]$$

Here, however, a problem concerning role realization constraints arises since the inherited NP, a proto-patient argument, is structurally encoded as an indirect object. (Recall that, according to the P-PAT REAL constraint, the proto-patient role must be linked to the innermost subcategorized NP immediately following the active sign linked to the proto-agent.) The problem arises because the ordering of argument in the output category structure of the lexical rule in (5-65) is far too constraining in that it encodes the NP which binds the complement subject as a proto-patient arguments (i.e. immediately following the proto-agent argument). Such a strict ordering, however, can be easily relaxed. Notice in fact that since specifications relative to role realization can be deferred to *Realization Constraint Templates*, the category structure of the ouput template in (5-65) needs only encode $\theta$-ASSOC restrictions. Consequently, the relative order of arguments can be underspecified as shown in (5-69) where set notation is used as an abbreviation for the disjunction of category structures which results from $\theta$-ASSOC. (This underspecification is also needed to allow causative formation to interact with other GR-changing rules (e.g. passive) as will be shown later.)

(5-69)

rule = CAUSATIVE IN CHICHEWA (*final version*)

$$\texttt{in} \;=\; \left[\begin{array}{l} \texttt{cat} = \left[\texttt{catn} = \textit{sent}\right] / \left[\begin{array}{l}\texttt{catn} = \textit{np}\\ \texttt{sem} = \boxed{2}\left[\texttt{arg2} = \boxed{1}\right]\end{array}\right] \left(/\ \boxed{3}\right) \\ \texttt{sem} = \left[\begin{array}{l}\texttt{pred} = \boxed{4}\\ \texttt{args} = \boxed{5}\end{array}\right] \end{array}\right]$$

$$\texttt{out} \;=\; \left[\begin{array}{l} \texttt{cat} = \left[\texttt{catn} = \textit{sent}\right] / , \left\{ \left[\begin{array}{l}\texttt{catn} = \textit{np}\\ \texttt{sem} = \texttt{@P-AGT}\end{array}\right], \left[\begin{array}{l}\texttt{catn} = \textit{np}\\ \texttt{sem} = \left[\begin{array}{l}\texttt{pred} = [\,]\\ \texttt{arg2} = \boxed{1}\end{array}\right]\end{array}\right], (\boxed{3}) \right\} \\ \texttt{sem} = \left[\begin{array}{l} \texttt{pred} = \textit{and} \\ \texttt{arg1} = \left[\begin{array}{l} \texttt{pred} = \textit{and} \\ \texttt{arg1} = \left[\begin{array}{l}\texttt{pred} = \textit{cause}\\ \texttt{arg1} = \textit{e}\end{array}\right] \\ \texttt{arg2} = \left[\begin{array}{l}\texttt{pred} = \boxed{4}\\ \texttt{arg1} = \boxed{5}\end{array}\right] \end{array}\right] \\ \texttt{arg2} = \boxed{2} \end{array}\right] \end{array}\right]$$

Note that the proto-role of the argument NP which binds the complement subject is also be underspecified. Its instantiation is context dependent, according to role realization constraints. With a transitive verb as input, for example, the output category structure will be as in (5-70) where the p-pat argument corresponds to the NP inherited from the input verb and the NP linked to the unspecified role is the argument which controls the input subject.

$$
(5\text{-}70)\quad
\left[
[\mathbf{catn} = \mathit{sent}] / \left\{
\begin{array}{l}
\left[\begin{array}{l}\mathbf{catn} = \mathit{np}\\ \mathbf{sem} = @\text{P-AGT}\end{array}\right],\\
\left[\begin{array}{l}\mathbf{catn} = \mathit{np}\\ \mathbf{sem} = [\mathbf{pred} = [\,]]\end{array}\right],\\
\left[\begin{array}{l}\mathbf{catn} = \mathit{np}\\ \mathbf{sem} = @\text{P-PAT}\end{array}\right]
\end{array}
\right\}
\right]
$$

Following the application of *Realization Constraint Templates*, the underspecified role will instantiate a prepositional role and will be encoded as an indirect object, e.g.

$$
(5\text{-}71)\quad
\left[
\begin{array}{l}
[\mathbf{catn} = \mathit{sent}] \;/\; \left[\begin{array}{l}\mathbf{catn} = \mathit{np}\\ \mathbf{sem} = @\text{P-AGT}\end{array}\right]\\
\qquad\qquad\qquad /\; \left[\begin{array}{l}\mathbf{catn} = \mathit{np}\\ \mathbf{sem} = @\text{P-PAT}\end{array}\right]\\
\qquad\qquad\qquad /\; \left[\begin{array}{l}\mathbf{catn} = \mathit{np}\\ \mathbf{sem} = [\mathbf{pred} = \mathit{prep}]\end{array}\right]
\end{array}
\right]
$$

For *type 1* languages such as Italian where causative constructions involve phrase formation, the basic insights of this approach to causative formation can be expressed in the template for the causative verb as shown in (5-72).

(5-72)

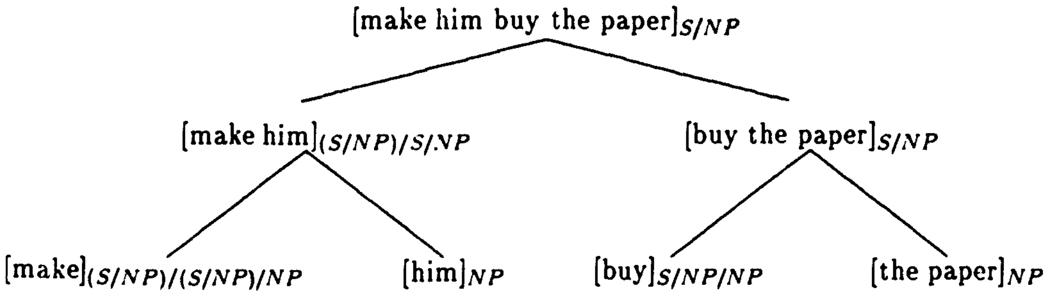
$$
\left[
\begin{array}{l}
\mathbf{cat} = [\mathbf{catn} = \mathit{sent}] / \left\{
\begin{array}{l}
\left[\begin{array}{l}\mathbf{catn} = \mathit{np}\\ \mathbf{sem} = @\text{P-AGT}\end{array}\right],
\left[\begin{array}{l}\mathbf{catn} = \mathit{np}\\ \mathbf{sem} = [\mathbf{arg2} = \boxed{1}]\end{array}\right], (\boxed{3}),\\
\left[\begin{array}{l}
\mathbf{cat} = [\mathbf{catn} = \mathit{sent}] / \boxed{2} \left[\begin{array}{l}\mathbf{catn} = \mathit{np}\\ \mathbf{sem} = [\mathbf{arg2} = \boxed{1}]\end{array}\right] \left(/\ \boxed{3}\right)\\
\mathbf{sem} = \left[\begin{array}{l}\mathbf{pred} = \boxed{4}\\ \mathbf{args} = \boxed{5}\end{array}\right]
\end{array}\right]
\end{array}
\right\}\\
\mathbf{sem} = \left[\begin{array}{l}
\mathbf{pred} = \mathit{and}\\
\mathbf{arg1} = \left[\begin{array}{l}\mathbf{pred} = \mathit{cause}\\ \mathbf{arg1} = e\end{array}\right]\\
\mathbf{arg2} = \boxed{2}
\end{array}\right]
\end{array}
\right]
$$

As in the example on complex predicate formation discussed in the previous section, the only significative difference between the lexical rule in (5-69) and the sign above concerns predicate composition. In (5-69) the semantics of the complement verb is directly combined with the semantics of the causative verb in the ouput template of the rule, while when causative verb is encoded as a verb sign of its own as in (5-72) this combination is done through functional application (see §5.1.2 for details). In both cases, causative verbal complexes in *type 1* languages form a syntactically monoclausal structure (e.g.

a complex predicate). The validity of this assumption is independently motivated by the fact that in Romance languages (a subgroup of *type 1* languages), causative verbal complexes count as a single V-node/predicate boundary for clitic placement. As shown in (5-73), clitics or double clitics may be adjacent to the causative verb rather than to their understood governor.

| | | | |
|---|---|---|---|
| (5-73) | a | *French* | Elle **les** fera partir |
| | | *Italian* | Lei **li** farà andar via |
| | | *Spanish* | Ella **los** harà partir |
| | | | "She'll have them(CLITIC) leave" |
| | b | *French* | Elle **lui** fera manger ce gateau |
| | | *Italian* | Lei **gli** farà mangiare quella torta |
| | | *Spanish* | Ella **le** harà comer aquella torta |
| | | | "She'll have him(CLITIC) eat that cake |
| | c | *French* | Elle **le lui** fera manger |
| | | *Italian* | Lei **gliela** fará mangiare |
| | | *Spanish* | Ella **se lo** harà comer |
| | | | "She'll have him(CLITIC) eat it(CLITIC) |

**Type 2 Languages** Causative formation in *type 2* languages involve predicate composition and object control, while argument inheritance is strictly limited to the complement subject. As with *type 1* languages, the inherited complement is removed from the category structure of the causative through the argument satisfaction operation which together with $\theta$-binding and $\theta$-satisfaction characterize *control*. In English, where causative structures involve phrase formation, this approach can be implemented by revising the causative verb sign in (5-72) in such a way that the object(s) of a complement verb (if there are any) are effectively consumed before the complement verb combines with the causative verb, e.g.

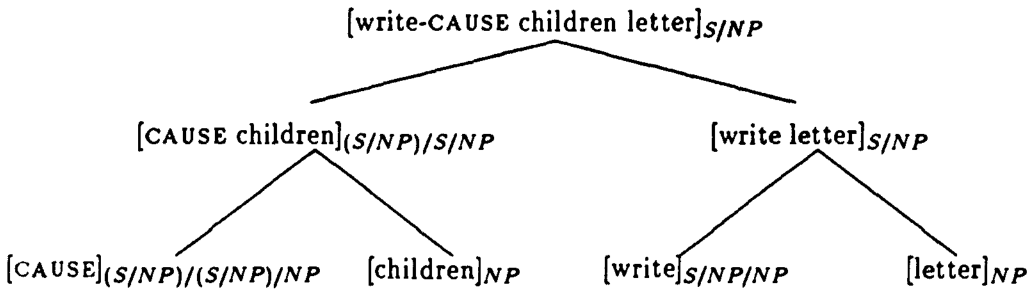


This is done by removing the optional tag in the active and result category structures of (5-72) which makes the inheritance of complement objects possible:

$$(5\text{-}74)\quad \left[\mathbf{cat} = \left[\mathbf{catn} = \mathit{sent}\right] / \left\{ \begin{matrix} \begin{bmatrix}\mathbf{catn} = \mathit{np}\\ \mathbf{sem} = @\text{P-AGT}\end{bmatrix}, \begin{bmatrix}\mathbf{catn} = \mathit{np} \\ \mathbf{sem} = [\mathbf{arg2} = \boxed{1}]\end{bmatrix}, \\ \left[\mathbf{cat} = [\mathbf{catn} = \mathit{sent}] / \begin{bmatrix}\mathbf{catn} = \mathit{np}\\ \mathbf{sem} = [\mathbf{arg2} = \boxed{1}]\end{bmatrix}\right] \end{matrix} \right\}\right]$$

Because no arguments of the complement verb can be passed on to the matrix causative, the matrix object which binds the complement subject will always be realized as a direct object.

In *type 2* languages where causative constructions involve word formation, however, this characterization is not available in the context of the present account. This is because we are expressly confining word formation operations to lexical rules, and lexical rules are not allowed to intermingle with functional application rules. Consequently, a verb cannot combine with any of its object arguments prior to causativization. For example, a derivation such as the one below for the sentence in (5-60b) would not be allowed in Chimwiini.




To give an account of Chimwiini causatives by means of lexical rule, I will treat the objects of the complement predicate as thematically bound adjuncts. The basic idea is that the object(s) of a verb undergoing causativization are removed through argument satisfaction. while the thematic entailments which were linked to the removed NPs are inherited by the causative verbal complex through predicate composition. The tree structure below provides an informal characterization of this approach for the Chimwiini verbal complex *-andik-ish-* "make write" in (5-61).

$$\left[\left[e_1 : \left\langle \begin{array}{c} to(e_1, X_1)\circ \\ p\text{-}pat(e_2, X_2)\circ \\ p\text{-}agt(e_1, X_3) \end{array} \right\rangle\right] [cause(e_1) \wedge prop(e_1, hit(e_2)) \wedge p\text{-}agt(e_2, X_1)]\right]_{S/NP/NP}$$

$$\left[\left[e_1 : \left\langle \begin{array}{l} [e_1 :< \boxed{1} \circ p\text{-}agt(e_2, X_1) >]A\circ \\ to(e_1, X_1) \circ \boxed{1} \circ p\text{-}agt(e_1, X_3) \end{array} \right\rangle\right] cause(e_1)\right]_{(S/NP/NP)/S/NP/NP}$$

$$\left[\left[e_1 : \left\langle p\text{-}pat(e_2, X_2) \circ p\text{-}agt(e_2, X_1) \right\rangle\right] write(e_2)\right]_{S/NP/NP}$$

Following the analysis proposed for the agent phrase in §5.1.1, object phrases can be encoded as VP-modifiers (e.g. (S/NP)/S/NP) which remove the outermost thematic entailment in the $\theta$-DOM of the causative verbal complex they combine with and incorporate it with its semantics. According to this approach, the causative lexical rule for *type 2* languages such as Chimwiini is:

(5-75)

**rule** = CAUSATIVE (*Chimwiini*)

$$\texttt{in} = \left[\begin{array}{l} \texttt{cat} = \left[\texttt{catn} = sent\right] / \left[\begin{array}{l} \texttt{catn} = np \\ \texttt{sem} = \boxed{2}\left[\begin{array}{l} \texttt{pred} = p\text{-}agt \\ \texttt{arg2} = \boxed{1} \end{array}\right] \end{array}\right] \left(/ \; []\right) \\ \texttt{sem} = \left[\begin{array}{l} \texttt{ind:}\theta\texttt{-dom} = \langle \boxed{3} \circ \boxed{2} \rangle \\ \texttt{pred} = \boxed{5} \\ \texttt{arg1} = \boxed{6} \end{array}\right] \end{array}\right]$$

$$\texttt{out} = \left[\begin{array}{l} \texttt{cat} = \left[\texttt{catn} = sent\right] / \left\{ \left[\begin{array}{l} \texttt{catn} = np \\ \texttt{sem} = \boxed{7}@\text{P-AGT} \end{array}\right], \left[\begin{array}{l} \texttt{catn} = np \\ \texttt{sem} = \boxed{8}\left[\begin{array}{l} \texttt{pred} = p\text{-}pat \\ \texttt{arg2} = \boxed{1} \end{array}\right] \end{array}\right] \right\} \\ \texttt{sem} = \left[\begin{array}{l} \texttt{ind:}\theta\texttt{-dom} = \langle \boxed{8} \circ \boxed{3} \circ \boxed{8} \rangle \\ \texttt{pred} = and \\ \texttt{arg1} = \left[\begin{array}{l} \texttt{pred} = and \\ \texttt{arg1} = \left[\begin{array}{l} \texttt{pred} = cause \\ \texttt{arg1} = e \end{array}\right] \\ \texttt{arg2} = \left[\begin{array}{l} \texttt{pred} = \boxed{5} \\ \texttt{arg1} = \boxed{6} \end{array}\right] \end{array}\right] \\ \texttt{arg2} = \boxed{2} \end{array}\right] \end{array}\right]$$

Note that while in general thematically bound adjuncts are optional. In this case, however, the syntactic realization of the role(s) which prior to causativization were linked to the complement object(s) ( $\boxed{3}$ in the output template of the rule above) is a necessary prerequisite to the realization of the subject role of the causative verbal complex (e.g. $\boxed{6}$ in the result template of the rule above).

### 5.2.2 Morphosyntactic Interactions

We saw in chapter 2 that there are severe restrictions on the range of morphosyntactic interactions allowed across languages. In most languages that have been investigated to-date, for example, causative formation is not possible with a passive verb ([Aissen 74]). Some illustrative examples are shown in (5-76).

(5-76) a *Turkish*

| | | |
|---|---|---|
| *Hasan | bavulu | ac-ıl-dır-dı |
| Hasan | suitcase | open-PASS-CAUSE-PAST |

"Hasan had the suitcase (be) open" [Aissen 74]

b *Chichewa*

| | | | |
|---|---|---|---|
| *Kalulu | a-na-meny-edw-ets-a | anyamata | (ndi anyani) |
| hare | SP-PAST-hit-PASS-CAUSE-ASP | boys | (by baboons) |

"The hare made the boys be hit by the baboons" [Baker 88]

c *Italian*

| | | | | | |
|---|---|---|---|---|---|
| *Mario | fece | essere compra-to | il giornale | (da Giorgio) |
| Mario | made | to be buy-PASS | the newspaper | (by Giorgio) |

"Mario had the newspaper bought (by Giorgio)"

d *French*

| | | | | | |
|---|---|---|---|---|---|
| *Jean | a fait | être | lu | le livre | (par Pierre) |
| Jean | made | to be | read-PASS | the book | (by Pierre) |

"Jean made the book be read (by Pierre)"

Recall that in our approach causative formation involves *control* of the embedded subject. In the canonical case the thematic role associated with the embedded subject will be a proto-agent, and in such cases causative formation is generally possible. By contrast, the embedded subject of all the sentences in (5-76) corresponds to a proto-patient; this is simply because passivization involves removal of the proto-agent role from the category structure of a transitive verb (cf. §5.1.1). The impossibility of making a passive verb into a causative can thus be captured by specifying that the thematic role associated with the subject of the complement verb of a causative must be a proto-agent. In other words, causative formation involves object *control* of an embedded proto-agent subject; if the embedded verb does not have a subject which matches this specification causative formation fails. The intuitive motivation for this restriction should be rather obvious: the causee actant of a causative complex predicate is typically understood as being in a position to be the protagonist of an event, and therefore should be characterized as a proto-agent in the complement predicate. This hypothesis is supported by the fact that causative formation is also not possible with verb forms other than passive whose proto-agent argument has been removed through argument satisfaction. For example, in Italian neither an inchoative nor a reflexive verb can undergo causative formation, as shown in (5-77).

(5-77) a *Il sole fece scioglier-si la neve
The sun made to melt-INCH the snow
"The sun made the snow melt"

b *Carlo fece rasar-si
Carlo made to shave-INCH
"Carlo$_i$ made someone shave him$_i$"

As we saw in the previous section both middle and reflexive formation involve removal of the proto-agent argument. Note that the ungrammaticality of the sentences in (5-77) cannot be explained as a restriction on either cliticization or reflexive anaphora. As shown in (5-78) verb+clitic structures may enter into causative complex predicates, and a reflexive pronoun like *se stesso* may be bound by the embedded subject.

(5-78) a Carlo fece leggerli a Maria
"Carlo made Maria read them(clitic)"

b Con le minacce, fecero accusare **se stesso** a Giovanni
"With threats, they made Giovanni accuse himself" [Burzio 86]

These restrictions on causative formation are by no means specific to Italian. For example causative/reflexive interactions are also ruled out in Turkish as shown in (5-79).

(5-79) *Hasan-ı-a yıka-n-dı-dı-m
Hasan-ACC/DAT wash-SELF-CAUSE-PAST-1SG
"I made Hasan wash himself" [Aissen 74]

Standard French and Spanish also exhibit the same kind of restrictions.[15]

[15]Substandard deviations, such as the one discussed by [Zubizarreta 85] (cf. §2.1), can be dealt in terms of *complement coercion*. This is a rather powerful technique, described by [Sag & Pollard 88] with respect to controller shifts, which makes it possible to interpolate a predicate between the matrix and complement verbs of a complemented structure. The interpolation of such a predicate can be used to modify a complement inchoative or reflexive verb so as to meet the specifications imposed by the causative verb.

Within the treatment of causativization developed above, this restriction on causative formation can be encoded uniformly across level of grammatical descriptions. Where causativization involves word formation — as in Chichewa and Turkish — the requirement that the complement subject be linked to a proto-agent role is encoded in the input template of the lexical rule, e.g.

(5-80) **rule** = CAUSATIVE (*Chichewa*)

$$\mathbf{in} \;=\; \left[\mathbf{cat} = \left[\mathbf{catn} = \mathit{sent}\right] \Big/ \begin{bmatrix}\mathbf{catn} = \mathit{np} \\ \mathbf{sem} = @\text{P-AGT}\end{bmatrix} \Big( / \;\boxed{3}\Big)\right]$$

**out** = ...

In languages such as Italian where the causative verb is an independent morpheme, the same requirement is expressed in the active sign of the causative verb (cf. (5-72)) which corresponds to the complement verb, as shown below.

$$\text{(5-81)} \quad \left[\mathbf{cat} = \left[\mathbf{catn} = \mathit{sent}\right] \Big/ \left\{\begin{matrix}\left[\mathbf{catn} = \mathit{np}\right], \left[\mathbf{catn} = \mathit{np}\right], (\boxed{3}), \\ \left[\begin{matrix}\mathbf{cat} = \left[\mathbf{catn} = \mathit{sent}\right] \Big/ \begin{bmatrix}\mathbf{catn} = \mathit{np} \\ \mathbf{sem} = @\text{P-AGT}\end{bmatrix} \\ \Big( / \;\boxed{3}\Big)\end{matrix}\right]\end{matrix}\right\}\right]$$

Consequently, the impossibility of forming causative verbal complexes with passive, reflexive and inchoative complements is given a uniform characterization while keeping the levels of word and phrase formation distinct.

The regime of constraints emerging from the requirements of each morphosyntactic rule is such that those rule interactions which are allowed are effectively recognized as possible morphosyntactic derivations by the system. For example, in both Italian and Chichewa causatives can be passivized in such a way that the complement object becomes the subject of the entire complex predicate, e.g.

| | | | | | | |
|---|---|---|---|---|---|---|
| (5-82) | a | Ana | a-na-meny-ets-edw-a | kwa | buluzi | ndi aniany |
| | | children | SP-PAST-hit-CAUSE-PASS-ASP | to | lizard | by baboons |

"The children were made to be hit by the lizard by the baboons" [Baker 88]

| | | | | | |
|---|---|---|---|---|---|
| b | Il giornale | fu fatto | comprare | a lui | |
| | the newspaper | was made | to buy | to him | |

"The newspaper was made to be bought by him"

In the Chichewa case, the possibility of passive-causative interactions follows from the fact that the output of the causative rule matches the requirements imposed on the input of passive. Given as imput a transitive verb such as *-meny-* "hit", the Chichewa causative rule in (5-67) will give as output a sign structure whose category structure is as in (5-83) where the proto-patient NP is the object argument inherited from the complement verb ("@PREP" is a template name for a prepositional thematic formula).

(5-83) $$\left[ \left[\mathbf{catn} = sent\right] \Big/ \left\{ \begin{bmatrix} \mathbf{catn} = np \\ \mathbf{sem} = @\text{P-AGT} \end{bmatrix}, \begin{bmatrix} \mathbf{catn} = np \\ \mathbf{sem} = @\text{PREP} \end{bmatrix}, \begin{bmatrix} \mathbf{catn} = np \\ \mathbf{sem} = @\text{P-PAT} \end{bmatrix} \right\} \right]$$

As was mentioned earlier, the set notation is used to indicate that the arguments are unordered with respect to each other. Therefore, the category structure in (5-83) will match the input of the passive rule below (cf. §5.1) where the proto-agent argument occurs as the outermost active NP sign in the category structure of the input template.

(5-84) $$\begin{aligned} \mathbf{rule} &= \text{PASSIVE} \\ \mathbf{in} &= \left[ \mathbf{cat} = \boxed{1} \Big/ \begin{bmatrix} \mathbf{catn} = np \\ \mathbf{sem} = @\text{P-AGT} \end{bmatrix} \right] \\ \mathbf{out} &= \left[ \mathbf{cat} = \boxed{1} \right] \end{aligned}$$

Passive-causative interactions in Italian can also be dealt in similar terms. The only difference with the Chichewa case is that in Italian the causative verb is passivized prior to combining with its complement verb. This follows from the fact that causative formation in Italian takes place in syntax through functional application while passive is a lexical rule. The fact that the causative verbs passivizes before combining with its complement verb, however, does not change the basic account illustrated above for Chichewa. The causative sign will in fact provide well-formed input for the passive rule, just as the causativized transitive in the Chichewa example above does. This is because prior to the application of *Role Realization Constraints*, the arguments in the category structure of the causative sign are unordered with respect to each other; therefore the category structure of the causative as a whole can instantiate a category structure where the proto-agent argument occurs as the outermost active NP sign as required by the passive rule.

$$(5\text{-}85)\quad \left[\ \mathbf{cat} = \left\{ \begin{array}{l} \left[\mathbf{catn} = \mathit{sent}\right], \begin{bmatrix}\mathbf{catn} = \mathit{np} \\ \mathbf{sem} = \text{@P-AGT}\end{bmatrix}, \begin{bmatrix}\mathbf{catn} = \mathit{np} \\ \mathbf{sem} = \text{@PREP}\end{bmatrix}, (\boxed{1}), \\ \left[\mathbf{cat} = \left[\mathbf{catn} = \mathit{sent}\right] / \begin{bmatrix}\mathbf{catn} = \mathit{np} \\ \mathbf{sem} = \text{@P-AGT}\end{bmatrix} \left( / \ \boxed{1}\right)\right] \end{array} \right\}\ \right]$$

The possibility of passive-causative interactions in Chichewa and Italian is thus captured in a uniform way even though causative formation involves distinct morphophonological processes in these two languages (i.e. word and phrase formation respectively).

## 5.3 Summary

According to the approach to morphosyntactic processing developed in this chapter, restrictions on GR-changing rules and rule interactions are expressed in terms of argument selection constraints. The assignment of grammatical relations as a whole is characterized as an incremental accretion of information relative to the syntactic realization of argument roles. This process is essentially monotonic in that the specifications contributed by GR-changing operations and argument selection constraints are never overridden. Monotonicity is achieved by factoring out constraints which regiment the realization of proto-roles as subject and object phrases (i.e. P-AGT REAL and P-PAT REAL) from template definitions, and by encoding these constraints as restrictions on the output of lexical rules. Subcategorized arguments in verb templates are always linked to thematic roles; nevertheless, the ordering of arguments on the category structure of these templates which yields the final specification of grammatical relations is underspecified. GR-changing rules add constraints on verb templates through a limited set of operations in such a way that the range of admissible role realization patterns is progressively reduced. Because these operations are information-preserving, only those templates which are compatible with the specifications contained in the input of a given rule will be processed by that rule. The same holds for rule interactions. where a GR-changing rule takes as input the output of another GR-changing rule. The output of each successful morphosyntactic derivation is checked for consistency against *Realization Constraint Templates* which encode thematic restrictions on the assignment of grammatical relations. At this stage, those verb templates which do not comply with argument selection principles are filtered out, while those where grammatical relations are still underspecified receive full functional instantiation.

Although this approach to GR-changing is essentially stated in terms of lexical rules, the basic insights which lie at its basis are also expressible in syntax. This is simply because in UCG there is a natural correspondence between signs and lexical rules. Informally, a lexical rules can be seen as a functor sign whose active and result parts correspond to the input and output of the rule respectively. Therefore, the same constraints which are encoded in a given lexical rule can essentially be expressed syntactically by designing a functor sign which has the same combinatorial properties of that rule. This correspondence makes it possible to generalize sets of constraints on GR-changing at both the phrase and word formation levels.

# Chapter 6

# Thematic and Aspectual Information in Verb Semantics

In the previous two chapters we saw that many crosslinguistic generalizations about argument selection, selection change and morphosyntactic interactions can be made to follow under a regime of constraints which integrates information about the participant roles and category structure of predicates. The goal of this chapter is to show how this approach can be augmented by bringing aspectual information to bear on lexically governed processes and the thematic make-up of predicates.

The need for this augmentation arises from two main factors:

1. lexical aspect is instrumental in the determination of proto-roles
2. aspectual and thematic information may independently contribute to the morpholexical and syntactic functionality of predicates.

The observation that aspectual and thematic information are closely related was originally due to [Verkuyl 72] who proposed to analyze the semantics of telic aktionsart in terms of the role "theme". More recently however, the preference has been in favour of the inverse approach, i.e. determination of thematic properties in terms of aspectual information — a change of perspective probably due to the fact that the study of aspect has progressed more rapidly than the study of thematic relations. For example, [Dowty 87] includes the property *incremental theme*[1] among those which contribute to

[1] I.e. the property ascribed to the argument of a verb whose reference properties are involved in the

the determination of the proto-patient role, and [Tenny 87] proposes to define *affectedness* — a property which is instrumental in the determination of the theme and patient roles — in terms of telicity. Evidence that aspectual information may independently contribute to the morpholexical and syntactic functionality of predicates has been recently given in [Zaenen 88, Zaenen 89] where it is shown that seemingly equivalent functional constraints on distinct (morpho)syntactic processes may effectively originate either from aspectual properties only, or from a combination of aspectual and thematic properties. For example, auxiliary selection and the formation of impersonal passives with Dutch intransitive verbs both appear to correlate with the possibility/impossibility of ascribing partial object functionality to the subject argument; nevertheless, auxiliary selection phenomena can be largely accounted for in terms of aspectual properties of verbs, while with impersonal passives the addition of a thematic characterization (ie. *controllability*) is needed (see section 2.3 below).

In unfolding the relevance of lexical aspect to grammar and its relation to thematic information, I will concentrate on natural language phenomena which have been brought to attention in connection with the classification of intransitive predicates into *unaccusatives* and *unergatives*. Following the basic insights of Perlmutter's *Unaccusative Hypothesis* ([Perlmutter 78]), it has been often assumed that the basis for this divergence lies in the ability of some intransitive subjects to exhibit the morpholexical and syntactic functionality of a transitive object. In multistratal frameworks such as RG and GB, this fact has been characterized by representing unaccusative subjects as "initial/deep" objects. However, while the insight according to which the subject of unaccusative verbs behaves "in some ways" like a transitive object is observationally correct, the assumption that unaccusative subjects are initial/deep objects preempts the possibility of a natural analysis in cases where unaccusative subjects and initial/deep objects part ways. For example, we saw in §2.1.1 and §5.2 that causative formation fails if the complement subject is associated with an *internal/proto-patient* role, e.g. the type of thematic specification which qualifies an initial/deep object. The assumption that the subject of unaccusatives is an initial/deep object would thus lead us to predict that causative formation with unaccusative complement verbs should fail. However, this prediction is not borne out as shown in §2.1.1 (see also §6.2 below). To be sure, close inspection of causative formation with unaccusatives, and other cases where the treatment

determination of telic aspect for the event denoted by the resulting verb phrase or sentence, see 3.1.1 and section 1 below.

of unaccusativity proposed in RG and GB is at odds with the data, strongly suggests that unaccusativity cannot be dealt with simply in terms of initial/deep grammatical functions or thematic roles.

In keeping with the general goal of the chapter, my aim will be to show that the Unaccusative Hypothesis is better characterized as a convergence of thematic and aspectual properties of predicates. My point of departure will be the observation that a considerable number of non-stative predicates can give rise to either a process or telic reading according to whether their *theme* argument — the participant which is understood as undergoing change of state to location — has *cumulative* or *quantized* reference. For example, the possibility of modifying a predicate such as "drink" or "arrive" with a time adverbial so as to obtain an atelic reading can be significantly affected by the occurrence of a *count* NP or *mass/bare plural* noun in the theme position as shown in (6-1).

(6-1) a John drank $\left\{ \begin{array}{l} \textit{beer} \\ \textit{??a glass of beer} \end{array} \right\}$ all day

b $\left\{ \begin{array}{l} \textit{Letters of solidarity} \\ \text{??two letters of solidarity} \end{array} \right\}$ arrived all day

Following [Krifka 87], I will assume that this relation between nominal and event reference can be captured by characterizing the semantics of telic aktionsart in terms of a homomorphism from algebraically structured proto-patient denotations into algebraically structured event denotations. Reasoning in terms of legal interactions between thematic and aspectual information, I will suggest that the (partial) object functionality attributed to the subject of some intransitive verbs under the Unaccusative Hypothesis can be derived from the following generalization:

(6-2) The reference properties of the participant of an event can contribute to the (internal) constitution of the event if and only if that participant is compatible with a thematic specification which is lower than a proto-agent.

One of the conclusions which I will draw is that while the relation between aspectual and thematic information can be captured by implicational statement such as the one in (6-2), ultimately neither one of the two types of linguistic information can be derived from the other.

The chapter is organized in three sections. §6.1 contains an introductory discussion of the contribution of argument NPs to aspect compositionality, and a first account of the thematic-aspectual interface. In §6.2, further motivations and refinements for this preliminary characterization will be provided in the light of natural language phenomena which have been discussed with reference to the Unaccusative Hypothesis. In §6.3, I will show how the treatment of unaccusativity and the relation between aspectual and thematic information presented in §6.1 and §6.2 can be given a precise interpretation within the UCG framework developed in the previous chapters.

## 6.1 Aspect Compositionality and Proto-Roles

The idea that the aspectual make-up of a sentence is built compositionally by computing the reference properties of the major syntactic constituents of the sentence goes back to [Dowty 72] and [Verkuyl 72].[2] Since then, the question of how to formalize the contribution of arguments to sentence aspect properly has been widely discussed, and a number of accounts have been proposed both in the context of interval and event based approaches to temporal semantics ([Dowty 79, Hinrichs 85, Krifka 87, Verkuyl 89]). A detailed review of these accounts falls outside the scope of this thesis; I shall therefore concentrate on Verkuyl's most recent treatment as a way of giving a characterization of the issues at stake.

### 6.1.1 The Contribution of Subject and Object NPs

The basic insights underlying Verkuyl's approach can be briefly summarized as follows:

- the aspect of a sentence is *terminative* (i.e. telic) if its verb expresses "progress in time" or "change" (i.e. the verb is non-stative) and the verb's arguments all express a specified quantity (e.g. they are countable).
- the aspect of a sentence is *durative* (i.e. stative or processual) if either its verb is stative, at least one of the verb's argument NPs expresses an unspecified quantity (the head of the NP is a mass/bare plural noun), or both.

The sentences in (6-3) give an example of Verkuyl's generalizations — (+A) is the feature assigned to verbs expressing "progress in time" or "change", and (+B) is the feature assigned to NPs which express a specified quantity.

[2]The observation that the aspectual classification of verbs should include reference to the object NP was already present in Vendler's aspectual classification of English verbs ([Vendler 67]).

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| (6-3) | (a) | She | (+B) | played | (+A) | that sonata | (+B) | terminative |
| | (b) | She | (+B) | played | (+A) | sonatas | (−B) | durative |
| | (c) | She | (+B) | hated | (−A) | that sonata | (+B) | durative |
| | (d) | She | (+B) | hated | (−A) | sonatas | (−B) | durative |
| | (e) | Soldiers | (−B) | played | (+A) | that sonata | (+B) | durative |
| | (f) | Adults | (−B) | hated | (−A) | that sonata | (+B) | durative |
| | (g) | Nobody | (−B) | hated | (−A) | sonatas | (−B) | durative |
| | (h) | Soldiers | (−B) | didn't play | −(+A) | sonatas | (−B) | durative |

([Verkuyl 89], p. 79)

The only sentence in (6-3) that has terminative aspect is (a) where the verb is neither stative not (inherently) processual and the argument NPs are both countable. The sentences in (6-3b) and (6-3e) have durative aspect since in both cases of the verb's arguments is a bare plural and as such it does not express a specified quantity. The sentence (6-3c) is also durative because the verb expresses neither "change" nor "progress in time". In (6-3d) and (6-3f), durativity in induced by both the verb and one of its arguments, while in (6-3g-h) durativity results from all the constituents of the sentence (i.e. negation induces durativity whether occurring in the NP (e.g. *nobody*) or in the verb (*did not play*), see [Verkuyl 87b] and [Krifka 87]).

Verkuyl's approach was initially couched within a generative semantics framework where rules governing aspect compositionality were essentially formulated in an ad hoc fashion. More recently Verkuyl ([Verkuyl 87a, Verkuyl 87b, Verkuyl 89]) has reproposed his account within a model-theoretic framework. The fundamental design of this new version can be summarized into four basic steps. First, the property "specified quantity of A" (henceforth [±SQA]) is defined in terms of the theory of generalized quantifiers (cf. [Barwise & Cooper 81], [van Benthem 83]) as indicated in (6-4).

(6-4) a Definition: *Specified Quantity of A*, [+SQA]
An $NP$ of the form $Det\ N$, where $[\![N]\!] = A$ and where $[\![Det]\!]$ relates a set $B$ to $A$ in a specific model $M$, denotes a specified quantity of $A$ in $E$ [i.e. the domain of discourse], $A^{\#}$, $(A^{\#} \subseteq A \subseteq E)$ iff
(i) $E$ is bounded
(ii) $A^{\#} = A \cap B$
(iii) $|A^{\#}| > 0$

b Definition: *Unspecified Quantity of A*, [−SQA]
An $NP$ of the form $Det\ N$ denotes an unspecified quantity of $A$
(i) if $A \cap B = 0$
(ii) if there is no number given by the definition of the quantifier by which the cardinality of the intersection is bounded.

([Verkuyl 89], pp. 82-3)

In the light of this approach, the interpretation of an NP containing a determiner is given as a collection of sets. For example, the NP *two cats* is seen as denoting a set which consists of all the sets containing two cats; i.e.

$$[\![exactly\ 2]\!](A) = \{B \subseteq E : |A \cap B| = 2\}$$

where $E$ represents the domain of discourse, $A$ the set of all cats, and $B$ the set denoted by the predicate with which the NP combines. Verkuyl assumes that most quantifiers presuppose a bounded $E$, so that in general it will be possible to determine the cardinality of $|A \cap B|$ for each choice of $B$ and $A$. However, with bare plurals $E$ is unbounded; this means that the cardinality of $A \cap B$ will be undetermined. For example, [Verkuyl 87a] defines bare plurals as: $\{B \subseteq E^* : A \subseteq B \wedge |A \cap B| = \mathit{undetermined}\}$. According to the definition in (6-4), bare plurals will thus express unspecified quantity.[3]

Second, Verkuyl defines the property "[+ADD TO]" — a property associated with verbs expressing "progress in time" or "change" — as a function which assigns to each interval $i$ its successor $i+1$ as stated in (6-5), where: $T$ is the set of points, $I$ the set of intervals, and $<$ the precedence relation defined as a strict partial ordering.

(6-5) [ + ADD TO ] is to be interpreted as (involving) a funtion $s : I \rightarrow I$ such that if $i = (a, b)$, then $\exists c(s(i)) = (a, c)$, and if $a, b, c \in T$, then $a < b \leq c$

This definition of the property [+ADD TO] makes it possible to characterize "progress in time" and "change" as an indeterminate succession of intervals, an assignment which will always result into an unbounded (i.e. durative) reading. Verkuyl proposes to adopt this characterization as some sort of default value. which is essentially maintained when the direct object expresses an unspecified quantity as in *drink wine, write poems*. In addition. Verkuyl assumes that the head verb of VPs such as *push the cart, stroke a cat. caress his wife. wash his shirt, etc.* whose aspectual properties do not seem to be affected by the reference properties of the direct object is inherently associated with the property [−SQA]. The occurrence of an object NP expressing a specified quantity will therefore not affect the durative interpretation of the verb phrase as a whole.

The third step concerns the contribution of object NPs which express a specified quantity to aspect compositionality. This contribution is accounted for by making the function

[3]Clauses a.iii and b.ii in (6-4) are meant for negative NPs.

$s$ (cf. (6-5)) sensitive to the property [+SQA] in such a way that $s$ will only generate a finite succession of intervals when combining a verb which has the property [+ADD TO] with a countable NP. This assignment gives rise to a terminative reading for the resulting VP (e.g. *lift four tables*). To do so, Verkuyl assumes that the thematic role assigned to the direct object functions as an equivalence relation which determines ways in which the members of the set denoted by the object NP count "as being involved as participants at the same time (interval) in the predication expressed by the verb" ([Verkuyl 89], p. 85). For example, with respect to the interpretation of the VP *lift three tables* there are eight ways in which the set of three tables contained in the denotation of the object NP can be partitioned according to whether the tables are envisaged as being lifted all at one time, one at the time, or in groups of one and two tables. The set of all partitions which can be derived from the NP denotation $A^{\#}$ is obtained as the quotient set $A^{\#}/P$, where $P$ is the equivalence relation expressed by the object thematic role. Insofar as the object expresses a specified quantity, the cardinality of its denotation will be finite, and so will be the number of partitions for the quotient set $A^{\#}/P$ as well as the number of elements in each partition. Consequently, a function can be defined which for each partition $[a_1], ..., [a_n] \in A^{\#}/P$ yields a bounded interval by mapping the succession of elements $[a_1], ..., [a_n]$ into the succession of intervals $i_1, ..., i_n$ such that for each $[a_i] \in [a_1], ..., [a_n]$ there is an $i_i \in i_1, ..., i_n$, ie.

(6-6) ...where [$A^{\#} = [\![NP]\!]$ expresses a specified quantity in the syntactic configuration [$_{VP}$ V NP] and] $[\![V]\!]$ is a function from $A^{\#}$ to $[\![VP]\!]$, there is an injective function $p_v : A^{\#}/P \rightarrow I$ s.t.

(a) $p_v([a_k]) = i_k$, where $[a_k]$ is the $k$-th member of $A^{\#}/P$;
(b) $A^{\#} = \{x|$is V-ed by the denotation of the subject NP$\}$. (adapted from [Verkuyl 89], p. 86)

By limiting the function $s$ in (6-5) to the set of intervals generated by $p_v$ for any given choice of partition in the quotient set $[\![NP]\!]/P$, we will therefore obtain the desired terminative reading in cases where verbs expressing "change" or "progress in time" are combined with an object NP which expresses a specified quantity, e.g. *drink a glass of wine*. *lift three tables*.

Finally, the contribution of a subject NP to the determination of sentential aspect is accounted for in terms of distributive and collective interpretations — e.g. the two interpretations which can be derived from the sentence in (6-7) according to whether a single or multiple event reading is chosen.

(6-7) Two chefs prepared a delicious dinner

a *Single event reading*
The two chefs collaborated on the preparation of the same meal

b *Multiple event reading*
Each one of the two chefs prepared a different meal

Verkuyl assumes that the compositional interpretation of a [NP VP] structure involves a function $p$ from VP denotations into the set of intervals $I_T$ which result from the compositional assembling of VP aspect. This function manifests itself in two distinct forms: a distributive one, $p_d$, and a collective one, $p_c$. In either case, the domain of $p$ consist of a set $A'$ corresponding to the denotation of the subject NP, e.g. the intersection of the subject head noun and VP denotations. However, in its distributive manifestation (i.e. $p_d$) $p$ assigns a distinct image (i.e. an $I_T$) to each element in its domain, while $p_c$ maps the element of its domain into a single image (the same $I_T$). If we think of each $I_T$ as an eventuality, it soon becomes clear how $p_d$ will give us the multiple event interpretation for a sentence like (6-8), while $p_c$ yields the single event interpretation.

Verkuyl's account implies that object and subject NPs contribute to the compositional interpretation of sentential aspect in two distinct ways. The contribution of an object NP to VP aspect involves a function which with a [−SQA] NP generate an unbounded succession of time intervals, and with [+SQA] NPs maps the (finite) succession of elements contained in each subset of partitioned object-denotata into a (finite) succession of intervals. In either case, the issue at stake is the temporal constitution of the time interval corresponding to a single eventuality. The contribution of a subject NP to S aspect instead involves a function which either associates the elements in the set denoted by the VP with a bounded interval corresponding to a single eventuality, or maps each element of the VP set into an interval corresponding to a distinct eventuality. That is, what seems to be at stake here is the possibility of assigning the sentence a single or multiple event reading. Here, durativity arises from the multiple event interpretation in case the set of partitions of subject-denotata is unbounded. This suggestion seems to be essentially correct. For example in (6-3e) where durative aspect is induced by referential properties of the subject NP, durativity can only be derived under a multiple event reading (i.e. the same sonata was played an undetermined number of times). Notice in fact that if the reference of object NP is contextually restricted to a single token as in (6-8), the durative reading is practically out; this is simply because a multiple event interpretation in this case is highly infelicitous (eg. an appendix is usually removed once for all).

(6-8) Skilled surgeons removed Bill's appendix $\left\{ \begin{array}{l} \text{in 45 minutes} \\ \text{*for years} \end{array} \right\}$

A word of caution about preferred and impossible aspectual readings at this point is in order. I think everyone would agree that both the sentences in (6-9) are acceptable under particular circumstances.

(6-9) a Bill played that sonata for years
b Bill ate peanuts in five seconds

For example, (6-9a) can be used to describe a situation where Bill played the same sonata over and over an undeterminate number of times, and (6-9b) could describe an event where Bill ate some specific quantity of peanuts. Relevant contexts are given below.

(6-10) a Bill played that sonata for years, at each charity performance he gave
b The participants of the show were asked to solve a puzzle, sing a song, and eat a bag of peanuts. The one who finished first would win a trip to Blackpool for two. Bill did not win, but *he ate peanuts in five seconds.*

I believe that in each case the resulting aspectual interpretation can still be seen as a consequence of the reference properties of the object NP. In (6-10a) the NP *that sonata* is understood as a *type* — rather than a single token — and as such it has the force of an NP which expresses an unspecified quantity, e.g. a bare plural such as "sonatas". In (6-10b) the bare plural "peanuts" is understood as referring to a specific quantity of peanuts. In other words, the reference properties which are attributed to quantified and bare plural NPs by default may be coerced so as to yield contexually appropriate interpretations. To capture the distinction between preferred vs. contextually-coerced interpretations I will use two consecutive question marks in place of an asterisk. For example the two question marks in (6-11) indicate that no durative reading is available under a single event reading, the reading which is most likely to be assigned to the sentence in absence of coercing information.

(6-11) John drank $\left\{ \begin{array}{l} \text{beer} \\ \text{??a glass of beer} \end{array} \right\}$ all day

### 6.1.2 From Grammatical Relations to Thematic Roles

It should be pointed out that Verkuyl's insights about subject/object asymmetries with respect to the compositional interpretation of sentential aspect may not be merely stated in terms of surface grammatical relations. For example, the subject of a passive sentence such as the one in (6-12a) contributes to aspect compositionality in the same way in which a direct object does. To be sure, the same durative interpretation which is induced by the mass noun in object position in (6-12b) is available — and indeed highly preferred — in (6-12a) where the initial object role is realized as subject.

(6-12) a Beer was drunk all night by Bill
b Bill drank beer all night

In addition, durative aspect with bare plural subjects in passive sentences does not seem to lead to a multiple event interpretation, unless the agent phrase contains a plural nominal. A sentence such as (6-12a) is in fact best characterized as referring to a single (unbounded) event. A multiple event interpretation may instead arise from the occurrence of a plural NP in the by-phrase as in (6-13).

(6-13) Beer was drunk all night by five guests

Insofar as the by-phrase can effectively be regarded as the syntactic realization of the role associated with the initial subject, the possibility of a multiple event interpretation in (6-13) confirms the hypothesis that initial subject and object NPs differ in the way they contribute to sentence aspect.

The distinct alignment of initial subject and object NPs with respect to aspectual interpretation is not limited to passive sentences, but it extends to other constructions where the (surface) subject is linked to the argument role which is canonically associated with a direct object (i.e. the proto-patient). For example, a mass noun in the subject position of an inchoative verb — corresponding to the object role of the homophonous causative verb form — induces a durative interpretation, as shown in (6-14).

(6-14) Snow melted $\left\{ \begin{array}{l} \text{all day long} \\ \text{??in 8 hours} \end{array} \right\}$

Note that (6-14) is fine — and in fact preferred — under a single event reading; therefore durativity may not be made to follow from an implied proto-agent argument expressing unspecified quantity (e.g. *snow melted all day long because* **warm winds** *kept blowing incessantly*).

Equivalent phenomena are found in languages other than English. For example, in Italian the subject of passive, inchoative and reflexive verbs is instrumental in the determination of the temporal constitution of the event expressed by the verb. As shown in (6-15)-(6-17) a telic interpretation is highly preferred with quantified NPs, while the occurrence of bare plural subjects favours a durative interpretation. As was discussed in the previous chapter, in all three cases the subject is linked to a proto-patient role.

(6-15) PASSIVE

a Comunicati stampa furono trasmessi $\left\{\begin{array}{l}\text{tutto il giorno}\\ \text{??in cinque minuti}\end{array}\right\}$

"Press releases were broadcasted $\left\{\begin{array}{l}\text{all day long}\\ \text{??in five minutes}\end{array}\right\}$"

b I 3 responsabili del tentato colpo di stato furono arrestati $\left\{\begin{array}{l}\text{in poche ore}\\ \text{??tutto il giorno}\end{array}\right\}$

"The three perpetrators of the attempted coup d'état were arrested $\left\{\begin{array}{l}\text{in a few hours}\\ \text{??all day long}\end{array}\right\}$"

(6-16) INCHOATIVE

a Enormi blocchi di ghiaccio si sciolsero $\left\{\begin{array}{l}\text{tutto il giorno}\\ \text{??in cinque minuti}\end{array}\right\}$

"Huge ice blocks melted $\left\{\begin{array}{l}\text{all day long}\\ \text{??in five minutes}\end{array}\right\}$"

b I tre cubetti di ghiaccio si sciolsero $\left\{\begin{array}{l}\text{in cinque minuti}\\ \text{??tutto il giorno}\end{array}\right\}$

"The tree ice cubes melted $\left\{\begin{array}{l}\text{in five minutes}\\ \text{??all day long}\end{array}\right\}$"

(6-17) REFLEXIVE

a Navi nemiche si affondarono l'un l'altra $\left\{\begin{array}{l}\text{tutto il giorno}\\ \text{??in cinque minuti}\end{array}\right\}$

"Enemy ships sank each other $\left\{\begin{array}{l}\text{??all day long}\\ \text{in five minutes}\end{array}\right\}$"

b Le due navi nemiche si affondarono l'un l'altra $\left\{\begin{array}{l}\text{in cinque minuti}\\ \text{??tutto il giorno}\end{array}\right\}$

"The two enemy ships sank each other $\left\{\begin{array}{l}\text{in five minutes}\\ \text{??all day long}\end{array}\right\}$"

These facts suggest that the contribution of an argument phrase to the determination of sentence aspect should be established on the basis of initial/deep grammatical relations (in the RG/GB sense) as indicated in (6-18).

(6-18) Only the initial/deep object of a verb can determine the internal temporal constitution of the event expressed by the verb.

Notice, incidentally, that indirect and oblique objects may also contribute to the internal temporal constitution of their governing verb. For example, [Verkuyl 72] observes that no durative reading is possible for the Dutch sentence in (6-19a) under a single event reading. However, if a bare plural occurs in place of the indefinite NP inside the indirect object, such reading becomes available as shown in (6-19b).

(6-19) a *Den Uyl overhandigde een uur lang het PVDA-speldje aan een congresganger
*"Den Uyl handed out the Labour Party badge *to a congress-goer* for an hour"

b Den Uyl overhandigde een uur lang het PVDA-speldje aan congresgangers
"Den Uyl handed out the Labour Party badge *to congress-goers* for an hour"

([Verkuyl 72], p. 105)

Hence the definition in (6-18) must be understood as including indirect and oblique objects.[4]

Within the UCG framework developed in the last two chapters, the generalization in (6-18) can be directly expressed in thematic terms, as shown in (6-20).

(6-20) THEMATIC-ASPECTUAL INTERFACE *preliminary version*
The reference properties of the participant of an event can determine the internal temporal constitution of the event if and only if that participant is not linked to a proto-agent role.

Note, however, that not all NP's linked to a proto-patient/prepositional role are determinant of sentence aspect. For example, we have already seen that with a number of process verbs (e.g. *push, stroke, caress, wash, etc.*) a terminative reading is impossible when the object NP expresses a specified quantity, eg.

(6-21) $$\text{Bill} \left\{\begin{array}{l}\text{pushed the cart}\\ \text{stroked a cat}\\ \text{caressed his wife}\\ \text{washed his shirt}\end{array}\right\} \left\{\begin{array}{l}\text{for an hour}\\ \text{??in an hour}\end{array}\right\}$$

The same holds for stative verbs, e.g.

[4]See [Tenny 87] for further remarks on this point.

$$\text{(6-22)}\quad \text{??Bill} \left\{\begin{array}{l}\text{loved}\\ \text{knew}\\ \text{liked}\end{array}\right\} \text{Mary in two years}$$

A priori, the failure of the object NP to influence sentence aspect in these cases could be taken as evidence that a close relation between aspectual and thematic information exists only for some verbs. If so, the general potential of proto-patient arguments to contribute to sentence aspect would have no grammatical import for verbs such as *push, stroke, caress, wash, love, know, like etc.* I believe that this conclusion is essentially wrong. It can in fact be shown that in some cases the relation between aspect and thematic roles may remain latent until appropriate conditions arise under which an aspectual shift is possible. Consider for example the verb *push* when occurring with a directional argument as in (6-23). In (6-23a) where the object NP expresses a specified quantity, the addition of a durative adverbial leads to near-ungrammaticality (i.e. ungrammaticality under the preferred single event reading). By contrast, if the object NP is a bare plural the durative reading is highly preferred, as shown in (6-23b). This suggests that the reference properties of the proto-patient NP *a cart* are relevant to the determination of sentence aspect in both sentences.

$$\text{(6-23)}\quad \text{a}\quad \text{John pushed a cart to the store} \left\{\begin{array}{l}\text{in ten minutes}\\ \text{??all day}\end{array}\right\}$$

$$\text{b}\quad \text{John pushed carts to the store} \left\{\begin{array}{l}\text{all day}\\ \text{??in ten minutes}\end{array}\right\}$$

In so far as the word senses of the predicate "push" in (6-23) and in (6-21) are closely related in meaning (e.g. the first implies the latter), it would be natural to assume that the possibility for the proto-patient argument to influence sentence aspect is always available, but may only be operative when a directional argument is present. (This would make it possible to establish links between closely related word senses without resorting to destructive operations.)

Analogous observations apply to stative verbs as well. Consider, for example, the subset of stative predicates containing experiencer verbs with stimulus subjects (e.g. *amuse, annoy, bore, concern, deceive, elude, frighten, please, scare, worry, ...*). It is well known that most of these verbs allow also for an inchoative reading ([Croft 86, Dowty 87, Engdahl 89]). For example, the interpretation of a sentence like (6-24a) can involve either a change of state in Mary's emotional attitudes as indicated in (6-24b), or the description of a particular psychological state which belongs to Mary's world of emotions as in (6-24c).

(6-24) a Bill worried Mary
b Mary got worried because of Bill (*inchoative interpretation*)
c Mary was worried about Bill (*stative interpretation*)

When understood as involving inchoation, the object of these verbs behaves exactly as the object of verbs like *drink, eat, read* in that its reference properties can trigger telic/atelic shifts. Notice in fact that the occurrence of a bare plural object in (6-25a) can induce a process interpretation (i.e. eventive and atelic) without forcing an iterated event reading as indicated in (6-25b), while in (6-26a) where the object is a proper name such an interpretation is not available.

(6-25) a The unification of East and West Germany worried *Russian bureaucrats* all day
b *Single event reading* (atelic)
Russian bureaucrats got worried all day, but each bureaucrat stopped getting worried after a while
c *Multiple event reading* (atelic)
Russian bureaucrats kept getting worried over and over, all day

(6-26) a The unification of East and West Germany worried Gorbachev all day
b *Single event reading* (atelic) ??
c *Multiple event reading* (atelic)
Gorbachev kept getting worried over and over, all day

As with verbs like "push", a sensible way to reconcile the semantic relatedness between the two senses of "worry" (i.e. inchoative and stative "worry") with the contrast regarding the possibility of an aspectual shift triggered by reference properties of the proto-patient role is to assume that such a possibility is inherently associated with the proto-patient participant, but is only operative under appropriate conditions (e.g. if the verb is understood to involve change of state). Of course, there are many verbs with which aspectual shifts induced by the reference properties of the proto-patient/prepositional argument are never allowed. This, however, may simply be because the contribution of argument roles to sentence aspect is a default operation: the reference properties of proto-patient/prepositional NPs may contribute to the reference properties of the verbs only if the contribution in question does not involve a feature clash. In §6.3 I will show how a characterization of this kind can be given a precise interpretation by combining Krifka's approach to the relation between temporal and nominal reference with the unification grammar framework developed in the previous two chapters.

## 6.2 Unaccusativity and the Thematic/Aspectual Interface

The term *unaccusative* was initially introduced by [Perlmutter 78] to single out a class of intransitive verbs whose subject proves to exhibit partial object functionality when subjected to certain (morpho)syntactic tests. In this section I will review some of the main issues relative to unaccusativity with specific reference to Dutch and Italian, and examine how these issues are related to questions regarding the thematic/aspectual interface.

### 6.2.1 Unaccusativity in Dutch

Perlmutter's initial characterization was essentially motivated with respect to the formation of impersonal passives, a morphosyntactic process found in languages such as Dutch and Turkish. Impersonal passive formation involves affixation of passive morphology to an intransitive verb, omission or relational change of the verb's initial subject, and introduction of a pleonastic element in subject position, e.g. compare the intransitive clause in (6-27a) with the impersonal passive structure in (6-27b).

| | | | | | | |
|---|---|---|---|---|---|---|
| (6-27) | a | De meisjies | hebben | hard | gewerkt | |
| | | the girls | have | hard | worked | |
| | | "The girls worked hard" [Perlmutter 78] | | | | |
| | b | | | | | |
| | | Er | werd | hard | gewerkt | (door de meisjes) |
| | | there | was | hard | work-PASS | (by the girls) |
| | | "There was hard working by the girls" [Perlmutter 78] | | | | |

The essential difference between impersonal passives and passives obtained from (di)transitive verbs — henceforth "personal passives" — is that with impersonal passives the subject position is filled with a dummy (e.g. *er* in (6-27b)), while with personal passives the subject position hosts the initial object — e.g. "John" in "John was loved (by everyone)". In keeping with the RG treatment of personal passive where the relational change of the initial object is analyzed as an *advancement* from 2 (object) to 1 (subject) (cf. [Perlmutter & Postal 77]), Perlmutter assumes that impersonal passives universally involve the introduction of a pleonastic element in initial object position (2), and "advancement" of this element to final subject (1). This assumption makes it possible to give a unified account of personal and impersonal passives.

Next, Perlmutter observes that not all intransitive verbs are amenable to impersonal passive formation; for example, a verb like "evaporate" fails to yield a grammatical impersonal passive as shown in (6-28b).

(6-28) a Het water was binnen een kwartier verdampt
"The water had evaporated in a quarter hour" [Perlmutter 78]
b *Er werd door het water binnen een kwartier verdampt [Perlmutter 78]

More generally, the possibility of making an intransitive predicate into an impersonal passive yields the following twofold classification of intransitive predicates.

(6-29)

| Can Appear in Impersonal Passive Constructions |
|---|
| Predicates describing willed or volitional acts<br>*e.g. work, think, laugh, speak, meow*<br>Involuntary bodily processes<br>*e.g. cough, vomit, sleep* |

| Cannot Appear in Impersonal Passive Constructions |
|---|
| Predicates expressed by adjectives (in English)<br>*e.g. to be big/heavy/green*<br>Predicates with patient subjects<br>*e.g. fall, float, slip, languish*<br>Predicates of existing and happening<br>*e.g. exist, happen, arise, result*<br>Non-voluntary emission of stimuli that impinge on the senses<br>*e.g. glow, smell, stink*<br>Aspectual predicates<br>*e.g. begin. stop. continue*<br>Duratives<br>*e.g. last. remain. survive* |

(adapted from [Perlmutter 78], p. 162)

Perlmutter's Unaccusative Hypothesis claims that this bifurcation is mirrored in syntactic representation: intransitive predicates which can appear in impersonal passive constructions (unergatives) have an initial 1 but no initial 2, while those which do not appear in impersonal passive constructions (unaccusatives) have an initial 2 but no initial 1. Insofar as all clause structures need a subject,[5] it follows that basic clauses

[5]This restriction in RG is expressed through the *Final 1 Law* which requires the final stratum of every basic clause to contain a 1-arc ([Perlmutter & Postal 77]).

containing an unaccusative verb (e.g. *evaporate* in (6-28)) will require advancement of their initial 2 to a final 1. Impersonal passive formation with unaccusatives would therefore involve a second instance of advancement to 1 (i.e. advancement of a dummy 2 to 1). But in RG, such occurrence is ruled out by the *1-Advancement Exclusiveness Law* according to which "No clause can involve more than one advancement to 1" ([Perlmutter 78], p. 166). The failure of unaccusative verbs to undergo (impersonal) passivization is thus accounted for.

Since Perlmutter's work on Dutch impersonal passives, the unergative/unaccusative distinction has increasingly been regarded as a pervasive phenomenon in the grammar of natural languages which can be used to capture generalizations concerning a significant number of seemingly unrelated processes. For example, [Hoekstra 84] proposes that impersonal passives as well as choice of auxiliary *hebben/zijn* in the formation of compound tenses and the possibility for an intransitive verb to partake of *prenominal past participle constructions* can be explained in terms of the unaccusative/unergative distinction. As shown in (6-30)-(6-32),[6] intransitive verbs which can appear in impersonal passive constructions (i.e. unergatives) require auxiliary *hebben* and may not be used as prenominal past participle, while intransitives which are not grammatical in the impersonal passive form (unaccusatives) select auxiliary *zijn* and may appear as past participle in prenominal position.

(6-30) IMPERSONAL PASSIVE

a Er werd (door de jongens) gewerkt
"There was worked (by the boys)"

b *Er werd (door de jongens) gevallen
"There was fallen (by the boys)"

(6-31) AUXILIARY SELECTION

a Jan $\left\{\begin{array}{l}\text{heeft}\\ \text{*is}\end{array}\right\}$ gewerkt
"John worked"

b Jan $\left\{\begin{array}{l}\text{is}\\ \text{*heeft}\end{array}\right\}$ gevallen
"Jan fell"

(6-32) PRENOMINAL PAST PARTICIPLE

a *De gewerkte man
"the worked man"

b Het gevallen blad
"The fallen leaf"

[6] All remaining Dutch examples in this chapter are adapted from [Zaenen 88] and [Zaenen 89].

In the light of the Unaccusative Hypothesis, the import of the unergative/unaccusative distinction to auxiliary selection, and prenominal past participles can be expressed as follows:

- AUXILIARY SELECTION:
  a verb select auxiliary *hebben* if its subject is an initial 1 (e.g. an external argument in GB terms), and *zijn* otherwise;
- PRENOMINAL PAST PARTICIPLES:
  an intransitive past participle may not occur in prenominal position if its subject is an initial 1.

This generalization is supported by the fact that active transitives select auxiliary *hebben*, while passives select *zijn*, as shown in (6-33).

(6-33) a Hij $\left\{\begin{array}{l}\text{heeft}\\ \text{*is}\end{array}\right\}$ een boterham gegeten
"He has eaten a sandwich"
b Een boterham (door Jan) $\left\{\begin{array}{l}\text{werd}\\ \text{*heeft}\end{array}\right\}$ gegeten
"A sandwich was eaten (by Jan)"

In addition, a transitive past participle may occur in prenominal position only if it is interpreted as passive — i.e. the head nominal is understood as filling the object slot as indicated below.

(6-34) a De gegeten boterham
"The eaten sandwich"
b De gegeten man
"The eaten man" (only cannibalistic interpretation is available)

### 6.2.2 Unaccusativity in Italian

In §5.1.2. a number of (morpho)syntactic processes were singled out in Italian which can be used as diagnostics in providing a characterization of the thematic proto-role associated with a given syntactic position. Following the insights of [Belletti & Rizzi 81, Rosen 84, Burzio 86] and several related works, it was argued that *ne*-cliticization, participle absolute formation, past participle agreement, and reduced relative formation may not affect an NP which is linked to a proto-agent role. For example, the four processes can all affect a transitive object or the subject of a passive, inchoative or reflexive verb, but fail to apply to transitive subjects. Now, it is well known that *ne*-cliticization, participle absolute formation, past participle agreement and reduced relative formation yield a bipartite classification of intransitive verbs. The resulting verb groups roughly correspond to the two sets of verbs which Perlmutter derived for Dutch under the Unaccusative Hypothesis. In Dutch, for example, a verb like "arrive" may not appear in impersonal passive constructions (but see (6-67) below), while "work" can (see above); as shown in (6-35) and (6-36) these two verbs in Italian exhibit parallel sets of contrasts with respect to *ne*-cliticization, participle absolute formation, past participle agreement and reduced relative formation.

(6-35) *ne*-CLITICIZATION

a Ne sono arrivati due
"Two of them arrived"

b *Ne hanno lavorato due
"Two of them worked"

(6-36) PARTICIPLE ABSOLUTE FORMATION

a Arrivati i sindacalisti, gli operai rientrarono in fabbrica
"The union representative having arrived the workers went back to the factory"

b *Lavorati i nuovi assunti, la produzione migliorò
"Having the new employees worked, production improved"

(6-37) PAST PARTICIPLE AGREEMENT

a Sono $\left\{\begin{array}{l}\text{arrivat-i}\\ \text{*arrivato}\end{array}\right\}$ due sindacalist-i
"Two union-representative-MASC, PL $\left\{\begin{array}{l}\text{arrived-MASC,PL}\\ \text{*arrived}\end{array}\right\}$"

b Olga ha $\left\{\begin{array}{l}\text{lavorato}\\ \text{*lavorat-a}\end{array}\right\}$
"Olga has $\left\{\begin{array}{l}\text{worked}\\ \text{*worked-FEM,SING}\end{array}\right\}$"

(6-38) REDUCED RELATIVE FORMATION

a Gli operai arrivati ieri sono tutti extracomunitari
"The employees (who) arrived yesterday are all from non-EEC countries"

b *Gli operai lavorati oggi sono in maggioranza extracomunitari
"The employees (who) worked today are mostly from non-EEC countries"

Because of the distributional properties of *ne*-cliticization, participle absolute formation, past participle agreement and reduced relative formation, it seems natural to conclude that the subject of verbs such as *lavorare* is linked to a proto-agent role while the subject of *arrivare* is associated with a proto-patient role. This conclusion is essentially equivalent to Perlmutter's Unaccusative Hypothesis and its later elaboration in GB (cf. chapter 2).

### 6.2.3 Unaccusativity and Thematic/Aspectual Interface

According to the generalization concerning the interface of thematic and aspectual properties of predicates sketched in §6.1.1 — here repeated as (6-39) — we would expect that the subject of unaccusative verbs should behave like transitive objects as well as passive, inchoative and reflexive subjects with respect to aspect compositionality as in both cases the argument is linked to a proto-patient role.

(6-39) THEMATIC-ASPECTUAL INTERFACE *preliminary version*
The reference properties of the participant of an event can determine the internal temporal constitution of the event if and only if that participant is not linked to a proto-agent role.

Interestingly enough, this prediction is borne out. As shown in (6-40) an unaccusative verb like *arrivare* is open to both a durative a terminative interpretation according to whether the subject NP expresses a specified or unspecified quantity (in Verkuyl's sense).

(6-40) a Un messaggio di solidarietà è arrivato proprio adesso
"A message of solidarity has just arrived"
b Messaggi di solidarietà sono arrivati tutto il giorno
"Messages of solidarity arrived all day"

Note that with unergative verbs a subject NP may not affect the temporal constitution of the event described by the verb. For example, the occurrence of a subject NP expressing a specified quantity with a verb like *dormire* "sleep" may not easily give rise to a telic interpretation, e.g.

(6-41) ??Carlo ha dormito in tre ore
??"Carlo slept in three hours"

The hypothesis upheld in RG and GB that the subject of unaccusative verbs correspond to an initial/deep object seems thus to receive further support with respect to the contribution of argument NPs to aspect compositionality (see [Tenny 87] for further comments on this point). Within the UCG framework presented in this thesis, the insights of the Unaccusative Hypothesis can be implemented by interleaving subcategorization and thematic information. More specifically, we could augment the algorithm concerning the assignment of proto-roles to predicates described in §4.3.2 with an additional clause which established that unaccusative predicates do not encode a proto-agent role entailment. However, before we actually procede to implement this augmentation it would be appropriate to make sure that the RG/GB account of unaccusativity provides a coherent characterization of the phenomena which the Unaccusative Hypothesis is set out to deal with.

### Some Problems for the Unaccusative Hypothesis

Abstracting away from theory-specific implementations, the essential claim advanced in RG and GB concerning unaccusativity is that the classification of intransitives which is relevant to sets of grammatical contrasts such as those examined in the previous two subsections can be exhaustively characterized in terms of grammatical relations as stated in (6-42).

(6-42) GRAMMATICAL BASIS OF THE UNACCUSATIVE HYPOTHESIS
Intransitive verbs whose subjects exhibit partial object functionality are unaccusatives. Intransitive verbs whose subjects exhibit no object functionality are unergative.

[Zaenen 88] has observed that if we take the generalization in (6-42) seriously, we are bound to conclude that some verbs can be either unaccusative or unergative according to which (morpho)syntactic test we take into account. For example, Zaenen cites cases of intransitive verbs which select auxiliary *hebben*, may not appear as prenominal past participle, and yet are ungrammatical in the impersonal passive, e.g.

(6-43) a De badkamer heeft gestonken
"The bathroom has stunk"

b *De gestonken badkamer
"There stunk bathroom"

c *Er werd (door de badkamer) gestonken
"There is stunk (by the bathroom)"

This is exactly the opposite behaviour which was taken by Hoekstra as evidence that sets of contrasts concerning impersonal passives, prenominal past participles. and auxiliary selection are related to the unaccusative/unergative distinction. Note incidentally that the mismatches discussed by Zaenen may not be regarded as marginal in that they can be generalized to two semantically coherent classes of verbs: ***duratives*** and ***verbs of non-voluntary emission of stimuli that impinge on the senses*** ([Perlmutter 78]).

Mismatches relative to sets of contrasts which involve the unaccusative/ergative distinction (as characterized according to the Unaccusative Hypothesis), are also found in languages other than Dutch. For example, we saw in §2.1.1 and §5.2 that the failure of causative formation with passive, reflexive and inchoative verbs in Romance can be made to follow from the fact that in such cases the complement subject corresponds to an internal/proto-patient role; relevant examples for Italian were:

| | | | | | | |
|---|---|---|---|---|---|---|
| (6-44) | a | *Mario | fece essere compra-to | il giornale | (da Giorgio) | |
| | | Mario | made to be buy-PASS | the newspaper | (by Giorgio) | |
| | | "Mario had the newspaper bought (by Giorgio)" | | | | |
| | b | *Il sole | fece | scioglier-si | la neve | |
| | | The sun | made | to melt-INCH | the snow | |
| | | "The sun made the snow melt" | | | | |
| | c | *Carlo | fece | rasar-si | (da Maria) | |
| | | Carlo | made | to shave-REFL | by Maria" | |
| | | "Carlo$_i$ made Maria shave him$_i$" | | | | |

Insofar as unaccusative subjects also corresponds to deep objects (proto-patient roles), we would expect causative formation to fail with unaccusative complements. However, as was noticed, this prediction is not borne out: unaccusative verbs are generally amenable to causativization, eg.

| | | | | | |
|---|---|---|---|---|---|
| (6-45) | Carlo | fece | arrivare | Maria | in ritardo |
| | Carlo | made | to arrive | Maria | late |
| | "Carlo made Maria arrive late" | | | | |

A somewhat similar problem arises in Italian with regard to auxiliary selection. As in Dutch, intransitive verbs in Italian divide into two classes according to whether they select auxiliary *essere* "be" or *avere* "have" to form compound tenses, e.g.

(6-46) a Carlo $\left\{\begin{matrix}\text{ha}\\ \text{*è}\end{matrix}\right\}$ parlato
"Carlo spoke"

b Carlo $\left\{\begin{matrix}\text{è}\\ \text{*ha}\end{matrix}\right\}$ arrivato
"Carlo arrived

Recent accounts of auxiliary selection ([Rosen 84, Burzio 86]) have assumed that the split between intransitive predicates which select *essere* and those which select *avere* can be explained under some version of the Unaccusative Hypothesis (e.g. the RG or GB version). The basic idea is that unergative verbs choose *avere* while unaccusatives choose *essere*. As was pointed out with respect to Dutch, this conclusion is supported by the fact that verb forms whose subject can be characterized as an initial/deep subject select *avere*, while in the remaining cases *essere* is chosen. For example, passive, inchoative and reflexive verbs choose auxiliary *essere*, while transitives select *avere*.

(6-47) a PASSIVE
Carlo $\left\{\begin{matrix}\text{è} \\ \text{*ha}\end{matrix}\right\}$ invitato
"Carlo is invited"

b REFLEXIVE
Carlo si $\left\{\begin{matrix}\text{è} \\ \text{*ha}\end{matrix}\right\}$ rasato
"Carlo shaved himself"

c INCHOATIVE
Il giaccio si $\left\{\begin{matrix}\text{è} \\ \text{*ha}\end{matrix}\right\}$ sciolto
"The ice melted"

d TRANSITIVE
Carlo $\left\{\begin{matrix}\text{ha} \\ \text{*è}\end{matrix}\right\}$ invitato Olga
"Carlo invited Olga"

However, the auxiliary selection properties associated with unaccusatives are not always identical to those of passive, reflexive and inchoatives. Differences arise, for example, in some verbal complexes with respect to the choice of auxiliary that the complement verb induces on the matrix verb. In general, the auxiliary selection properties of verbs taking infinitaval/sentential complement are independent of the auxiliary selection properties of the complement verb. For example the verb *cercare* "try" selects *avere* regardless of the auxiliary selection properties of the complement verb, e.g.

(6-48) Carlo $\left\{\begin{array}{l}\text{ha}\\ \text{*è}\end{array}\right\}$ cercato di $\left\{\begin{array}{ll}\text{convincere Olga} & \textit{transitive}\\ \text{lavorare} & \textit{unergative}\\ \text{arrivare in orario} & \textit{unaccusative}\\ \text{essere eletto} & \textit{passive}\\ \text{radersi} & \textit{reflexive}\\ \text{preoccuparsi di meno} & \textit{inchoative}\end{array}\right\}$

"Carlo tried to $\left\{\begin{array}{l}\text{convince Olga}\\ \text{work}\\ \text{arrive on time}\\ \text{be elected}\\ \text{shave himself}\\ \text{worry less}\end{array}\right\}$"

Modal verbs (*volere, potere, dovere*, "want, can, must") exhibit an interesting departure from this general pattern: they can select either *essere* or *avere* when their complement infinitive is an unaccusative verb, but only select *avere* if the complement verb is transitive, passive, inchoative or reflexive.

(6-49) a *unaccusative complement*
Carlo $\left\{\begin{array}{l}\text{ha}\\ \text{è}\end{array}\right\}$ voluto arrivare in anticipo
"Carlo wanted to arrive there early"

b *unergative complement*
Carlo non $\left\{\begin{array}{l}\text{ha}\\ \text{*è}\end{array}\right\}$ voluto lavorare
"Carlo did not want to work"

c *transitive complement*
Carlo non $\left\{\begin{array}{l}\text{ha}\\ \text{*è}\end{array}\right\}$ voluto invitare Olga
"Carlo did not want to invite Olga"

d *passive complement*
Carlo $\left\{\begin{array}{l}\text{ha}\\ \text{*è}\end{array}\right\}$ voluto essere invitato
"Carlo wanted to be invited"

e *si-inchoative complement*
Il cancello non $\left\{\begin{array}{l}\text{ha}\\ \text{*è}\end{array}\right\}$ voluto aprirsi
"the window did not want to open"

f *reflexive complement*
Carlo non $\left\{\begin{array}{l}\text{ha}\\ \text{*è}\end{array}\right\}$ voluto radersi
"Carlo did not want to shave himself"

In brief, choice of auxiliary in modal complex predicates seems to be influenced by the type of verb which they take as complement. The difficulty here is to reconcile ways in which properties which the modal inherits from its complement verb determine auxiliary selection with the predictions made by the Unaccusative Hypothesis. To be sure, an account according to which the auxiliary properties of the complement verb are directly transfered to the modal would not do. Such an account would in fact invite the expectation that the auxiliary properties of the modal verb should be exactly like those of the complement verb. This expectation is incorrect in two main regards. First, identity in auxiliary selection properties between the modal and complement verb only occur with transitive and unergative complements — both the complement and matrix verbs in this case select *avere*. Second, the alignment of verb forms predicted by the Unaccusative Hypothesis predicts that unaccusatives, passive, reflexive and inchoative complements should induce identical auxiliary selection properties on the matrix modal, contrary to the data in (6-49). The issue arises then as to whether these mismatches can be made to follow from independent factors, so that the validity of the Unaccusative Hypothesis with respect to auxiliary selection can be rescued.

Following [Rizzi 78], [Burzio 86] proposes to solve this issue by relating the possibility of *essere* selection in cases such as (6-50a) to the occurrence of *restructuring*, i.e. movement of the embedded verb phrase into the matrix VP as indicated in (6-50b).

(6-50) a Carlo $\left\{ \begin{array}{c} \text{ha} \\ \text{è} \end{array} \right\}$ voluto arrivare
"Carlo wanted to arrive"
b Carlo$_i$ [$_{VP}$ è voluto [$_{VP}$ arrivare $t_i$] [$_S$ PRO — ]]

In Burzio's approach, a crucial environment in which a verb selects *essere* is when the subject of the verb binds an object NP position at the level of surface structure (see [Burzio 86], §1.7 and §6.1 for details). According to Burzio's analysis, unaccusative verbs fit this configuration. More precisely, Burzio maintains that unaccusatives assign a $\theta$-role but not case to their object, and case but not $\theta$-role to their subject. Unaccusative subjects are base-generated in object position where they receive their $\theta$-role, and subsequent movement into subject position at surface structure is derived under case assignment considerations as shown in (6-51).

(6-51) Carlo$_i$ è arrivato t$_i$
"Carlo arrived"

The binding relation responsible for *essere* selection in (6-51) will also hold of the matrix subject and the object trace of the complement verb in the restructured version of (6-50a), i.e. (6-50b). The modal will therefore select auxiliary *essere*. If no restructuring takes place, the matrix subject and complement object trace will be separated by a clause boundary, e.g. the S-node in (6-52).

(6-52) Carlo$_i$ [$_{VP}$ ha voluto [$_S$ PRO$_i$ [$_{VP}$ arrivare t$_i$]]]

Burzio assumes that when a configuration of this type occurs, auxiliary selection is determined by "the lexical propensity" of the verb. In (6-52) *avere* is selected because *volere* — as all subject control verbs — has a propensity for auxiliary *avere*.

Binding relations leading to *essere* selection are never found in restructuring environments when the complement verb is either transitive or unergative. This is simply because there is no element in the complement VP which is coindexed with the complement subject at surface structure,[7] as shown in (6-53).

(6-53) Carlo$_i$ [$_{VP}$ ha voluto [$_{VP}$ $\left\{ \begin{array}{l} \text{parlare} \\ \text{invitare Olga} \end{array} \right\}$] [$_S$ PRO$_i$ — ]]
"Carlo wanted to $\left\{ \begin{array}{l} \text{speak} \\ \text{invite Olga} \end{array} \right\}$"

To account for the impossibility of *essere* selection with passive complements, Burzio assumes that in passive constructions *essere* is a raising verb taking a ***small clause*** complement as shown in (6-54).

(6-54) Carlo$_i$ è stato [$_{SC}$ t$_i$ invitato t$_i$]
"Carlo was invited"

After *restructuring*, the surface structure of the sentence in (6-48d) will thus be as in (6-55).

(6-55) Carlo$_i$ ha voluto [$_{VP}$ essere [$_{SC}$ t$_i$ invitato t$_i$]] [ PRO$_i$ —]

As in unrestructured constructions involving unaccusatives (e.g. (6-53)), the binding relation between the matrix subject and the complement object will cross a clausal boundary (a small clause in this case); auxiliary selection will thus be determined by the lexical propensity of the modal verb.

[7] Burzio assumes that the relation between the subject and a reflexive object NP in sentences such as (i) does not exists at surface structure, but only at LF; hence the choice of *avere* as auxiliary (see [Burzio 86], §6.1).

(i) Giovanni $\left\{ \begin{array}{l} \text{ha} \\ \text{*è} \end{array} \right\}$ accusato se stesso
"Giovanni accused himself"

However, this account does not not explain why only auxiliary *avere* occurs with reflexive and inchoative complements; relevant examples are repeated (6-56).

(6-56) a *inchoative complement*
Il cancello non $\left\{\begin{array}{c}\text{ha}\\ \text{*è}\end{array}\right\}$ voluto aprirsi
"The gate did not want to open"
b *reflexive complement*
Carlo non $\left\{\begin{array}{c}\text{ha}\\ \text{*è}\end{array}\right\}$ voluto radersi
"Carlo did not want to shave himself"

In Burzio's analysis, restructured sentences with reflexive and inchoative complements would yield a binding relation at surface structure between the matrix subject and complement object similar to that which obtains with unaccusative complements, as schematically indicated in (6-57).

(6-57) $\text{NP}_i\ [_{VP}\ \text{WANT}\ [_{VP}\ \text{V}+si_i\quad t_i]\ [_S\ \text{PRO}\ \_\_]]$

The occurrence of this binding relation incorrectly predicts that *essere selection* should be possible in these cases. In addition — as Burzio's himself notices — the assumption that restructuring always gives rise to *essere* selection with unaccusative complements does not always yield the right predictions. For example, the matrix verb of restructured constructions such as the one in (6-58) can select either *essere* or *avere*. Note that in this case the occurrence of the complement object clitic *le* to the left of the matrix verb makes it unequivocable that we are dealing with a restructured construction, i.e. the complement and matrix verb form a single verbal complex (see §5.2).

(6-58) Giovanni le $\left\{\begin{array}{c}\text{?sarebbe}\\ \text{?avrebbe}\end{array}\right\}$ dovuto essere fedele
"Giovanni would have had to be faithful to her"

In the light of these problems, Burzio's account may not be regarded as providing an explanation of auxiliary selection in Italian which can be fully integrated with the Unaccusative Hypothesis.

### What's Wrong with the Unaccusative Hypothesis, and How to Fix it

Mismatches in the alignment of intransitive verb classes with respect to sets of contrasts as those reviewed in this section make it clear that an account of unaccusativity which relies entirely on the thematic or deep/initial functional identity of the subject argument is inadequate. This is simply because the criterion of object/proto-patient functionality yields contrasting results when applied to the subject of some verbs, e.g. the same verb behaves as an unaccusative with respect to some set of contrasts and as an unergative with respect to another set of contrasts. Incidentally, mismatches of this kind are also found between languages: some verbs which are defined as unergative in some languages — according to the Unaccusative Hypothesis — behave as unaccusative in some other languages ([Rosen 84]). This suggests that the semantic basis of the unaccusative/unergative distinction is not so uniform as it may be expected on an account which is exclusively thematically-based. The only way to maintain semantic uniformity would in fact be to conclude that predicates which do not differ in meaning may have different thematic structure in different languages. However, this is a rather undesirable conclusion. if at all plausible.

I think that the occurrence of mismatches — both language internally and between languages — shows that distinct factors are at stake in establishing the classification of intransitive verbs which is responsible for the set of contrasts which have been related to the unergative/unaccusative distinction. This is essentially Zaenen's conclusion with respect to Dutch ([Zaenen 88]). More specifically, Zaenen proposes that the mismatch concerning auxiliary selection and impersonal passive formation with verbs like *stinken* can be accounted for by interlocking aspectual and thematic constraints. The relevant feature for auxiliary selection is telicity: telic intransitives choose *zijn*, while atelic intransitives are construed with *hebben*. Constraints on impersonal passive formation are instead stated in terms of both aspectual and thematic properties. Verbs which can appear in impersonal passive constructions correspond to atelic intransitives which are easy to control, e.g. *telephone, work* but not *stink, bleed. burn*. (In Dowty's terms. these are verbs whose subject proto-role has the default property *volitionality*). In the remaining part of this chapter I will discuss ways in which aspectual and thematic information can be interleaved so as to provide a general characterization of the unergative/unaccusative distinction.

**Aspectual Information** Let us first consider how the import of aspectual information may be best characterized to capture the (morpho)syntactic divergence which lies at the basis of the unergative/unaccusative distinction. [Zaenen 89] brings to attention the importance of two aspectual factors:

- telicity, and
- the distinction between *aktionsart* and *sentence aspect.*

The basic idea is that telic (intransitive) verbs fall within the unaccusative class, but that this generalization may be just limited to aktionsart. For example, Zaenen observes that in Dutch verbs such as "run" and "swim" may select either *hebben* or *zijn* according to whether they give rise to a process or telic reading. As shown in (6-59) and (6-60), telicity may arise from the addition of either a directional argument or a prefix which fixes a bound for the event expressed by the verb. In both cases the aspectual shift which affects choice of auxiliary results from lexical specifications which establish aktionsart.

(6-59) a Hij $\left\{\begin{matrix}\text{heeft} \\ \text{*is}\end{matrix}\right\}$ gelopen
"He has run"
b Hij $\left\{\begin{matrix}\text{is} \\ \text{?heeft}\end{matrix}\right\}$ naar huis gelopen
"He has run home"

(6-60) a Hij $\left\{\begin{matrix}\text{heeft} \\ \text{*is}\end{matrix}\right\}$ gezwommen
"He has swum"
b Hij $\left\{\begin{matrix}\text{is} \\ \text{?heeft}\end{matrix}\right\}$ weggezwommen
"He has swam-away"

However, if change in the internal constitution of an event is induced by an element whose aspectual contribution is at the sentential level rather than at the lexical level, no shift in auxiliary selection occurs. As shown in (6-61), "arrive" selects *zijn* even when the occurrence of a bare plural in subject position induces a process interpretation.

(6-61) Er zijn hier urelang reizigers aangekomen
"There have arrived travellers for hours here"

Zaenen's generalization is also valid for Italian. In (6-62) and (6-63) the addition of a directional argument or particle to the verb induces telicity and result into a change of auxiliary selection preferences.

(6-62) a Maria $\left\{\begin{array}{c}\text{ha}\\ \text{*è}\end{array}\right\}$ corso
"Mary has run"

b Maria $\left\{\begin{array}{c}\text{è}\\ \text{*ha}\end{array}\right\}$ corsa a casa
"Maria has run home"

(6-63) a L'aereo $\left\{\begin{array}{c}\text{ha}\\ \text{*è}\end{array}\right\}$ volato (per ore)
"The airplane flew (for hours)"

b Il foglio $\left\{\begin{array}{c}\text{è}\\ \text{*ha}\end{array}\right\}$ volato via
"The sheet of paper flew away"

In (6-64), however, where the aspectual shift is induced by referential properties of the subject NP no change in auxiliary selection preferences occurs.

(6-64) Messaggi di solidarietà $\left\{\begin{array}{c}\text{sono}\\ \text{*hanno}\end{array}\right\}$ arrivati tutto il giorno
"Messages of solidarity have arrived all day long"

Notice, incidentally, that the verbs which allows for shift in auxiliary selection preferences in Dutch and Italian may differ. For example, *nuotare* ("swim") can only select *avere*, while *swemen* can select either *heeft* or *zijn* as shown in (6-62). Interestingly enough, *nuotare* differs from *swemen* in that it is not susceptible to aspectual changes which take place at the level of aktionsart. As shown in (6-65), telic readings with *nuotare* may not result from mere addition of a directional particle. That is, *nuotare* does not have a word sense in which its aktionsart receives a telic specification, while *swemmen* does.

(6-65) *Carlo nuotò via
"Carlo swam away"

This suggests that within a semantic account some unaccusative mismatches between languages, if not all, can be made to follow from differences concerning word sense extensions.

The different contribution of lexical and sentence aspect to auxiliary selection is not an easy one to model within a unification framework. Suppose for example that aspectual constraints on auxiliary selection with intransitives in Dutch were expressed through direct reference to telic/atelic aspect: telic intransitive select *zijn* and atelic intransitives select *hebben*. Having done so, it would be impossible to account for the contribution of the subject to sentence aspect in cases such as (6-66) without overriding the aspectual specification provided at the level of aktionsart.

(6-66) Er zijn hier urelang reizigers aangekomen
"There have here arrived travellers for hours"

It seems to me that what we want to say in these cases is that lexical aspect (aktionsart) is partially specified, e.g. it is open to either a telic or atelic (though eventive) interpretation. The contribution of the subject can then be seen as a further constraint on lexical aspect. This view is independently motivated by the fact that impersonal passives in Dutch are possible with unaccusative verbs like "arrive" and "leave" if sentence aspect is atelic as shown in (6-67).

(6-67) In dat hotel heb ik geen oog dicht gedaan, *want er werd the hele nacht aangekommen en vertrokken*
"In that hotel I didn't sleep a wink, for there was the whole night arrived and left"

As was previously noted, impersonal passive formation can only involve verbs with atelic aktionsart. This means that if the aktionsart of *arrive* and *leave* were fully specified with respect to telicity, sentences such as the one in (6-67) should be ungrammatical. Therefore the aspectual value of verbs like "arrive" and "leave" cannot be fully instantiated at the lexical level: the possibility of atelic instantiation must be available. Impersonal passive formation would force an atelic instantiation on these verbs, similarly to how the occurrence of a bare plural subject does in (6-66). Of course in this view, auxiliary selection cannot be expressed through direct reference to telic/atelic aspect.

I would like to suggest that a more profitable way to encode preferences in auxiliary selection is to distinguish intransitive predicates whose internal temporal structure may potentially be affected by referential properties of the subject argument on the same word sense (e.g. without adding a prefix of modifying the argument structure of the verb) from those intransitive predicates whose internal temporal constitution is independent of the reference properties of the subject argument. The first class includes predicates such as *arrive, leave, swim-away, run-home.* The second class includes verbs such as *phone. sleep. swim.* Having done so, the relevant generalization concerning auxiliary selection in Dutch can be stated as follows:

(6-68) CONSTRAINTS ON AUXILIARY SELECTION

a A verb selects *zijn* if the referential properties of the subject NP can influence the internal temporal constitution of the event expressed by the verb

b A verb selects *hebben* if the referential properties of the subject NP may not influence the internal temporal constitution of the event expressed by the verb.

The advantage of this approach is that it makes it possible to state auxiliary selection preferences without changing the aspectual properties of a predicate. In the case of *zijn* selection, for example, subsequent instantiations will be possible which may result in an atelic specification. The problem of giving a unification-based account for aspectual shifts such as the one in (6-65) is therefore considerably simplified (i.e. no destructive operations on feature values are necessary). Constraints on impersonal passive formation can be derived by integrating the restriction of atelic instantiation with the possibility of attributing *volitionality* to the subject argument:

(6-69) CONSTRAINTS ON IMPERSONAL PASSIVE FORMATION
A verb is amenable to impersonal passive formation if its aspectual specification is compatible with an atelic instantiation and its subject proto-role has the default property *volitionality*

**Thematic Information** An aspectual characterization of unaccusativity provides an account of the object/proto-patient functionality of unaccusative subjects. More precisely, we find that alongside unaccusative subject only arguments which are not linked to a proto-agent role may determine the internal temporal constitution of the event expressed by the verb. A natural question to ask at this point is whether there are any thematic similarities between unaccusative subjects and transitive objects.

As I pointed out earlier in this section, the proto-role of unaccusative subjects may not be encoded as a proto-patient. This means that the generalization about the thematic identity of arguments which may affect the internal constitution of an event expressed earlier — here repeated as (6-70) — is essentially incorrect.

(6-70) THEMATIC-ASPECTUAL INTERFACE *preliminary version*
The reference properties of the participant of an event can determine the internal temporal constitution of the event if and only if that participant is not linked to a proto-agent role.

A possible conclusion then might be that there is no thematic similarity between unaccusative subjects and transitive objects. Under this view, unaccusatives would encode a proto-agent role as do unergative and (di)transitive verbs. Consequently, unaccusativity would be essentially characterized as an aspectual matter. Such a conclusion, however, does not take into consideration that verbs with agent subjects cross-linguistically do not have the option of being unaccusative ([Levin 83]). This observation makes it unequivocable that some thematic similarities between unaccusative subjects and transitive objects exist. Notice in fact that crosslinguistically transitive objects may not be agents.[8]

It seems then that the claim that the role of unaccusative subjects is a proto-patient is as inadequate as the claim that it is a proto-agent. Suppose, however, we were to assume that unaccusative subjects are linked to a role which is compatible with either a proto-patient and proto-agent specification. It would then be possible to capture thematic similarities between unaccusative subjects and transitive objects without commitment to a specific thematic instantiation. Such commitment, as we saw earlier, preempts the possibility of a natural treatment of causative formation and auxiliary selection in Italian, and leads to inconsistency with respect to unaccusative mismatches in Dutch. The assignment of a partially specified proto-role to unaccusative subjects makes it possible to overcome these problems. For example, the constraint on causative formation that the complement subject be instantiated to a proto-agent role will no longer rule out causative structures containing unaccusative complements as such instantiation would effectively be allowed. With respect to causative formation, unaccusative subjects will therefore have the same thematic functionality of transitive subjects. Still, the subject role of unaccusatives will differ from transitive subjects in that — all else being equal — it also allows for a proto-patient instantiation. In the next section I will show how this thematic assignment to unaccusative subjects can be exploited to explain the Italian data on auxiliary selection with modal verbs.

### Towards a New Characterization of the Unaccusative Hypothesis

The conclusions which may be drawn from the last section is that the phenomena which have traditionally been accounted for exploiting the syntactic insights of the

[8] Following [Wierzbicka 81, Kiparsky 87, Bresnan & Kanerva 88], I assume that agent roles which are realized as ergative NPs in syntactically ergative languages are not direct object as claimed by [Marantz 84].

Unaccusative Hypothesis are best seen as the (morpho)syntactic reflexes of the following two converging semantic factors:

- the contribution of the subject of an intransitive verb to the internal constitution of the event expressed by the verb
- compatibility of the subject proto-role with either a proto-agent or proto-patient instantiation.

Thematic properties such as *volitionality* also appear to provide a significant contribution, as Zaenen has shown for Dutch with respect to impersonal passive formation as well as auxiliary selection and prenominal past participles with experiencer verbs (see §6.3.3). The extent to which this contribution can be regarded as independent of other factors which determine unaccusativity will remain an open question in the present account.

In keeping with these conclusions, the class of unaccusative verbs can be characterized as the class of intransitive predicates whose subject is compatible with either a p-agt or p-pat specification, and whose subject referential properties can be determinant of telicity (on a single event reading). A first account of this characterization can be obtained by augmenting the algorithm concerning the assignment of proto-roles to predicates described in §4.3.2 with the following clause:

(6-71) PROTO-ROLE ASSIGNMENT TO UNACCUSATIVE PREDICATES (first version)
The proto-agent of an intransitive verbs whose aktionsart may be either telic or atelic is a default proto-agent.

According to the treatment of defaults given in §4.3.3, a default proto-agent would be one whose thematic specification is maintained only if no incompatible instantiations occur. In the event of a unification clash the default thematic specification is overridden by the non-default thematic value. This means that a default proto-agent can potentially instantiate a non-default proto-patient. Thematic underspecification may therefore be encoded as default thematic specification. To do so, default unification will be extended to atomic feature structures.

However, a consequence of clause (6-71) is that stative verbs are denied membership to the class of unaccusatives, i.e. stative verbs have atelic aktionsart. This consequence is problematic insofar as stative verbs have usually been included within the class of unaccusative verbs on the basis of their distributional properties. For example, stative intransitive verbs in Italian select auxiliary *essere*, induce either *essere* or *avere* selection on a matrix modal, may undergo *ne*-cliticization, and may occur in reduced relative constructions.

(6-72) a Carlo $\left\{ \begin{matrix} \text{è} \\ \text{*ha} \end{matrix} \right\}$ restato a casa
"Carlo remained at home"

b Carlo $\left\{ \begin{matrix} \text{è} \\ \text{ha} \end{matrix} \right\}$ voluto restare a casa
"Carlo wanted to remain at home"

c Ne sono rimasti tre a casa
"Three of them remained at home"

d L'uomo rimasto a casa è tuo cugino
"The man who remained at home is your cousin"

The possibility of regarding stativity as a sign of unaccusativity is also motivated with respect to thematic factors. It is a well known fact that the subject role of most stative intransitive has low agentive properties. For example, the subject role of stative intransitive which express location has been traditionally encoded as a theme (cf. §3.1).

In Dutch, the situation is more complex in that intransitive stative verbs canonically may not undergo impersonal passive formation, and yet they have a lexical propensity for *hebben* selection and do not seem to occur as prenominal participles.[9] However, the relation between stativity and low agency may still be needed to characterize unaccusativity. For example, the impossibility of forming impersonal passives with stative verbs in Dutch (cf. (6-29)) cannot be solely accounted for in terms of *controllability*. Verbs such as "remain, stay, live" may in fact involve subject volitionality/control. It seems reasonable to assume that subject of stative intransitives lacks the agentive strength which is required of a verb by impersonal passive formation. If agentivity is to play a role in the unaccusative/unergative distinction, then we may conclude that *hebben* selection with stative intransitives is not a sign of unergativity. I will thus assume that stativity is instrumental in establishing the proto-role of an intransitive subjects as stated in the revision of (6-71) shown in (6-73).

[9] For example, [Zaenen 89] considers *zijn* selection with *blijven* "stay" an exception to the rule that atelic verbs select *hebben*.

(6-73) PROTO-ROLE ASSIGNMENT TO UNACCUSATIVE PREDICATES (final version)
The proto-role of an intransitive verbs whose aktionsart is either stative or eventive and unspecified with respect to telicity is a default proto-agent.

I think that (6-73) is essentially the right generalization — with further qualifications to be discussed in §6.3.3 — although it captures the relevant facts in a somewhat indirect way. It would in fact be more appropriate to state the assignment of a default proto-role on the basis of thematic properties such as volitionality, sentiency, affectedness etc. This could be done by capturing regularities across all clusters of proto-agent and proto-patient properties which can be attributed to the subject argument of intransitive verbs whose aktionsart is either stative or eventive and unspecified with respect to telicity. Clearly, this task cannot be carried out simply on the basis of the insights concerning verb meaning which we have adopted so far; a more sophisticated treatment of verb meaning is needed to locate these insights. In adopting the generalization in (6-73) I will thus assume that more work at the level of lexical semantics needs to be done to flesh out properties of verb meanings which lead to the assignment of a default proto-agent.

In the light of this discussion on unaccusativity, the generalization about the interaction of aspectual and thematic information presented earlier in the chapter can be refined by weakening the requirement of thematic identity in (6-70) to thematic compatibility:

(6-74) THEMATIC-ASPECTUAL INTERFACE *final version*
The reference properties of the participant of an event can determine the internal temporal constitution of the event if and only if that participant is compatible with a thematic specification which is lower than that a proto-agent

The generalization in (6-74) should be considered as a providing a default mapping of referential properties from NP to verb meanings. As was pointed out in §6.1.2, a countable object NP may not induce a telic interpretation with inherently durative verbs (e.g. statives). The same observation applies to the subject NP of intransitive statives: compatibility with a proto-patient (prepositional) role grants the NP the possibility of contributing to the aspectual make-up of the eventuality expressed by the verb. However. this contribution becomes effective only by default (e.g. if no feature clash occurs). In practice, this means that the possibility of mapping referential properties from NP to verb meanings is secured even in cases where no aspectual shift takes place, e.g. *push a chart. loves a woman, John remained.* This is perhaps a contentious claim, but nevertheless a harmless one which — as I hope to have shown in this section — plays an important role in capturing (morpho)syntactic reflexes of the unaccusative/unergative distinction.

## 6.3 A UCG Interpretation

According to the representation of the aspectual/thematic interface provided in the last section, transitive, unergative and unaccusative verbs can be characterized as follows:

- TRANSITIVES
  1. subject NP is linked to proto-agent role and its reference properties may not contribute to the internal temporal constitution of the eventuality expressed by the verb
  2. object NP is linked to proto-patient role and its reference properties may contribute to the internal temporal constitution of the eventuality expressed by the verb
- UNERGATIVES
  atelic, non-stative verbs whose subject NP is linked to proto-agent role; reference properties of subject NP may not contribute to the internal temporal constitution of the eventuality expressed by the verb
- UNACCUSATIVES
  stative or aspectually underspecified eventive verbs whose subject NP is linked to a default proto-agent role; reference properties of subject NP may contribute to the internal temporal constitution of the eventuality expressed by the verb.

In order to provide a UCG specification, the following additions to the current system are needed: an aspectual classification of eventualities into states, processes and telic events. and a unification account of the contribution of argument NPs to aspect compositionality.

### 6.3.1 Aspectual Classes

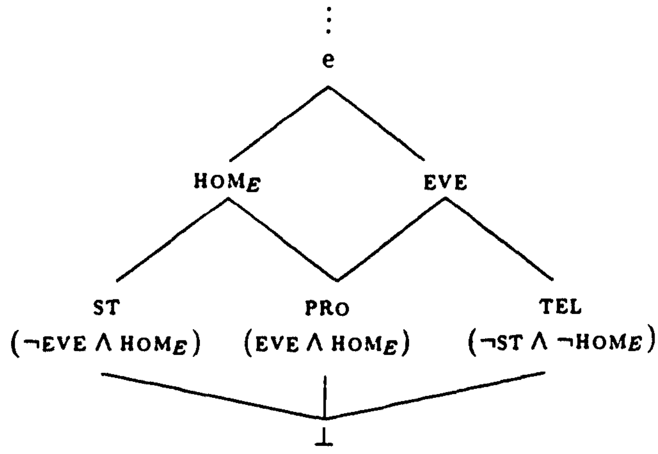
With respect to aspectual classification I will adopt a simplified version of Vendler's system. Vendler's verb classification ([Vendler 67]) is based on the assumption that event descriptions involve reference to the two temporal properties *homogeneity* and *punctuality*. Consequently English verb phrases can be divided into four categories as shown in (6-75).

(6-75)

| | HOMOGENEOUS | HETEROGENEOUS |
|---|---|---|
| PUNCTUAL | states<br>*e.g. love, stay* | achievements<br>*e.g. wink, reach the top* |
| EXTENDED | processes<br>*e.g. run, push a cart* | accomplishments<br>*e.g. run a mile, drink a beer* |

Stative and process predicates are homogeneous because the property they express persists when their extensions are segmented into minimal parts, e.g. "John ran for a hour" and "John was sick for a week" describe events which have proper subparts for which "John ran" and "John was sick" hold. Achievements and accomplishments are heterogeneous as the event description they engender does not apply to any of their proper subparts, e.g. "Bill read Anna Karenina" and "the dog died" do not have proper subparts for which the two event descriptions "read Anna Karenina" and "die" hold. States and achievements are punctual because they have minimal (sub)parts which correspond to a singleton of time, e.g. *John died* holds of a moment of time, and *John loved Mary for a year* entails that John loved Mary for each instant of that year. Processes and accomplishments are extended because they do not have minimal parts which correspond to a singleton of time, e.g. if *John run* and *Bill read Anna Karenina* hold for an interval of time $i$, $i$ is greater than a moment of time. Since the distinction between achievements and accomplishments is not relevant for the task at hand, I will not take into consideration the punctuality of events. For ease of exposition, I will continue to use the letter $e$ as a variable name for any kind of eventuality, and assume two additional atomic eventuality sorts: EVE for processes, achievements and accomplishments, and HOM$_E$ for homogeneous eventualities (e.g. states and processes). The eventuality sort for accomplishments and achievements (i.e. TEL) will be defined as the logical conjunction of EVE and ¬HOM$_E$. The eventuality sort for processes is defined as the logical conjunction of EVE and HOM$_E$. The sort ST, defined as the conjunction of ¬EVE and HOM$_E$ will characterize the argument variable of stative predicates. The resulting lattice fragment would be as in (6-76).

(6-76)




### 6.3.2 The Interface between Nominal and Temporal Reference

Concerning the question of how to represent the contribution of argument NPs to aspect compositionality, the strategy which I will follow is to adapt Krifka's treatment of the relation betweeen temporal and nominal reference to the present framework and assumptions about the thematic/aspectual interface. This decision is essentially motivated by the fact that Krifka's approach is couched within an event-based algebraic framework which lends itself to an easy integration with the UCG system developed in this thesis. Our preference for Krifka's formalization over that of Verkyul's is not going to change the substance of the approach to the thematic/aspectual interface developed in this chapter. This is essentially because the subject/object asymmetry concerning the contribution of arguments to sentence aspect can be expressed, and is effectively encoded, in Krifka's treatment. For example, to capture the relation between nominal and event reference arising from the aspectual contrasts in the sentences in (6-77), Krifka suggests that the semantics of telic aktionsart should be characterized in terms of a homomorphism from algebraically structured theme denotations into algebraically structured event denotations. This encoding allows successive phases of change of the theme argument to be reflected into successive stages of development of the event in such a way that the desired interaction between nominal and temporal reference obtains.

(6-77) a John drank $\left\{ \begin{array}{l} \text{beer} \\ \text{??a glass of beer} \end{array} \right\}$ all day

b John drank $\left\{ \begin{array}{l} \text{a glass of beer} \\ \text{??beer} \end{array} \right\}$ in fifteen minutes

Collective/distributive readings are obtained by establishing a biunique mapping between the cardinality of the extension of nominal predicates and the cardinality of the extension of verbal predicates; here no thematic restrictions are imposed. (In adapting Krifka's insights to the present framework, I will not take into consideration issues related to quantification, thus leaving the task of providing a characterization of collective and distributive readings to subsequent research.)

Following Krifka, I will assume that the two semantic properties which are involved in the semantics of telic aktionsart are *cumulative* and *quantized* reference. Nominal predicates which refer cumulatively (e.g. mass nouns, and bare plurals) respond positively to the additivity test: if there are two entities to which a predicate applies separately, then the predicate holds of their collection as well. Nominal predicates which have quantized reference (e.g. an apple, Bill, the zoo, every book), do not have this property: if there are two entities to which a predicate applies separately, then the predicate does not holds of their collection. When applied to the domain of eventualities cumulative and quantized reference corresponds to the notions of homogeneity and heterogeneity discussed above.[10] To give a formal definition of cumulative and quantized reference, Krifka organizes the domain of individuals and eventualities into a lattice structure where reference properties of members of the domain can be logically expressed in terms of algebraic operations. For example, cumulative (e.g. homogeneous) reference for individuals is defined as a second order property — e.g. $\lambda P[CUM_O(P)]$ — which picks out any predicate $P$ such that if $P$ holds separately of two distinct individuals $x, y$, e.g. $P(x)$ and $P(y)$, then $P$ will also hold for the join (i.e. union) of $x$ and $y$:

(6-78) *Cumulative Reference for Individual Objects*
$\forall P[CUM_O(P) \rightarrow \forall x, y[P(x) \wedge P(y) \rightarrow P(x \sqcup_O y)]]$

Quantized reference for individuals is defined as in (6-79); e.g. if $P$ holds separately of $x$ and $y$, then $y$ may not be properly contained in $x$.

(6-79) *Quantized Reference for Individual Objects*
$\forall P[QUA_O(P) \rightarrow \forall x, y[P(x) \wedge P(y) \rightarrow \neg y \sqsubset_O x]]$

[10] See [Bach 86] and [Hinrichs 85] for forther remarks on this point.

This characterization of cumulative and quantized reference is also applied to the domain of eventualities, e.g.

(6-80) *Cumulative Reference for Eventualities*
$\forall P[CUM_E(P) \leftrightarrow \forall e, e'[P(e) \wedge P(e') \rightarrow P(e \sqcup_E e')]]$

(6-81) *Quantized Reference for Eventualities*
$\forall P[QUA_E(P) \leftrightarrow \forall e, e'[P(e) \wedge P(e') \rightarrow \neg e' \sqsubset_E e]]$

The basic insight of Krifka's approach to the relation between nominal and event reference is that certain thematic relations have transfer properties which allow reference properties of arguments to affect the reference properties of eventualities. Some of the predicates which characterize these transfer properties are listed in (6-82).

(6-82) a UNIQUENESS OF OBJECTS
$\forall R[UNI\text{-}O(R) \leftrightarrow \forall e \forall x \forall x'[R(e,x) \wedge R(e,x') \rightarrow x = x]]$

b UNIQUENESS OF EVENTS
$\forall R[UNI\text{-}E(R) \leftrightarrow \forall e, e', x[R(e,x) \wedge R(e',x) \rightarrow e = e']]$

c MAPPING TO OBJECTS
$\forall R[MAP\text{-}O(R) \leftrightarrow \forall e, e', x[R(e,x) \wedge e' \sqsubseteq_E e \wedge \exists x'[x' \sqsubseteq_O x \wedge R(e',x')]]]$

d MAPPING TO EVENTS
$\forall R[MAP\text{-}E(R) \leftrightarrow \forall e, x, x'[R(e,x) \wedge x' \sqsubseteq_O x \wedge \exists e'[e' \sqsubseteq_E e \wedge R(e',x')]]]$

UNIQUENESS OF OBJECTS corresponds to Carlson's condition of "thematic uniqueness" discussed earlier in §3.2.2 (see also [Dowty 89]): for any given event, the same role can only be assigned to the same object. UNIQUENESS OF EVENTS says that for any specific object there can only be one event related to the object by the thematic relation. This property holds of those thematic relations which characterize the argument of a verb undergoing gradual change. as discussed in §3.1.1 with reference to Dowty's notion "incremental theme". MAPPING TO OBJECTS and MAPPING TO EVENTS concern the construction of the homomorphism from objects to events. MAPPING TO OBJECTS establishes a one-to-one mapping between subparts of an event and subpart of an object, while MAPPING TO EVENTS establishes the inverse relation (e.g. every subpart of the object correspond to a subpart of the event). According to Krifka, this homomorphism obtains with verbs which encode a "gradual patient" — e.g. a role for which UNIQUENESS OF EVENTS holds — where each intermediate stage of completion of the event denoted by the verb corresponds to an intermediate change of state for the patient argument (e.g. "drink a beer, mow the lawn, unload a truck"; see §3.1.1). Consider, for example, the case of a property of eventualities such as $\lambda e[read(e) \wedge \theta(e,x) \wedge letter(x)]$ where the verbal predicate is cumulative and the nominal predicate is quantized (e.g. as in *read the letter*). Krifka proves that one set of conditions under which the expression as a whole has quantized reference is that all the properties in (6-82) hold of the thematic relation $\theta$. The proof goes as follows:

> I assume that an expression like *read the letter* is translated by formula $\Phi$,
>
> $$(15)\ \Phi = \lambda e \exists x[\alpha(e) \wedge \delta(x) \wedge \theta(e, x)]$$
>
> where $\alpha$ represents the verbal predicate (*read*), $\delta$ represents the nominal predicate (*a letter*), and $\theta$ represents a thematic relation (here, a specific patient relation). ... The verbal predicate $\alpha$ will be considered to be cumulative throughout. ... Under which conditions can we assume that they [i.e. quantized nominal predicates] cause the complex verbal predicate to be quantized as well? One set of conditions is that the thematic role $\theta$ must satisfy uniqueness of objects, uniqueness of events and mapping to objects. Proof: We assume to the contrary that $\delta$ [i.e. the predicate beer in our example] is quantized, $\Phi(e_1)$, $\Phi(e_2)$ [where $\Phi = \lambda e[drink(e) \wedge \theta(e, x) \wedge beer(x)]$], and $e_2 \sqsubset_e e_1$. Then there are $x_1, x_2$ with $\delta(x_1)$, $\theta(e_1,\ x_1)$, $\delta(x_1)$, $\theta(e_1, x_1)$ according to the definition of $\Phi$. Because $e_2 \sqsubset_E e_1$ and $\theta$ satisfies mapping to objects, there is an $x_3$ such that $x_3 \sqsubseteq_O x_1$ and $\theta(e_2, x_3)$. Because uniqueness of objects, it holds that $x_3 = x_2$, and therefore $x_2 \sqsubseteq_O x_1$. Because $\neg e_2 = e_1$ and uniqueness of events, it holds that $\neg x_2 = x_1$, and therefore $x_2 \sqsubset_O x_1$. But this contradicts the assumption that $\delta$ is quantized. ([Krifka 87], pp. 14-6)

Our approach will differ from Krifka's in the following respects. First, the eventuality argument of verbal predicates which allow for telic/atelic aspectual shifts (e.g. "drink", but not "love") is underspecified with respect to cumulative/quantized reference, i.e. the sort specification HOM$_E$. An example is provided below for the predicate "drink" (recall that the eventuality sort EVE can potentially assume a telic instantiation ($\neg$HOM$_E$) or an atelic one (HOM$_E$)).

$$(6\text{-}83)\quad \begin{bmatrix} \textbf{pred} & = & \textit{drink} \\ \textbf{arg1} & = & \text{EVE} \end{bmatrix}$$

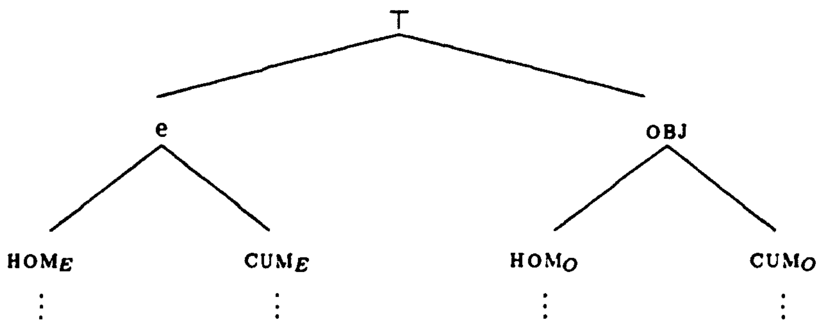
This will make it possible to compute aspect compositionality in terms of information-preserving instantiation. Second, the whole set of conditions which promotes the transfer properties of a thematic role are attributed to any role which is compatible with either a proto-patient or prepositional instantiation (see below for details). Third, the transfer of reference properties is effectively carried out by letting the verbal predicate inherit the quantized/cumulative specification of the nominal predicate by default. Default inheritance will make it possible to generalize the same transfer properties to all roles which are compatible with a proto-patient/prepositional specification regardless of the predicate contest in which they are found. For example, the $\neg\mathrm{HOM}_E$ instantiation induced by a quantized nominal on the eventuality variable of a verb will be realized with a predicate like "drink" in (6-83), while it will be overridden with a stative predicate such as "love" below since the sort ST is incompatible with such an instantiation.

(6-84) $\begin{bmatrix} \mathbf{pred} = \textit{love} \\ \mathbf{arg1} = \mathrm{ST} \end{bmatrix}$

This result is obtained by encoding the eventuality sort specification which arises from the object-to-event homomorphism as a default sort.

The integration of this modified version of Krifka's system with the present UCG framework requires that the encoding of NP semantics adopted hitherto be enriched so as to facilitate the transfer of reference properties from objects to eventualities. The basic idea is that this transfer is directly encoded by the appropriate thematic roles. The cumulative/quantized distinction is reflected in the domain of both objects and eventualities as shown below where $\mathrm{HOM}_O$ is a sort for cumulative objects, and $\mathrm{CUM}_E$ and $\mathrm{CUM}_O$ stand for $\neg\mathrm{HOM}_E$ and $\neg\mathrm{HOM}_O$ respectively.

(6-85)




Thematic roles are endowed with the ability to relate object and eventuality sorts which are homomorphic, e.g. the two pairs $\mathrm{HOM}_E$-$\mathrm{HOM}_O$and $\mathrm{CUM}_E$-$\mathrm{CUM}_O$. This is done by adding a third argument place to role predicates; this argument is reserved to the eventuality sort which is homomorphic to the object argument sort of the role predicate. A thematic roles is thus defined as a three-place predicate which relate an eventuality sort, an object sort and its homomorphic eventuality sort, e.g.

(6-86) a $[e_1]p\text{-}pat(e_1, \text{HOM}_O, \text{HOM}_E)$

b $[e_1]p\text{-}pat(e_1, \text{CUM}_O, \text{CUM}_E)$

For example, the sign for a bare plural NP, e.g. "beer", will relate a cumulative object sort ($\text{HOM}_O$) to a cumulative eventuality sort ($\text{HOM}_E$) as shown in the sign below where the phonology attribute has been simplified for expository convenience.

(6-87) OBJECT-TO-EVENT HOMOMORPHISM IN NPs (first version)

$$\left[\begin{array}{l} \text{phon} = \textit{beer} \\ \text{cat} = \boxed{1} \Big/ \left[\begin{array}{l} \text{cat} = \boxed{1} \Big/ \left[\begin{array}{l} \text{cat} = np \\ \text{sem} = \boxed{2}\left[\begin{array}{l} \text{pred} = [\,] \\ \text{arg1} = e \\ \text{arg2} = \boxed{3}\,\text{HOM}_O \\ \text{arg3} = \text{HOM}_E \end{array}\right] \end{array}\right] \\ \text{sem} = \left[\begin{array}{l} \text{pred} = \boxed{4} \\ \text{args} = \boxed{5} \end{array}\right] \end{array}\right] \\ \text{sem} = \left[\begin{array}{l} \text{pred} = \textit{and} \\ \text{arg1} = \left[\begin{array}{l} \text{pred} = \boxed{4} \\ \text{args} = \boxed{5} \end{array}\right] \\ \text{arg2} = \left[\begin{array}{l} \text{pred} = \textit{and} \\ \text{arg1} = \boxed{2} \\ \text{arg2} = \left[\begin{array}{l} \text{pred} = \textit{beer} \\ \text{arg1} = \boxed{3} \end{array}\right] \end{array}\right] \end{array}\right] \end{array}\right]$$

The proto-patient argument of a transitive verb like "drink" is encoded as shown in (6-88) where the two eventuality argument sorts of the p-pat role share the same sorted variable (EVE).

$$\text{(6-88)} \quad \left[\begin{array}{l} \text{phon} = \textit{drink} \\ \text{cat} = [\text{catn} = \textit{sent}] \big/ [\text{catn} = np] \Big/ \left[\begin{array}{l} \text{catn} = np \\ \text{sem} = \left[\begin{array}{l} \text{pred} = p\text{-}pat \\ \text{arg1} = \boxed{1} \\ \text{arg2} = \text{OBJ} \\ \text{arg3} = \boxed{1} \end{array}\right] \end{array}\right] \\ \text{sem} = \left[\begin{array}{l} \text{pred} = \textit{drink} \\ \text{arg1} = \boxed{1}\,\text{EVE} \end{array}\right] \end{array}\right]$$

This reentrancy is responsible for establishing the transfer of cumulative reference from the object nominal to the verbal predicate. The actual transfer results from instantiating the event sort of the verb with the event sort in the object NP which is homomorphic with the object sort of the NP. When the NP and verb signs in (6-87) and (6-88) combine, the $\text{HOM}_E$ sort of the NP instantiates the EVE sort in the verb sign; this instantiation will give as result an atelic eventuality sort (PRO), as shown in (6-89), since the conjunction of the two sorts $\text{HOM}_E$ and EVE describes an event which has cumulative reference. This gives us the desired interpretation for the verb phrase "drink beer", i.e. a cumulative eventuality.

(6-89)
$$\begin{bmatrix} \textbf{phon} = \textit{drink beer} \\ \textbf{cat} = \begin{bmatrix}\textbf{catn} = \textit{sent}\end{bmatrix} \Big/ \begin{bmatrix}\textbf{catn} = \textit{np}\end{bmatrix} \\ \textbf{sem} = \begin{bmatrix} \textbf{pred} = \textit{and} \\ \textbf{arg1} = \begin{bmatrix} \textbf{pred} = \textit{drink} \\ \textbf{arg1} = \boxed{1}\text{PRO} \end{bmatrix} \\ \textbf{arg2} = \begin{bmatrix} \textbf{pred} = \textit{and} \\ \textbf{arg1} = \begin{bmatrix} \textbf{pred} = \textit{p-pat} \\ \textbf{arg1} = \boxed{1} \\ \textbf{arg2} = \boxed{3}\text{HOM}_O \\ \textbf{arg3} = \boxed{1} \end{bmatrix} \\ \textbf{arg2} = \begin{bmatrix} \textbf{pred} = \textit{beer} \\ \textbf{arg1} = \boxed{3} \end{bmatrix} \end{bmatrix} \end{bmatrix} \end{bmatrix}$$

Default inheritance is established by flagging the second eventuality argument of role predicates in the NP semantics as a default sort specification, e.g.

(6-90)
$$\begin{bmatrix} \textbf{pred} = \textit{p-pat} \\ \textbf{arg1} = e \\ \textbf{arg2} = \text{OBJ} \\ \textbf{arg3} = \{\text{DEF}, e\} \end{bmatrix}$$

The basic idea is that the homomorphism between object and eventuality sorts established by role predicates operates by default. If no incompatibilities arise with respect to the eventuality sort specification inherent to the meaning of the verb (e.g. EVE in the example above), then the role predicate is allowed to relate an object sort to its homomorphic eventuality sort; otherwise, the second eventuality sort specification of the role predicate is overridden by that of the verb. Suppose, for example, a stative verb were to combine with a quantized NP, as in the verb phrase "love that book". In this case, the eventuality sort specification introduced by the third argument of the role predicate in the NP ($\text{CUM}_E$) would clash with the eventuality sort of the predicate "love" (ST) if it were to be maintained, as schematically shown below.

$$
(6\text{-}91)\quad
\begin{bmatrix}
\textbf{phon} = \textit{love} \\[6pt]
\textbf{cat} = \begin{bmatrix}\textbf{catn} = \textit{sent}\end{bmatrix} \Big/ \begin{bmatrix}\textbf{catn} = \textit{np}\end{bmatrix} \Big/ \begin{bmatrix} \textbf{cat} = \textit{np} \\ \textbf{sem} = \begin{bmatrix} \textbf{pred} = \textit{p-pat} \\ \textbf{arg1} = \boxed{1} \\ \textbf{arg2} = \text{OBJ} \\ \textbf{arg3} = \boxed{1} \end{bmatrix} \end{bmatrix} \\[6pt]
\textbf{sem} = \begin{bmatrix} \textbf{pred} = \textit{love} \\ \textbf{arg1} = \boxed{1}\text{ST} \end{bmatrix}
\end{bmatrix}
$$

(6-92) OBJECT-TO-EVENT HOMOMORPHISM IN NPs (final version)

$$
\begin{bmatrix}
\textbf{phon} = \textit{that book} \\[6pt]
\textbf{cat} = \boxed{1} \Big/ \begin{bmatrix} \textbf{cat} = \boxed{1} \Big/ \begin{bmatrix} \textbf{cat} = \textit{np} \\ \textbf{sem} = \boxed{2} \begin{bmatrix} \textbf{pred} = [\,] \\ \textbf{arg1} = e \\ \textbf{arg2} = \boxed{3}\text{CUM}_O \\ \textbf{arg3} = \{\text{DEF}, \text{CUM}_E\} \end{bmatrix} \end{bmatrix} \end{bmatrix}
\end{bmatrix}
$$

However, since the eventuality sort introduced by the third argument of the role predicate in the NP sign is a default sort ($\{\text{DEF}, CUM\}$), this incompatibility is resolved in favor of the eventuality sort of the verb (ST), e.g. $\text{ST} \sqcap \{\text{DEF}, \text{CUM}_E\} = \text{ST}$. The resulting verb phrase, "love that book", will be correctly interpreted as describing a cumulative eventuality (a state in this case) in spite of the quantized reference properties of the object nominal, as indicated below.

$$
(6\text{-}93)\quad
\begin{bmatrix}
\textbf{phon} = \textit{love that book} \\
\textbf{cat} = \begin{bmatrix}\textbf{catn} = \textit{sent}\end{bmatrix} \Big/ \begin{bmatrix}\textbf{catn} = \textit{np}\end{bmatrix} \\
\textbf{sem} = \begin{bmatrix}
\textbf{pred} = \textit{and} \\
\textbf{arg1} = \begin{bmatrix} \textbf{pred} = \textit{love} \\ \textbf{args} = \boxed{1}\text{ST} \end{bmatrix} \\
\textbf{arg2} = \begin{bmatrix}
\textbf{pred} = \textit{and} \\
\textbf{arg1} = \begin{bmatrix} \textbf{pred} = \textit{p-pat} \\ \textbf{arg1} = \boxed{1} \\ \textbf{arg2} = \boxed{3}\text{CUM}_O \\ \textbf{arg3} = \boxed{1} \end{bmatrix} \\
\textbf{arg2} = \begin{bmatrix} \textbf{pred} = \textit{beer} \\ \textbf{arg1} = \boxed{3} \end{bmatrix}
\end{bmatrix}
\end{bmatrix}
\end{bmatrix}
$$

The transfer of reference properties from object to eventuality sorts is strictly limited to argument roles which are compatible with a proto-patient/prepositional specification.

Consequently, proto-agent roles should not be allowed to relate the eventuality argument sort of a verb with the eventuality sort which is homomorphic to a nominal object sort. This can be done by making the third argument place of proto-agent roles inaccessible to any sortal instantiation for eventualities. To preclude access to this argument, I will assume that the third argument of a proto-agent role is always assigned *nil* as value. e.g. $[e_1]p\text{-}agt(e_1, X, nil)$, as shown in (6-94) for the subject argument of the verb "work".[11] This captures the idea that the reference properties of a proto-agent participant of an event cannot contribute to the internal temporal constitution of the event.

(6-94) CLOSURE OF TRANSFER PROPERTIES FOR PROTO-AGENT ARGUMENTS

$$\begin{bmatrix} \textbf{phon} = \textit{work} \\ \textbf{cat} = \begin{bmatrix}\textbf{catn} = \textit{sent}\end{bmatrix} \Big/ \begin{bmatrix} \textbf{cat} = \textit{np} \\ \textbf{sem} = \begin{bmatrix} \textbf{pred} = \textit{p-agt} \\ \textbf{arg1} = e \\ \textbf{arg2} = \text{OBJ} \\ \textbf{arg3} = \textit{nil} \end{bmatrix} \end{bmatrix} \end{bmatrix}$$

No further changes need to be added to NP signs. Since the third argument variable of role predicate in the NP sign is a default sort, it will turn to *nil* when the NP instantiates a proto-agent argument role. This is because the unification of any default sort with *nil* is *nil* (see previous footnote). Hence, the combination of a verb with its proto-agent NP will will not involve transfer of reference properties from the argument nominal to the verb.

According to this specification of the thematic-aspectual interface, the characterization of *transitive*, *unergative*, and *unaccusative* verbs developed in this chapter (see page 265) can be given in terms of structure sharing between the eventuality argument of the verb and that introduced by the third argument of role predicates. The leading assumption is that such a relation of structure sharing is only possible when the argument roles involved is not compatible with a proto-agent specification. With transitive verbs, transfer of the reference properties of the subject NP is blocked because the third argument of the proto-agent role is set to *nil*. This transfer will instead be possible from the object NP through structure sharing as indicated with the tag $\boxed{1}$.

[11] Recall that *nil* is only compatible with $\top$, $\bot$ and itself: see §4.2.1.

(6-95) TRANSITIVES

$$\begin{bmatrix} \mathbf{cat} = \begin{bmatrix}\mathbf{catn} = \mathit{sent}\end{bmatrix} / \begin{bmatrix} \mathbf{cat} = \mathit{np} \\ \mathbf{sem} = \begin{bmatrix} \mathbf{pred} = \mathit{p\text{-}agt} \\ \mathbf{arg1} = \boxed{1} \\ \mathbf{arg2} = \textsc{obj} \\ \mathbf{arg3} = \mathit{nil} \end{bmatrix} \end{bmatrix} / \begin{bmatrix} \mathbf{cat} = \mathit{np} \\ \mathbf{sem} = \begin{bmatrix} \mathbf{pred} = \mathit{p\text{-}agt} \\ \mathbf{arg1} = \boxed{1} \\ \mathbf{arg2} = \textsc{obj} \\ \mathbf{arg3} = \boxed{1} \end{bmatrix} \end{bmatrix} \\ \\ \mathbf{sem} = \begin{bmatrix} \mathbf{pred} = [\,] \\ \mathbf{arg1} = \boxed{1}e \end{bmatrix} \end{bmatrix}$$

Unergative verbs are akin to transitives in that they disallow default inheritance of reference properties from the subject NP as indicated in (6-96). The motivation for this similarity is that unergative subjects are linked to a p-agt role, as are transitive subjects.

(6-96) UNERGATIVES

$$\begin{bmatrix} \mathbf{cat} = \begin{bmatrix}\mathbf{catn} = \mathit{sent}\end{bmatrix} / \begin{bmatrix} \mathbf{cat} = \mathit{np} \\ \mathbf{sem} = \begin{bmatrix} \mathbf{pred} = \mathit{p\text{-}agt} \\ \mathbf{arg1} = \boxed{1} \\ \mathbf{arg2} = \textsc{obj} \\ \mathbf{arg3} = \mathit{nil} \end{bmatrix} \end{bmatrix} \end{bmatrix}$$

The subject role of unaccusatives is instead encoded as a default proto-agent, a specification which can be overridden following unification failure. To encode role predicates as defeasible values, default unification is extended to atomic feature structures as indicated below.

(6-97) DEFAULT UNIFICATION (for atomic feature structures)

a If $\alpha$ is an atomic feature structure, then $\{\textsc{def}, \alpha\}$ is a default atomic feature structure.

b If $A$ is a feature structures, and $\{\textsc{def}, B\}$ a default feature structure then:

$$\begin{aligned} A \sqcap \{\textsc{def}, B\} &= \{\textsc{def}, B\} \text{ if } A \text{ subsumes } B \text{ (e.g. } A = [\,]) \\ &= A \sqcap B \text{ if } B \text{ subsumes } A \text{ or } B = A \\ &= \{\textsc{def}, A \sqcap B\} \text{ if } A \text{ is a default feature structure} \\ &= A \text{ otherwise} \end{aligned}$$

The possibility of a proto-patient instantiation licenses default inheritance of cumulative/quantized reference from the subject NP, as indicated in (6-98) where the the third argument of the role predicate and the argument of the verb share the same eventuality sort as value.

(6-98) UNACCUSATIVES

$$\begin{bmatrix} \textbf{cat} = \begin{bmatrix}\textbf{catn} = \textit{sent}\end{bmatrix} \Big/ \begin{bmatrix} \textbf{cat} = \textit{np} \\ \textbf{sem} = \begin{bmatrix} \textbf{pred} = \textit{p-agt} \\ \textbf{arg1} = \boxed{1} \\ \textbf{arg2} = \text{OBJ} \\ \textbf{arg3} = \boxed{1} \end{bmatrix} \end{bmatrix} \\ \\ \textbf{sem} = \begin{bmatrix} \textbf{pred} = [\,] \\ \textbf{arg1} = \boxed{1}e \end{bmatrix} \end{bmatrix}$$

To conclude this chapter, I will show how this characterization of verb classes — and in particular the contrasts between unergative and unaccusative predicates — can be utilized to give an account of some of the problematic data in Italian and Dutch discussed in the previous section.

### 6.3.3 Auxiliary Selection in Dutch and Italian

According to our discussion in §6.2, the distribution of Italian verbs with respect to auxiliary selection can be stated as follows:

(6-99)

| Select *avere* | Select *essere* |
|---|---|
| - active transitives<br>- process intransitives<br>(unergatives) | - passives<br>- inchoatives<br>- reflexives<br>- stative intransitives<br>(unaccusatives)<br>- eventive predicates with<br>underspecified telicity<br>(unaccusatives) |

This distribution can be captured combining aspectual and thematic constraints. Verbs which select *avere* have subjects which are associated with a proto-agent role and whose reference properties cannot affect the internal temporal constitution of their governing verb. Verbs which select *essere* have subjects which are associated with a role which is not compatible with a proto-agent specification; consequently, the NPs which fill the subject role are allowed to contribute to the temporal constitution of the governing predicate. The three verb signs below show how these properties are encoded within the present UCG framework.

(6-100) TRANSITIVES, UNERGATIVES

$$\left[\begin{array}{l}\textbf{cat} = \left[\textbf{catn} = \textit{sent}\right] \Big/ \left[\begin{array}{ll}\textbf{cat} = \textit{np} & \\ \textbf{sem} = & \left[\begin{array}{lcl}\textbf{pred} & = & \textit{p-agt} \\ \textbf{arg1} & = & e \\ \textbf{arg2} & = & \text{OBJ} \\ \textbf{arg3} & = & \textit{nil}\end{array}\right]\end{array}\right] \Big(\Big/\ [\,]\Big)\end{array}\right]$$

(6-101) PASSIVES, INCHOATIVES, REFLEXIVES

$$\left[\begin{array}{l}\textbf{cat} = \left[\textbf{catn} = \textit{sent}\right] \Big/ \left[\begin{array}{ll}\textbf{cat} = \textit{np} & \\ \textbf{sem} = & \left[\begin{array}{lcl}\textbf{pred} & = & \textit{p-pat} \\ \textbf{arg1} & = & \boxed{1} \\ \textbf{arg2} & = & \text{OBJ} \\ \textbf{arg3} & = & \boxed{1}\end{array}\right]\end{array}\right]\end{array}\right]$$

(6-102) UNACCUSATIVES

$$\left[\begin{array}{l}\textbf{cat} = \left[\textbf{catn} = \textit{sent}\right] \Big/ \left[\begin{array}{ll}\textbf{cat} = \textit{np} & \\ \textbf{sem} = & \left[\begin{array}{lcl}\textbf{pred} & = & \{\text{DEF}, \textit{p-agt}\} \\ \textbf{arg1} & = & \boxed{1} \\ \textbf{arg2} & = & \text{OBJ} \\ \textbf{arg3} & = & \boxed{1}\end{array}\right]\end{array}\right]\end{array}\right]$$

Both auxiliaries *essere* and *avere* can be encoded as VP modifiers, e.g. (sent/np)/sent/np; thematic as well as aspectual constraints are expressed on the active part of the category structure which corresponds to the argument verb. The sign for *avere* will require that the subject of the argument verb be associated with a proto-agent role, and that its reference properties cannot contribute to the internal constitution of its governing verb, i.e. no eventuality sort is introduced in by the subject role predicate in its third argument position as shown in (6-103).

(6-103) AUXILIARY *avere*

$$\left[\ \mathbf{cat} = \boxed{1} \Big/ \left[\ \mathbf{cat} = \boxed{1}\left[\mathbf{catn} = \mathit{sent}\right] \Big/ \left[\begin{array}{l} \mathbf{catn} = \mathit{np} \\ \mathbf{sem} = \left[\begin{array}{l} \mathbf{pred} = \mathit{p\text{-}agt} \\ \mathbf{arg1} = \mathit{e} \\ \mathbf{arg2} = \mathrm{OBJ} \\ \mathbf{arg3} = \mathit{nil} \end{array}\right] \end{array}\right]\ \right]\ \right]$$

The impossibility of combining *avere* with passive, inchoative and reflexive verbs is thus captured both on aspectual and thematic grounds. From a thematic point of view, there is incompatibility between the argument subject role of the auxiliary (p-agt), and the subject role of these verb forms (a p-pat as shown in (6-101)). With respect to aspectual factor, the incompatibility of auxiliary *avere* with passive, inchoative and reflexive verbs concerns the encoding of the event-to-object homomorphism in role predicates. The argument subject role of the auxiliary does not encode such a homomorphism as its third argument is *nil*, while the subject role of passive, inchoative and reflexive verbs do by sharing a value for their third argument with the eventuality sort of the verb, as indicated in (6-102) with the tag $\boxed{1}$. This contrast will engender a further unification clash if the attempt is made to combine *avere* with a passive, inchoative or reflexive verb. With unaccusatives the thematic constraint does not apply since the subject of this verbs is linked to a (default) proto-agent role. The relevant constraint which prevents *avere* selection in this case concerns the possibility of transfering reference properties from the object to the event sort in the argument subject semantics — a property which unaccusatives share with passive, inchoative and reflexive verbs. The attempt to combine *avere* with an unaccusative verb will thus give rise to unification failure relative to the third argument of the subject role. This can be seen more clearly by matching the active sign of the auxiliary in (6-103) with the unaccusative verb sign in (6-102).

Auxiliary *essere* will essentially be structured as *avere*, except that the argument subject role is not compatible with a *p-agt* specification, and its reference properties must be allowed to contribute to the internal constitution of its governing verb as the tag $\boxed{1}$ in (6-104) — in place of *nil* in (6-103) — indicates.

(6-104) AUXILIARY *essere*

$$\left[\mathbf{cat} = \boxed{1} \Big/ \left[\mathbf{cat} = \boxed{1}\left[\mathbf{catn} = \mathit{sent}\right] \Big/ \left[\begin{array}{l} \mathbf{catn} = \mathit{np} \\ \mathbf{sem} = \left[\begin{array}{l} \mathbf{pred} = \neg \mathit{p\text{-}agt} \\ \mathbf{arg1} = \boxed{1}\, e \\ \mathbf{arg2} = \textsc{obj} \\ \mathbf{arg3} = \boxed{1} \end{array}\right] \end{array}\right]\right]\right]$$

Selection of auxiliary *essere* with transitive and unergative verbs is therefore ruled out both on aspectual and thematic grounds (e.g. compare the active sign of the auxiliary above with the sign for transitives and unergatives in (6-101)). This treatment of auxiliary selection can be summurized as follows:

(6-105) AUXILIARY SELECTION IN ITALIAN

a AVERE SELECTION
Auxiliary *avere* is selected when the subject role is compatible with a proto-agent which encodes no object-to-event homomorphism

b ESSERE SELECTION
Auxiliary *essere* is selected when the subject role is not compatible with a proto-agent role, and it promotes an object-to-event homomorphism.

Consider next the question of auxiliary selection in the context of modal verbal complexes. As shown in (6-46a-f) — here repeated as (6-106) — a modal verb can select either *avere* or *essere* when taking an unaccusative complement, while with an unergative, transitive, passive, inchoative or reflexive complement verb only auxiliary *avere* is possible.

(6-106) a *unaccusative complement*

Carlo $\left\{ \begin{array}{c} \text{ha} \\ \text{è} \end{array} \right\}$ voluto arrivare in anticipo

"Carlo wanted to arrive there early"

b *unergative complement*

Carlo non $\left\{ \begin{array}{c} \text{ha} \\ {*}\text{è} \end{array} \right\}$ voluto lavorare

"Carlo did not want to work"

c *transitive complement*

Carlo non $\left\{ \begin{array}{c} \text{ha} \\ {*}\text{è} \end{array} \right\}$ voluto invitare Olga

"Carlo did not want to invite Olga"

d *passive complement*

Carlo $\left\{ \begin{array}{c} \text{ha} \\ {*}\text{è} \end{array} \right\}$ voluto essere invitato

"Carlo wanted to be invited"

e *inchoative complement*

Il cancello non $\left\{ \begin{array}{c} \text{ha} \\ {*}\text{è} \end{array} \right\}$ voluto aprirsi

"The gate did not want to open"

f *reflexive complement*

Carlo non $\left\{ \begin{array}{c} \text{ha} \\ {*}\text{è} \end{array} \right\}$ voluto radersi

"Carlo did not want to shave himself"

Intuitively, there is a clear sense in which the properties of the complement verb influence the choice of auxiliary for the modal. However, this intuition is not an easy one to express because of the seemingly peculiar correspondence between the auxiliary chosen and the complement verb. Burzio's solution consists in relating the choice of auxiliary *essere* to the occurrence of restructuring (e.g. movement of the complement VP into the matrix VP). With unaccusative complements, restructuring yields a structural configuration in which the matrix subject binds the complement object trace with no intervening clausal barriers. This binding relation is essentially the same as the one which is found in canonical environments for *essere* selection (e.g. *essere* selection with unaccusatives. passives and reflexives). The impossibility of *essere* selection with other restructured modal complexes is derived from either the occurrence of a clausal barrier between the matrix subject and the coindexed complement object trace (e.g. with passive complements). or the lack of such a binding relation. If no restructuring takes place, then *avere* is selected. However. Burzio's account does not explain why either *essere* or *avere* can be chosen in some restructured structures (cf. (6-55)), and it is at odds with the occurrence of *avere* with reflexive and inchoative complements (cf. (6-106e-f)).

Perhaps an even more worrying aspect of Burzio's account is that it does not take into consideration semantic correlates of auxiliary selection. This omission can hardly be tolerated in the light of more recent studies where it is shown that a semantic characterization is possible and indeed desirable ([Centineo 86, Zaenen 88, Zaenen 89, van Valin 87]). In keeping with the basic insights of these studies and the characterization of verb semantics developed in this thesis, I would like to suggest that a better account of auxiliary selection with modal verbs can be obtained by bringing aspectual and thematic factors to bear on the issue. The basic idea is that verbs such as *volere* "want" function as pseudo-auxiliaries when forming modal verbal complexes, and as such the thematic structure of the arguments they encode may not be fixed until the thematic properties of their complement verb are checked. Because thematic information is specified contextually, the subject argument of the modal is open to either a proto-agent or proto-patient instantiation; consequently, there will be no lexical constraints on the realization of the thematic/aspectual interface: the subject may or may not have the faculty of contributing to the internal temporal constitution of the eventuality denoted by the modal.

With respect to thematic instantiation, I will assume that the assignment of a proto-role to the subject of the modal is (contextually) determined by the most prominent role in the thematic domain of the complement verb — e.g. the proto-agent role. Recall that the order of thematic formulae in the thematic domain of a predicate is such that the proto-agent role is always the last element of the sequence. Contextual determination of the proto-role for the subject of the modal can therefore be established through structure sharing by binding the subject role predicate to the role predicate of the innermost thematic formula in the $\theta$-DOM of the argument verb. This is indicated below in the revised sign for the Italian modal verb discussed earlier in §5.1.2 (cf. (5-60)) with the tag $\boxed{1}$.

(6-107)

MODAL VERB (final version)

$$
\left[
\begin{array}{l}
\mathbf{cat} = \left[\mathbf{catn} = \mathit{sent}\right] \Big/ \left[\begin{array}{l}
\mathbf{catn} = \mathit{np} \\
\mathbf{sem} = \left[\begin{array}{l}
\mathbf{pred} = \boxed{1} \\
\mathbf{arg1} = e \\
\mathbf{arg2} = \boxed{2} \\
\mathbf{arg3} = [\,]
\end{array}\right]
\end{array}\right] \\
\qquad\qquad \left(/\boxed{3}\right) \\
\qquad\qquad \Big/ \left[\begin{array}{l}
\mathbf{cat} = \left[\mathbf{catn} = \mathit{sent}\right] \Big/ \left[\begin{array}{l}
\mathbf{catn} = \mathit{np} \\
\mathbf{sem} = \left[\mathbf{arg2} = \boxed{2}\right]
\end{array}\right] \left(/\ \boxed{3}\right) \\
\mathbf{sem} = \left[\mathbf{ind{:}\theta\text{-}dom} = \left\langle \ldots \circ \left[\mathbf{pred} = \boxed{1}\right]\right\rangle\right]
\end{array}\right]
\end{array}
\right]
$$

Notice, incidentally, that the subject of the modal is always understood as coreferential with the subject of the argument verb whether or not the subject role corresponds to the most prominent role in the argument thematic domain (see examples in (6-106)). This requirement is encoded in the sign above where the individual object variables of the matrix and that of complement subject are reentrant as indicated with the tag $\boxed{2}$. Concerning the realization of the thematic/aspectual interface, the idea — mentioned above — is that modal verbs are unspecified as to whether the reference properties of their subject may or may not contribute to the internal constitution of the eventuality denoted by the modal verb. This assumption is encoded in the modal sign above where the third argument of the active subject role is underspecified (e.g. [ ] can instantiate either an eventuality sort as required by auxiliary *essere*, or *nil* as required by *avere*). The basic features of this treatment of modals can be summarized as follows:

- the subject of the modal inherits the object sort of the complement subject
- the subject of the modal inherits the role predicate of the innermost thematic entailment of the complement verb
- the transfer properties of the subject role of the modal are established contextually (e.g. the third argument of the subject role is underspecified)

Let us see how this assignment of values to sign for modal verbs works with respect to auxiliary selection. Consider first the case where the complement of the modal is unaccusative as in (6-102), here repeated in (6-108) with information concerning the thematic domain of the verb.

(6-108) UNACCUSATIVES

$$\begin{bmatrix} \textbf{cat} = \begin{bmatrix}\textbf{catn} = \textit{sent}\end{bmatrix} \Big/ \begin{bmatrix} \textbf{cat} = \textit{np} \\ \textbf{sem} = \boxed{2} \begin{bmatrix} \textbf{pred} = \{\text{DEF}, \textit{p-agt}\} \\ \textbf{arg1} = \boxed{1} \\ \textbf{arg2} = \text{OBJ} \\ \textbf{arg3} = \boxed{1} \end{bmatrix} \end{bmatrix} \\ \textbf{sem:}\theta\textbf{-dom} = \langle \boxed{2} \rangle \end{bmatrix}$$

In this case, the subject of the resulting complex predicate, e.g. "want to arrive", will be a default proto-agent as shown in (6-109), since the most prominent role of an unaccusative verb encodes such a thematic specification.

(6-109) MODAL + UNACCUSATIVE COMPLEMENT, e.g. *want to arrive*

$$\begin{bmatrix} \textbf{cat} = \begin{bmatrix}\textbf{catn} = \textit{sent}\end{bmatrix} \Big/ \begin{bmatrix} \textbf{catn} = \textit{np} \\ \textbf{sem} = \begin{bmatrix} \textbf{pred} = \{\text{DEF}, \textit{p-agt}\} \\ \textbf{arg1} = \textit{e} \\ \textbf{arg2} = \text{OBJ} \\ \textbf{arg3} = [\,] \end{bmatrix} \end{bmatrix} \end{bmatrix}$$

With respect to aspectual constraints, the complex predicate in (6-109) is in principle amenable to either *avere* or *essere* selection. This is because the underspecification in the third argument of the role predicate makes the subject semantics of the MODAL + UNACCUSATIVE verbal complex compatible with the argument subject semantics of either auxiliary. This compatibility is not disturbed by thematic factors since the role predicate which the matrix subject inherits from the complement unaccusative is a default role and therefore open to any proto-role instantiation. The possibility of either *essere* or *avere* selection with MODAL + UNACCUSATIVE verbal complexes can thus be related to thematic inheritance from the complement verb. And so is the mandatory choice of *avere* with all other complement types. Notice in fact that all verbs, but unaccusatives, have as their most prominent role a *non-default proto-agent*. For example, the innermost thematic entailment of transitive and unergative verbs contains a non-default proto-agent role:

(6-110) TRANSITIVES, UNERGATIVES

$$\begin{bmatrix} \mathbf{cat} = \left[\mathbf{catn} = \textit{sent}\right] / \begin{bmatrix} \mathbf{cat} = \textit{np} \\ \mathbf{sem} = \boxed{1} \begin{bmatrix} \mathbf{pred} = \textit{p-agt} \\ \mathbf{arg1} = \textit{e} \\ \mathbf{arg2} = \text{OBJ} \\ \mathbf{arg3} = \textit{nil} \end{bmatrix} \end{bmatrix} \left( /\ [\,] \right) \\ \mathbf{sem{:}}\theta\mathbf{\text{-}dom} = \langle \ldots \boxed{1} \rangle \end{bmatrix}$$

This is also the case when the p-agt role is syntactically unexpressed — as with passive, inchoative or reflexive verbs which according to the analysis given in §5.1.1 preserve the proto-agent entailment in their $\theta$-DOM:

(6-111) PASSIVES, INCHOATIVES, REFLEXIVES

$$\begin{bmatrix} \mathbf{cat} = \left[\mathbf{catn} = \textit{sent}\right] / \begin{bmatrix} \mathbf{cat} = \textit{np} \\ \mathbf{sem} = \boxed{2} \begin{bmatrix} \mathbf{pred} = \textit{p-pat} \\ \mathbf{arg1} = \boxed{1} \\ \mathbf{arg2} = \text{OBJ} \\ \mathbf{arg3} = \boxed{1} \end{bmatrix} \end{bmatrix} \\ \mathbf{sem{:}}\theta\mathbf{\text{-}dom} = \left\langle \boxed{2} \circ \left[\mathbf{pred} = \textit{p-agt}\right] \right\rangle \end{bmatrix}$$

Consequently, the sign resulting from combining a modal with an unergative, transitive, passive, reflexive or inchoative complement will encode a non-default proto-agent specification for the subject, e.g.

(6-112) MODAL + UNERGATIVE/TRANSITIVE/PASSIVE/REFLEXIVE/INCHOATIVE COMPLEMENT

$$\begin{bmatrix} \mathbf{cat} = \left[\mathbf{catn} = \textit{sent}\right] / \begin{bmatrix} \mathbf{cat} = \textit{np} \\ \mathbf{sem} = \boxed{1} \begin{bmatrix} \mathbf{pred} = \textit{p-agt} \\ \mathbf{arg1} = \textit{e} \\ \mathbf{arg2} = \text{OBJ} \\ \mathbf{arg3} = [\,] \end{bmatrix} \end{bmatrix} \left( /\ [\,] \right) \end{bmatrix}$$

Selection of auxiliary *essere* will therefore be ruled out on thematic grounds, while *avere* selection is available both with respect to thematic and aspectual properties of the subject argument. This can be ascertained by comparing the category structure of the complex predicate sign in (6-112) with the active category structure of auxiliaries *essere* and *avere* in (6-103) and (6-104).

Can the characterization of auxiliary selection and unaccusativity developed above for Italian be applied to Dutch? I think the answer is yes, although further qualifications are needed to account for the selection auxiliary selection properties of statives. As discussed in the previous section, stative intransitives canonically select *avere* in Dutch. This is a problem for the current account of auxiliary selection where intransitive statives are treated as unaccusatives both on thematic and aspectual grounds. The problem, however, cannot be solved by assuming that stativity has no bearing on unaccusativity. For example, Zaenen's suggestion to relate the contrast between *hebben* and *zijn* selection to the telic/atelic distinction is just as problematic. First there is the problem of accounting for the few instances where intransitive statives select *zijn*, e.g. *blijven* "stay". An even bigger problem arises with respect to experiencer verbs with stimulus subjects (henceforth St/Exp). As [Zaenen 89] points out, a large number of St/Exp verbs have stative aktionsart and yet select *zijn*. Let us consider briefly the relevant data.

Zaenen observes that St/Exp verbs in Dutch divide into two classes with respect to the following two sets of contrasts:

- selection of auxiliary *zijn* or *hebben* in the formation of compound tenses, and
- possibility of interpreting the head nominal as the subject of the adjectival participle in prenominal past participle constructions.

Verbs such as *bevallen, ontglippen, ontvallen, opvallen, ontgaan* ("please", "escape", "escape". "be-noticed", "elude") select auxiliary *zijn*, while *ergeren, vervelen, treffen* ("annoy", "bore", "be-noticed") select *hebben*, e.g.

(6-113) a De fouten *zijn* Jan ontgaan
"The mistakes have eluded John"
b De fouten *hebben* Jan geergerd
"The mistakes have annoyed John"

With those verbs which select *zijn*, the head nominal of prenominal past participle constructions is understood as bearing the stimulus role, i.e. the role which is associated with the subject:

(6-114) De hem ontgane fout
the him eluded mistake
"The mistake which eluded him"

With verbs selecting *zijn*, the head nominal must instead be understood as bearing the experiencer role, i.e. the role which is associated with the object:

(6-115) a *De geergerde fouten
*"The annoyed mistakes"

b De geergerde jongen
"The annoyed boy"

Zaenen proceeds to show that at the level of lexical semantics the two classes of St/Exp verbs can be distinguished with respect to volitionality. As the contrasts in (6-116) and (6-117) show, volitionality can be attributed only to the stimulus participant of St/Exp verbs which select *hebben*:

(6-116) a *Hij dwong me hem te bevallen
"He forced me to please him"

b Hij dwong me je te ergeren
"He forced me to irritate you"

(6-117) a *Ze beviel hem opzettelijk
"She pleased him on purpose"

b Ze amuseerde hem opzettelijk
"She amused him on purpose"

The sets of contrasts concerning auxiliary selection and prenominal past participle constructions with St/Exp verbs in Dutch can thus be explained in terms of volitionality. Within the present framework, this can be done by bringing lack of volitionality to bear on the assignment of a default proto-agent to the stimulus argument of the relevant subset of experiencer verbs, i.e. the St/Exp class. Verbs such as *bevallen, onglippen, ontgaan* etc. would then effectively be treated as unaccusatives. Insomuch as the St/Exp class can be isolated from other experiencer verbs in semantic terms, the task of giving such characterization should be feasible.[12] In any event, it is clear that appeal to the

[12]According to Dowty, the class of psychological verbs whose subject realizes the stimulus role contains all those whose experiencer role can be characterized as undergoing change of state. This class contains psychological verbs such as *please* which can give rise to an inchoative interpretation, e.g. *The birthday party is pleasing Mary (right now).* Such an interpretation implies a change of state in the experiencer participant. Dowty maintains that in this cases the experiencer is not realized as a subject since argument roles which have the property of undergoing change of state are canonically more suitable to be realized as objects. All else being equal, psychological verbs which may express change of state (e.g. *amuse, please, frighten, irritate*) will thus belong to the class of St/Exp verbs, while those which cannot (e g. *like, fear*) will have experiencer subjects and stimulus objects. Dowty's hypothesis

telic/atelic distinction is not going to provide the appropriate tools to capture contrasts concerning auxiliary selection in Dutch.

Returning to our initial question, I would like to propose that the treatment of unaccusativity developed for Italian can be extended to Dutch by minimally modifying the characterization of intransitive statives assumed so far. The modification I have in mind consists of two basic changes:

- the differentiation of intransitive statives from all other verbs in terms of thematic assignment, and
- the introduction of a parametric dimension in the way of expressing the potential ability of an argument role to allow reference properties of a nominal to be transferred to the verb

With respect to the first point, I will assume that cross-linguistically the relation between stativity and low agency with intransitives leads to the assignments of a *default proto-patient role* as shown in (6-118). Intuitively, this thematic divergence is motivated by the fact that stative intransitives are generally less agentive than eventive intransitives.

(6-118) a STATIVE UNACCUSATIVES

$$\begin{bmatrix} \mathbf{cat} = \begin{bmatrix}\mathbf{catn} = \textit{sent}\end{bmatrix} \Big/ \begin{bmatrix} \mathbf{cat} = \textit{np} \\ \mathbf{sem} = \begin{bmatrix} \mathbf{pred} = \{\text{DEF}, \textit{p-pat}\} \\ \mathbf{arg1} = \text{ST} \end{bmatrix} \end{bmatrix} \end{bmatrix}$$

b EVENTIVE UNACCUSATIVES

$$\begin{bmatrix} \mathbf{cat} = \begin{bmatrix}\mathbf{catn} = \textit{sent}\end{bmatrix} \Big/ \begin{bmatrix} \mathbf{cat} = \textit{np} \\ \mathbf{sem} = \begin{bmatrix} \mathbf{pred} = \{\text{DEF}, \textit{p-agt}\} \\ \mathbf{arg1} = \text{EVE} \end{bmatrix} \end{bmatrix} \end{bmatrix}$$

This newly introduced thematic differentiation of stative and eventive unaccusatives does not affect our account of auxiliary selection in Italian (e.g. both default proto-agent and proto-patient roles can be overridden in the event of a unification clash involving a non-default value).

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is supported by the fact that psychological verbs with experiencer subjects may not give rise to an inchoative interpretation ([Croft 86]).

Concerning the second point, I will maintain that crosslinguistically the potential ability of the subject role of stative unaccusatives to allow reference properties of a nominal to be transfered to the verb is expressed by underspecification of the third argument of the subject role as indicated in (6-119).

(6-119) STATIVE UNACCUSATIVES: CROSS-LINGUISTIC CHARACTERIZATION

$$\left[\begin{array}{l} \textbf{cat} = \left[\textbf{catn} = \textit{sent}\right] \Big/ \left[\begin{array}{l} \textbf{cat} = \textit{np} \\ \textbf{sem} = \left[\begin{array}{l} \textbf{pred} = \{\text{DEF}, \textit{p-pat}\} \\ \textbf{arg1} = \text{ST} \\ \textbf{arg2} = \text{OBJ} \\ \textbf{arg3} = [\,] \end{array}\right] \end{array}\right] \end{array}\right]$$

In Dutch such a characterization is maintained, while in Italian the aspectual properties of stative unaccusatives are assimilated to those of eventive unaccusatives, as indicated in the tree structure below where the tag $\boxed{1}$ indicates that in Italian the subject role of stative unaccusatives in Italian encodes an object-to-event homomorphism.

(6-120) STATIVE UNACCUSATIVES

$$\left[\begin{array}{l} \left[\textbf{catn} = \textit{sent}\right] \Big/ \left[\begin{array}{l} \textbf{cat} = \textit{np} \\ \textbf{sem} = \left[\begin{array}{l} \textbf{pred} = \{\text{DEF}, \textit{p-pat}\} \\ \textbf{arg1} = \text{ST} \\ \textbf{arg2} = \text{OBJ} \\ \textbf{arg3} = [\,] \end{array}\right] \end{array}\right] \end{array}\right]$$

DUTCH
(same as top node)

ITALIAN

$$\left[\begin{array}{l} \left[\textbf{catn} = \textit{sent}\right] \Big/ \left[\begin{array}{l} \textbf{cat} = \textit{np} \\ \textbf{sem} = \left[\begin{array}{l} \textbf{pred} = \{\text{DEF}, \textit{p-pat}\} \\ \textbf{arg1} = \boxed{1}\text{ST} \\ \textbf{arg2} = \text{OBJ} \\ \textbf{arg3} = \boxed{1} \end{array}\right] \end{array}\right] \end{array}\right]$$

This difference implies that in Dutch, but not in Italian, the subject argument of stative intransitives can potentially be assimilated to either unaccusative or unergative subjects with respect to the possibility/impossibility of transfering reference properties of the nominal to the verbal predicate. This is because the third argument of the subject role of Dutch unaccusatives need not instantiate an eventuality sort which is token identical to the argument sort of the verb, while in Italian such an instantiation is mandatory. In other words, Italian is more restrictive in the encoding of aspectual properties of stative unaccusative subjects than Dutch is, although the representation of stative unaccusatives has a common denominator in both languages. This difference provides an account of the diverging syntactic reflexes of unaccusativity in Dutch and Italian relative to auxiliary selection.

In the light of the characterization of intransitives provided so far, two subclasses of unaccusative verbs can be distinguished across languages: stative and eventive unaccusatives. Stative unaccusative encode a default proto-patient subject, while eventive unaccusatives have a default proto-agent subject, as shown in (6-118). In addition, the encoding of the aspectual-thematic interface in stative unaccusatives is subject to two distinct degrees of specificity for each choice of language, as indicated in (6-120). The tree structure below gives a schematic characterization of the relevant contrasts.

(6-121)

UNACCUSATIVES

$$\left[ [\,\textbf{catn} = \textit{sent}\,] \Big/ \begin{bmatrix} \textbf{cat} = \textit{np} \\ \textbf{sem} = \begin{bmatrix} \textbf{pred} = \{\text{DEF}, [\,]\} \\ \textbf{arg1} = [\,] \\ \textbf{arg2} = \text{OBJ} \\ \textbf{arg3} = [\,] \end{bmatrix} \end{bmatrix} \right]$$

EVENTIVE, DUTCH/ITALIAN

$$\left[ [\,\textbf{catn} = \textit{sent}\,] \Big/ \begin{bmatrix} \textbf{cat} = \textit{np} \\ \textbf{sem} = \begin{bmatrix} \textbf{pred} = \{\text{DEF}, \textit{p-agt}\} \\ \textbf{arg1} = \boxed{1}\text{EVE} \\ \textbf{arg2} = \text{OBJ} \\ \textbf{arg3} = \boxed{1} \end{bmatrix} \end{bmatrix} \right]$$

STATIVE

$$\left[ [\,\textbf{catn} = \textit{sent}\,] \Big/ \begin{bmatrix} \textbf{cat} = \textit{np} \\ \textbf{sem} = \begin{bmatrix} \textbf{pred} = \{\text{DEF}, \textit{p-pat}\} \\ \textbf{arg1} = \boxed{1}\text{ST} \\ \textbf{arg2} = \text{OBJ} \\ \textbf{arg3} = [\,] \end{bmatrix} \end{bmatrix} \right]$$

ITALIAN

$$\left[ [\,\textbf{catn} = \textit{sent}\,] \Big/ \begin{bmatrix} \textbf{cat} = \textit{np} \\ \textbf{sem} = \begin{bmatrix} \textbf{pred} = \{\text{DEF}, \textit{p-pat}\} \\ \textbf{arg1} = \boxed{1}\text{ST} \\ \textbf{arg2} = \text{OBJ} \\ \textbf{arg3} = \boxed{1} \end{bmatrix} \end{bmatrix} \right]$$

DUTCH
(same as node above)

In Italian, stative and eventive unaccusatives are treated alike with respect to auxiliary selection (e.g. both select auxiliary "be"). This distribution was accounted for by requiring that the active subject role of auxiliary *avere* encodes no object-to-event homomorphism (e.g. third argument of subject role is *nil*), while the active subject role of *essere* encodes such a homomorphism, e.g.

(6-122) a AUXILIARY *avere*

$$\left[\mathbf{cat} = \boxed{1} \Big/ \left[\mathbf{cat} = \boxed{1}[\mathbf{catn} = \textit{sent}] \Big/ \left[\begin{array}{l} \mathbf{catn} = \textit{np} \\ \mathbf{sem} = \left[\begin{array}{l} \mathbf{pred} = \textit{p-agt} \\ \mathbf{arg1} = e \\ \mathbf{arg2} = \text{OBJ} \\ \mathbf{arg3} = \textit{nil} \end{array}\right] \end{array}\right]\right]\right]$$

b AUXILIARY *essere*

$$\left[\mathbf{cat} = \boxed{1} \Big/ \left[\mathbf{cat} = \boxed{1}[\mathbf{catn} = \textit{sent}] \Big/ \left[\begin{array}{l} \mathbf{catn} = \textit{np} \\ \mathbf{sem} = \left[\begin{array}{l} \mathbf{pred} = \neg\textit{p-pat} \\ \mathbf{arg1} = \textit{indl e} \\ \mathbf{arg2} = \text{OBJ} \\ \mathbf{arg3} = \boxed{1} \end{array}\right] \end{array}\right]\right]\right]$$

In Dutch, stative unaccusative select "have"; otherwise, auxiliary selection is essentially as in Italian, e.g. eventive unaccusative, passive, select "be" while transitives and unergatives select "have". This difference can be accounted for by changing the thematic restriction which was imposed on the argument subject of auxiliary "be" in Italian, while maintaining the same characterization auxiliary "have" in (6-122b). The basic idea is that auxiliary "be" in Dutch is selected when the subject role is a default proto-agent and it encodes an object-to-event homomorphism, as shown below.

(6-123) AUXILIARY, *zijn*

$$\left[\mathbf{cat} = \boxed{1} \Big/ \left[\mathbf{cat} = \boxed{1}[\mathbf{catn} = \textit{sent}] \Big/ \left[\begin{array}{l} \mathbf{catn} = \textit{np} \\ \mathbf{sem} = \left[\begin{array}{l} \mathbf{pred} = \{\text{DEF}, \textit{p-agt}\} \\ \mathbf{arg1} = \textit{indl e} \\ \mathbf{arg2} = \text{OBJ} \\ \mathbf{arg3} = \boxed{1} \end{array}\right] \end{array}\right]\right]\right]$$

*Zijn* selection will fail with stative intransitives on thematic grounds, since the thematic specification for the argument subject of the auxiliary sign in (6-123) is a default proto-agent, while the subject role of stative intransitives is a default proto-patient, as shown in (6-121). This is simply because default values cannot override each other: $\{\text{DEF}, \textit{p-agt}\} \sqcap \{\text{DEF}, \textit{rgppat}\} = \bot$. The sign for auxiliary *hebben* will essentially be the same as Italian *avere*, e.g. compare (6-122a) with (6-124).

(6-124) AUXILIARY *hebben*

$$\begin{bmatrix} \mathbf{cat} = \boxed{1} / \begin{bmatrix} \mathbf{cat} = \boxed{1}\left[\mathbf{catn} = \mathit{sent}\right] / \begin{bmatrix} \mathbf{catn} = \mathit{np} \\ \mathbf{sem} = \begin{bmatrix} \mathbf{pred} = \mathit{p\text{-}agt} \\ \mathbf{arg1} = \mathit{e} \\ \mathbf{arg2} = \textsc{obj} \\ \mathbf{arg3} = \mathit{nil} \end{bmatrix} \end{bmatrix} \end{bmatrix} \end{bmatrix}$$

*Hebben* selection will go through with stative intransitives. Notice in fact that the default proto-patient specification of stative unaccusative subjects can be overridden by the (non-default) proto-agent specification of the argument subject in *hebben*. Moreover, the requirement that the argument subject role of the auxiliary encodes no object-to-event homomorphism is met by the subject role of stative unaccusatives since the third argument of this role predicate is unspecified. The subject semantics of the argument verb in *hebben* is thus compatible with the subject semantics of stative unaccusatives.

Because auxiliary selection is not directly stated in terms of telicity, it follows that in Dutch atelic verbs whose subject role has appropriate thematic and aspectual specification will be amenable to *zijn* selection. For example, the subject role of stative St/Exp verbs discussed above (e.g. *bevallen, onglippen, ontgaan* etc.) can be represented as the subject role of eventive unaccusatives. This will guarantee that auxiliary *zijn* is selected with these verbs. Moreover, because an atelic instantiation does not in principle block *zijn* selection, we can explain why intransitive verbs such as *kommen* and *trokken* select *zijn* and not *hebben* when their aspectual specification receives an atelic instantiation through impersonal passive as shown below[13]

(6-125) In dat hotel heb ik geen oog dicht gedaan, want er *werd* the hele nacht aangekommen en vertrokken
"In that hotel I didn't sleep a wink, for there was the whole night arrived and left"

[13]See previous section and [Zaenen 89] for relevant discussion.

# Chapter 7

# Thematic Accessibility In Dislocation Dependencies

Throughout the thesis, my main objective has been to show how issues concerning the syntactic projection of lexical properties with respect to argument selection, selection change, morphosyntactic interactions, and the interface of thematic and aspectual information can all be accommodated within a neo-Davidsonian approach to verb semantics which integrates Dowty's treatment of thematic relations as semantic defaults. To conclude, I would like to consider the relevance of this approach to other areas of grammar where the thematic structure of lexical items has a direct bearing on the realization of syntactic dependencies independently of subcategorization properties.

Various syntactic environments in which thematic structure alone is instrumental in establishing the dependency between a predicate and its (semantic) arguments have already been discussed in previous chapters. These include the following:

- the dependency between a verb and its subject and object phrases in null anaphora languages (cf. §4.3.1)
- the dependency between a passive verb and the agent phrase (cf. §5.1.1)
- the dependency between a causative complex predicate and the complement objects in *type 2* languages (cf §5.2.1)

The basic idea adopted in the analysis of these dependencies was that the semantic arguments of a verb can be syntactically realized as thematically bound adjuncts. In this chapter, the practice of divorcing thematic dependency from subcategorization will be shown to be central to the treatment of Clitic Dislocation in Romance and subject-verb dependencies in Null-Subject Languages (NSL). Both types of dependencies are known to diverge from canonical argument-verb dependencies in a number of ways; these divergences, however, do not yield a clear-cut classification into arguments and adjuncts. For example both dislocated NPs and NSL subjects may violate weak islands constraints (e.g. the *wh*-island constraint), while they generally obey stronger conditions on extraction (eg. the Complex NP Constraint). Our objective will be to show that these complex divergences can be accounted for by treating dislocated NPs and NSL subjects as syntactic adjuncts which saturate a thematic entailment of the predicate with which they combine. A crucial assumption of this treatment will be that the object clitics which occur in Clitic Dislocations as well as subject agreement morphemes in NSL can be characterized as (morpho)syntactic arguments which do not saturate an argument role.

The chapter is organized in three sections. In §7.1 phenomena concerning Clitic Dislocation are discussed in the light of Cinque's and Dobrovie-Sorin's recent works ([Cinque *forth.*], [Dobrovie-Sorin 1990]). In §7.2 a detailed account of the approach to Clitic Dislocation outlined above will be presented. The sensitivity of dislocated NPs to strong island constraints as well as their immunity to the *wh*-island constraint will be derived as a corollary of the definition of $\theta$-DOM developed in chapter 4. In §7.3 I will argue that this approach can essentially be extended to dislocated and non-dislocated subjects in NSLs, and will show how a parametric perspective can be introduced which makes it possible to account for crosslinguistic differences regarding sensitivity to island constraints as well as the distribution of clitics. Parametric considerations will be shown also to be central to the treatment of dislocation phenomena other than Clitic Dislocation.[1]

## 7.1 Clitic Doubling and Dislocation In Italian

The term *clitic doubling* describes a dependency relation in which the same valency slot of a predicate is shared by an argument phrase and a coreferential pronominal clitic. Clitic doubling is well attested in languages such as Spanish where cooccurrence of

[1]Earlier versions of some of the material discussed in this chapters have appeared as [Sanfilippo 90a, Sanfilippo 90b, Sanfilippo 90c].

an object phrase with a concordant pronominal clitic within a clause is often possible ([Suñer 88]), and in some cases even desirable. For example, a sentence such as (7-1a) where an object phrase and a pronominal clitic share the indirect argument position of a ditransitive verb is generally preferred to either one of the sentences in (7-1b) and (7-1c) where no clitic doubling occurs ([Beaven 90]).

| | | | | | | |
|---|---|---|---|---|---|---|
| (7-1) | a | María | *le* | dio | el libro | *a Juan* |
| | | Maria | to-him(CLITIC) | gave | the book | to Juan |
| | | "Maria gave the book to Juan" | | | | |
| | b | María | *le* | dio | el libro | |
| | | Maria | to-him(CLITIC) | gave | the book | |
| | | "Maria gave the book to him" | | | | |
| | c | María | dio | el libro | *a Juan* | |
| | | Maria | gave | the book | to Juan | |
| | | "Maria gave the book to Juan" | | | | |

Italian is usually thought of as a language where clitic doubling is not allowed. As shown in (7-2) and (7-3), pronominal clitics are in complementary distribution with argument phrases.

| | | | | | | |
|---|---|---|---|---|---|---|
| (7-2) | a | Maria | vedrà | *Carlo* | domani | |
| | | Maria | will see | Carlo | tomorrow | |
| | | "Maria will see Carlo tomorrow" | | | | |
| | b | Maria | *lo* | vedrà | domani | |
| | | Maria | him(CLITIC) | will see | tomorrow | |
| | | "Maria will see him tomorrow" | | | | |
| | c | *Maria | *lo* | vedrà | *Carlo* | domani |
| | | Maria | him(CLITIC) | will see | Carlo | tomorrow |

| | | | | | | |
|---|---|---|---|---|---|---|
| (7-3) | a | Maria | scrive | *a Carlo* | ogni mese | |
| | | Maria | writes | to Carlo | every month | |
| | | "Maria writes to Carlo every month" | | | | |
| | b | Maria | *gli* | scrive | ogni mese | |
| | | Maria | to-him(CLITIC) | writes | every month | |
| | | "Maria writes to Carlo every month" | | | | |
| | c | *Maria | *gli* | scrive | *a Carlo* | ogni mese |
| | | Maria | to-him(CLITIC) | writes | to Carlo | every month |

However, it is well known that if the object phrase is left (or right) dislocated, cooccurrence of a clitic pronoun and a concordant object phrase is possible as shown in (7-4) and (7-5) ([Cinque 77], [Duranti & Ochs 79]).[2]

[2]Clitic dislocation applies to arguments which convey given information at the level of discourse structure ([Cinque 77]). The affected phrase is prosodically marked with a short intonational break which is orthographically notated with a comma.

| (7-4) | a | *Carlo,* | Maria | *lo* | vedrà | domani |
|---|---|---|---|---|---|---|
| | | Carlo, | Maria | him(CLITIC) | will see | tomorrow |
| | | "Carlo, Maria will see him tomorrow" | | | | |

| | b | Maria | *lo* | vedrà | domani, | *Carlo* |
|---|---|---|---|---|---|---|
| | | Maria | him(CLITIC) | will see | tomorrow, | Carlo |
| | | "Maria will see him tomorrow, Carlo" | | | | |

| (7-5) | a | *A Carlo,* | Maria | *gli* | scrive | ogni mese |
|---|---|---|---|---|---|---|
| | | To Carlo | Maria | to-him(CLITIC) | writes | every month |
| | | "To Carlo, Maria writes to him every month" | | | | |

| | b | Maria | *gli* | scrive | ogni mese, | *a Carlo* |
|---|---|---|---|---|---|---|
| | | Maria | to-him(CLITIC) | writes | every month | to Carlo |
| | | "Maria writes to him every month, to Carlo" | | | | |

These data suggests that clitic doubling occurs in both Spanish and Italian, albeit in different measure:[3] Italian allows clitic doubling only in dislocated sentences, while Spanish appears to be more liberal. In view of a parametric characterization of clitic doubling. it would thus be desirable to flesh out features of dislocation which make clitic doubling possible in Italian, and then see whether and how these features can be generalized as lexical parameters which bear on the occurrence of clitic doubling in other languages.

A priori, at least three distinct perspectives can be adopted in relating dislocation and clitic doubling phenomena according to whether the relation between a dislocated NP and its understood governing verb is conceived as a discourse-level, extraction, or adjunction type of dependency. For ease of reference I shall refer to these three views as the DISCOURSE-BASED, EXTRACTION, and BASE-GENERATION analyses. The assumptions underlying each analysis are briefly summarized in (7-6).

[3]The term "clitic doubling" here is used as a descriptive term which does not carry any of the implications of the "clitic doubling parameter" of GB (see below).

(7-6) a DISCOURSE-BASED ANALYSIS
Inasmuch as no sentence-level syntactic dependency exists between a dislocated NP and its understood governing verb, the relation between dislocated NPs and clitics is not an issue which concerns sentence grammar; dislocation should be viewed as a discourse phenomenon.

b EXTRACTION ANALYSIS
In dislocated sentences, object clitics do not saturate the syntactic valency of verbs; dislocated phrases are thus to be treated as extracted arguments.

c BASE-GENERATION ANALYSIS
In dislocated structures, clitics function as arguments and dislocated phrases as adjuncts; the relation between a dislocated phrase and its understood governing verb must therefore be characterized as a dependency which does not involve movement.

### 7.1.1 Left Dislocation vs. Clitic Left Dislocation

Prima facie the DISCOURSE-BASED analysis appears to be the most desirable in that it removes the problem of explaining the occurrence of clitics in dislocated structure; such a problem arises only when dislocated NPs are placed within a sentential context. An argument in favor of this approach is also the already mentioned immunity of dislocated NPs to island constraints. For example, a dislocated NP can be related to a clause which occurs within an NP in both Spanish and English as shown in (7-7).

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| (7-7) | *El dinero,* | acepto | la pretensión | de que | *lo* | tienen | ya |
| | the money | accept-I | the pretension | of that | it(CLITIC) | have-they | already |

"The money, I accept the pretension that they have it already" [Rivero 80]

However. on second inspection it transpires that dislocation is not such a homogeneous phenomenon as the *discourse-based* analysis would lead us to believe. In Italian, for example. a sentence structurally parallel to (7-7) can only be accepted if the following two conditions are met:[4]

(7-8) a the left displaced NP is prosodically marked with the rising intonation typical of a questioned NP, and followed by a long intonational break

b at the level of discourse structure, the dislocated NP does not convey "given information", but rather signals a shift in the discourse topic.

In this case. the prosodic features and discourse functionality of the displaced NP differ substantially from more common cases of left dislocation — e.g. Clitic Left Dislocation

[4]See [Cinque 77].

— where no rising contour and long intonational break are observed, and where the NP conveys given information. This suggests that — at least in Italian — we are dealing with two distinct dislocation phenomena. The acknowledgement of this distinction goes back to Cinque's earlier work on dislocation ([Cinque 77]), and has more recently been reproposed with further evidence by [Cinque *forth.*] and [Dobrovie-Sorin 1990].

[Cinque *forth.*] individuates a number of properties which distinguish between the two kinds of dislocation, i.e. Left Dislocation vs. Clitic Left Dislocation (henceforth LD and CLLD). A schematic list of the relevant properties with illustrative examples is given below; phrases in boldface are intended to be read and interpreted as LD phrases (i.e. they have the properties specified in (7-8)).

(7-9) In CLLD, the sentence-internal resumptive element (when present) must be a clitic pronoun (hence the term Clitic Left Dislocation), e.g.

a $\left\{\begin{array}{c}\text{Carlo}\\ \textbf{Carlo}\end{array}\right\}$, l'ho visto ieri
"Carlo, I saw him(CLITIC) yesterday"

b $\left\{\begin{array}{c}\text{*Carlo}\\ \textbf{Carlo}\end{array}\right\}$, ho visto lui ieri
"Carlo, I saw him yesterday"

(7-10) LD is limited to NPs, while CLLD can involve any kind of maximal projection, e.g.
$\left\{\begin{array}{c}\text{A Carlo}\\ \textbf{*A Carlo}\end{array}\right\}$, gli ho già scritto
"To Carlo, I have written spoken to him(CLITIC)"

(7-11) In CLLD, phrases can immediately precede subordinate clauses, while LD phrases generally cannot, e.g.
Maria ha detto che $\left\{\begin{array}{c}\text{Carlo}\\ \textbf{*Carlo}\end{array}\right\}$, l'ha visto ieri
"Maria said that Carlo, she saw him(CLITIC) yesterday"

(7-12) Only CLLD may give rise to multiple displacements, e.g.
$\left\{\begin{array}{c}\text{A Gianni}\\ \textbf{*A Gianni}\end{array}\right\}$, $\left\{\begin{array}{c}\text{Carlo}\\ \textbf{*Carlo}\end{array}\right\}$, gliel' ha presentato Maria
"To Gianni, Carlo, to-him(CLITIC)–him(CLITIC) has introduced Maria"

(7-13) Only in CLLD there is a strong syntactic bond between the dislocated phrase and the sentence internal argument position to which it is related ("Obligatory Connectivity" in Cinque's terms); for example, a dislocated object NP is subject to constraints on reflexive binding in CLLD but not in LD, e.g.

a $\left\{\begin{array}{l}\text{In *lei/se stessa}\\ \textbf{Lei/Se stessa}\end{array}\right\}$, Rosa non ci crede
"In $\text{her}_i$/herelf, $\text{Rosa}_i$ does not believe there(CLITIC)"

b $\left\{\begin{array}{l}\text{In lei/*se stessa}\\ \textbf{Lei/Se stessa}\end{array}\right\}$, Rosa pensa che non ci crede nessuno
"In $\text{her}_i$/$\text{herelf}_i$, $\text{Maria}_i$ thinks that nobody believes there(CLITIC)"

(7-14) CLLD is sensitive to strong island contraints (e.g. the *Complex NP Constraint*), while LD is not, e.g.
$\left\{\begin{array}{l}\text{*Carlo}\\ \textbf{Carlo}\end{array}\right\}$, Maria ha conosciuto il giornalista che l' ha intervistato
"Carlo, Maria has met the reporter who interviewed him(CLITIC)"

In light of this evidence, two types of dislocations must be recognized: LD and CLLD. Moreover, it is evident that CLLD may not be characterized as a discourse phenomenon as the dependencies which it gives rise to are subject to syntactic constraints (e.g. (7-13) and (7-14)). The DISCOURSE-BASED analysis may thus not be applied to all cases of dislocation.

### 7.1.2 Against an Extraction Analysis of CLLD

One way to deal with the emergence of the two types of dislocation in Italian is to maintain that LD is a discourse phenomenon while giving a syntactic treatment of CLLD in terms of extraction. An extraction analysis would readily account for Obligatory Connectivity (cf. (7-13)) and the sensitivity to strong island constraints (cf. (7-14)) which obtain in CLLD. According to this account, CLLD dependencies would be dealt with in terms of *wh*-movement. Consequently, the prediction is made that CLLD should exhibit all relevant properties which qualify *wh*-movement. However, this prediction is not borne out. For example, the fact that CLLD does not license parasitic gaps and is insensitive to weak crossover effects, places serious doubts on the possibility of assimilating CLLD to *wh*-movement. It is in fact well known that *wh*-movement exhibits the opposite distribution (i.e. parasitic gaps are licensed, while weak crossover leads to ungrammaticality). The following sets of contrasts exemplify this issue.[5]

[5] See [Cinque *forth.*] for details. and [Dobrovie-Sorin 1990] for further evidence from Romanian.

(7-15) *wh*-MOVEMENT

a *Chi$_i$ ama sua$_i$ madre?
*"Who$_i$ does his$_i$ mother love?"

b Quale articolo hai archiviato senza aver letto?
"Which article did you file without reading?"

(7-16) CLLD

a Carlo$_i$, l'ha sempre viziato sua$_i$ madre
"Carlo$_i$, his$_i$ mother has always spoiled him"

b *Quell'articolo, l'ho archiviato senza aver letto
"That article, I file it(CLITIC) without reading"

[Dobrovie-Sorin 1990] has recently claimed that a movement analysis of CLLD is possible, in spite of these differences, if two types of *wh*-movement are distinguished according to whether or not quantification is involved. The basic idea in Dobrovie-Sorin's approach is that dependencies which involve movement (e.g. they obey island constraints) may differ with respect to quantification properties. Only when quantification is involved, the empty category left behind by the displaced element functions as a variable and as such it can license parasitic gaps and induces sensitivity of weak crossover effects. For example, Romanian interrogatives formed with either one of the two interrogative pronouns *cine* "who" and *care* "which" should be analyzed in terms of extraction since they both obey island constraints. Yet, *cine* *wh*-structures are sensitive to weak crossover effects and license parasitic gaps, while with *care* the opposite distribution obtains. Dobrovie-Sorin suggests that the empty category related to *cine* has quantificational properties (i.e. is a variable) while the empty category related to *care* does not. The contrasts relative to weak crossover and parasitic gaps can thus be explained in terms of the quantificational/non-quantificational distinction, while maintaining a movement analysis in both cases. Dobrovie-Sorin concludes that this analysis can essentially be extended to CLLD — in Romanian as well as in Italian — by assuming that the empty category related to a dislocated phrase does not have quantificational properties.

Whether or not a true and exclusive relationship exists between quantificational structures and weak crossover effects as well as the licensing of parasitic gaps, I think that Dobrovie-Sorin's attempt to assimilate CLLD to *wh*-movement is ultimately doomed to fail. First. CLLD differs from extraction processes such as question formation, topicalization and relativization in that it can relate a verb and one of its arguments across two *wh*-islands as shown in (7-17), and it allows for multiple displacements and crossed dependencies as indicated in (7-18).[6]

(7-17) a *Carlo,* chi sa chi *l'* ha visto?
Carlo, who knows who him(CLITIC) has seen
"Carlo, who knows who saw him?"

b *Questo problema,* chi ti ha chiesto come
this problem, who to-you(CLITIC) has asked how
si faccia a risolver*lo*?
IMP makes COMP to-solve-it(CLITIC)
"This problem, who asked of you how to solve it?"

(7-18) a *A Gianni,* *Carlo,* *gliel'* ha presentato
To Gianni, Carlo, to-him(CLITIC)–him(CLITIC) has introduced
Maria
Maria
"To Gianni, Carlo, Maria introduced him to him"

b *Carlo*$_1$, *a Gianni*$_2$, *gliel'*ha presentato Maria $\_\_{}_1$ $\_\_{}_2$

Second, an extraction analysis of dislocation is deemed to assume that the object clitic pronouns which are associated with dislocation sites (e.g. *gli* and *lo/l'* in the examples above) may function as agreement markers which do not reduce the valency of a verb. This assumption is at variance with the behavior that pronominal clitics exhibit in environments other than dislocation: a clitic is in complementary distribution with a concordant object phrase whether the phrase is *in situ* (cf. (7-2c) and (7-3c)), or displaced through topicalization, *wh*-movement, and relative clause formation as shown in (7-19).

(7-19) a *CARLO* Luigi (**l'*) ha incontrato ieri, non Maria
CARLO Luigi (*him(CLITIC)) has met yesterday, not Maria
"CARLO Luigi met yesterday, not Maria"

b *Chi* (**l'*) hai incontrato ieri?
Who (*him(CLITIC)) have-you met yesterday?
"Who did you meet yesterday?"

c L'uomo *il quale* Gianni (**l'*) ha incontrato ieri ...
The man whom Gianni (*him(CLITIC)) has met yesterday ...
"The man whom Gianni met yesterday ..."

Notice, incidentally, that to invoke the *clitic doubling parameter* of GB to explain the contrast between CLLD and *wh*-movement in this case would not do. The existence of this parameter relies on Kayne/Jaeggli's generalization ([Kayne 75, Jaeggli 82, Jaeggli 86]) according to which the cooccurrence of a clitic and a concording phrase is due to the

[6]In (7-17b) IMP stands for "impersonal pronoun clitic", and COMP for "complementizer".

presence of a preposition able to assign case to the doubled NP as in the Porteño Spanish example below.

| | | | | | | |
|---|---|---|---|---|---|---|
| (7-20) | ... lo | vamos | a empujar | *al* | ómnibus | |
| | it(CLITIC) | 1PL-are going | to push | to-the | bus | |
| | "...we are going to push the bus" | | | | | (Suñer 1988) |

As Cinque points out, displaced direct object in CLLD are not preceded by a preposition (see examples above). Therefore, the claim that the clitic doubling parameter is at work in Italian CLLD cannot be maintained. In fact, such a parameter is itself subject to criticism. [Suñer 88], for example, points out that the presence of a preposition in cases like (7-20) may be related to factors other than case marking (e.g. specificity); clitic double constructions with direct objects are in fact found in Porteño where the object NP is not preceded by a preposition. (In §7.3, I will suggest an alternative way to conceive of the clitic doubling parameter which does not rely on Kayne/Jaeggli's generalization).

Were we to generalize the restrictions which hold for canonical extraction operations to dislocation, we would be at a loss to explain the different behavior which these two types of long distance dependencies exhibit with respect to the *wh*-island constraint, the occurrence of multiple displacements and crossed dependencies, as well as clitic doubling. It would then be advisable to consider alternative treatments where obedience to strong island constraints (e.g. the CNPC) does not imply an extraction analysis of dislocation. The search for an alternative of this type is also motivated by the fact that obedience to strong islands does not seem to be a distinguishing mark of dislocation across languages. As was already mentioned, a dislocated NP can be related to a clause which occurs within an NP in Spanish. Moreover, this instance of CNPC violation cannot be related to the LD/CLLD contrast. A sentence such as (7-7), here repeated as (7-21), need not be interpreted as an instance of LD: the sentence is still grammatical when the dislocated NP is read as a clitic left dislocation despite the CNPC violation.[7]

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| (7-21) | *El dinero.* | acepto | la pretensión | de que | *lo* | tienen | ya |
| | the money | accept-I | the pretension | of that | it(CLITIC) | have-they | already |
| | "The money, I accept the pretension that they have it already" | | | | | | [Rivero 80] |

While it is possible that equivalent dislocation phenomena may arise out of different syntactic processes for each choice of language (adjunction in Spanish and extraction

[7] John Beaven, p.c.

in Italian), an account where crosslinguistic variation can be explained on the basis of lexically governed parameters without assuming two entirely distinct syntactic strategies would certainly be superior. In §7.3 I will argue that such a characterization can indeed be attained, and can be in principle be generalized to provide a unified account of all dislocation phenomena (i.e. CLLD and LD).

### 7.1.3 Cinque's Analysis: Dislocated Phrases as Base-Generated Adjuncts

The analysis of dislocated phrases as base-generated sentential adjuncts is certainly not a novelty,[8] although Cinque's recent account is the first attempt to locate such an analysis within the context of a theory of A'-dependencies which includes *wh*-movement. Cinque distinguishes four types of A'-dependencies according to sensitivity to strong and weak island constraints:

- "successive cyclic" *wh*-movement, which is sensitive to all island constraints (e.g. adjunct extraction)
- "long" *wh*-movement, sensitive only to strong islands (e.g. extraction of verbal complements)
- "apparent wh-movement" of NPs which selectively violates strong islands (e.g. parasitic gaps, and the gap of *easy-to-please* constructions)
- the relation between a sentence initial phrase and a resumptive pronoun which is totally insensitive to island constraints (e.g. LD, and the relative construction of many languages)

This basic quatripartition is further differentiated in terms of other properties which qualify *wh*-movement such as the absence of a resumptive pronominal element, the impossibility of multiple displacements into the same presentential position, the licensing of parasitic gaps and the lack of successive cyclic *wh*-movement. Cinque observes that with respect to island constraints CLLD shares the distributional properties of long *wh*- movement in that it is sensitive only to strong island (see above). Yet, CLLD

[8]See [Postal 71], [Roadman 74], [Gundel 75] and [Chomsky 77] for English, [Hirschbühler 75] for French, and [van Riemsdijk & Zwarts 74] for Dutch.

cannot be assimilated to *wh*-movement since it involves the occurrence of a resumptive element, it does not license parasitic gaps and allows for multiple displacements as was noted above. In addition, dislocated adjuncts in CLLD are not amenable to successive cyclic movement. For example, Cinque maintains that in sentences such as (7-22) the dependency between the topicalized adjunct and the complement predicate is licensed by a *government chain* which relates the post-verbal gap and topicalized adjunct in terms of antecedent government.

(7-22) [PER QUESTA RAGIONE]$_i$ ha detto che se ne andrà $t_i$
"[FOR THIS REASON]$_i$, he said he will leave $t_i$"

As indicated in (7-23), the creation of such a government chain is crucially dependent on the presence of an intermediate trace in the VP adjoined position,[9] e.g. $t'_i$, which results from *successive cyclic wh*-movement. The absence of such an intermediate trace would in fact break the government link between the object trace, $t_i$, and the operator in COMP, $O_i$ (i.e. without $t'_i$, the lower VP would be a barrier for government).

(7-23)
$[_{TOP}$PER QUESTA RAGIONE$]_i$ $[_{CP}O_i$ ha detto $[_{CP}$ che $[_{VP}$ $t'_i$ $[_{VP}$ se ne andrà $t_i]]]]$
$*[_{TOP}$PER QUESTA RAGIONE$]_i$ $[_{CP}O_i$ ha detto $[_{CP}$ che $[_{VP}$ se ne andrà $t_i]]]$

Adjunct topicalization contrasts with adjunct dislocation in that no licensing relation can be established between the postverbal gap and the diplaced adjuncts across two sentential boundaries. For example, the sentence in (7-24) is ungrammatical if the dislocated adjunct, *per questa ragione*, is interpreted as a modifier of the lower predicate.

(7-24) Per questa ragione, ha detto che se ne andrà
{ *"He said that this is the reason why he will leave"
"This is the reason why he said that he will leave" }

Cinque argues that this contrast is due to the fact that no successive cyclic *wh*-movement is available through clitic dislocation.

Cinque's solution consists in treating dislocated phrases as base-generated sentential adjuncts and characterize CLLD dependencies in terms of *binding chains*. In Cinque's system, binding chains can establish dependencies between phrases without resorting to movement. In addition, binding chains differ from the government chains which are

[9]Cinque points out that the intermediate trace could alternatively be in the specifier position of the embedded CP.

established via successive cyclic movement (e.g. as in the topicalization case discussed above) in that they are not sensitive to weak island constraints.[10] This account makes it possible to capture the relevant constraints on CLLD (e.g. Obligatory Connectivity and obedience to strong island constraints), while avoinding the complications which arise from an analysis of dislocation which relies on *wh*-movement.

I think that the basic insights of Cinque's approach are essentially correct, although the specific implementation of these insights raises a number of questions. For example, given that all dislocated phrases are adjuncts we would expect sentences such as (7-25) to be ungrammatical as is (7-24).

(7-25) Carlo, Maria dice che lo vedrà domani
"Carlo, Maria says that she will meet him tomorrow"

In (7-25) the dislocated NP — an adjunct in Cinque's analysis — is "reconstructed" into the complement sentence similarly to how the topicalized adjunct in (7-22) is. However, this reconstruction should not be allowed in CLLD as it requires the formation of a government chain via successive cyclic *wh*-movement. The question arises then as to how Cinque's analysis can be made to account for the contrast between complement and adjunct dislocations with respect to the possibility of establishing a dependency across a sentential complement. A further question concerns the treatment of dislocation dependencies which do not conform to CLLD. While Cinque succeeds in showing that a clear diversification of dislocation processes into CLLD and LD is empirically motivated in Italian, no indication is given as to how LD is to be dealt with. Moreover, in some languages the LD/CLLD distinction as characterized by Cinque is not so transparent as it is in Italian. As was pointed out with respect to the Spanish example in (7-22), dislocations which exhibit most of the qualifying properties of CLLD may give rise to strong island violations.

## 7.2 A Unification Categorial Grammar Account

In this section I will show how an alternative treatment of dislocation can be developed for Italian within the UCG framework developed in this thesis which eschews the shortcomings of an extraction analysis, and provides an account of clitic doubling where

[10] This fact is a consequence of Cinque's definition of *binding* and *government barriers*, (see [Cinque *forth*], §1).

cliticization can be unambiguously rendered as an "argument satisfaction" operation.

### 7.2.1 Thematic Roles, Verb Semantics and Argument-Verb Dependencies

As anticipated in the introduction, our treatment of dislocation will make crucial reference to the notion of $\theta$-DOM developed in §4.3. Recall that the $\theta$-DOM of a verb was defined so as to contain the thematic entailments of the verb which are lexicalized as subcategorized arguments. To accommodate this fact the index attribute of a UCG formula was allowed to be a complex structure consisting of a sorted variable and a $\theta$-DOM as shown in (7-26).

(7-26) **TD9**

$$\textit{complex\_ind} \Rightarrow \begin{bmatrix} \mathbf{var} = \textit{basic} \\ \theta\text{-}\mathbf{dom} = \textit{θ\_seq} \end{bmatrix}$$

The $\theta$-DOM was encoded as a sequence of thematic formulae which is constructed with the associative operator "o" as indicated in (7-27a), and for which the identity axiom in (7-27b) holds.

(7-27) a **TD10**

$$\textit{θ-seq} \Rightarrow \Lambda \sqcup \langle \textit{formula} \circ \textit{θ-seq} \rangle$$

b The symbol $\Lambda$ is a string (i.e. the empty string), such that $\Lambda \circ \sigma = \sigma = \sigma \circ \Lambda$ for any element $\sigma$ of a sequence.

The addition of this axiom makes it possible to generalize the selection of an arbitrary element out of a $\theta$-DOM sequence (e.g. $\langle \ldots \circ \phi \circ \ldots \rangle$) to cases where the selected element occurs as the first, last, or only element of the sequence (i.e. $\langle \phi \circ \ldots \rangle$, $\langle \ldots \circ \phi \rangle$, or $\langle \phi \rangle$) without having to introduce sign ambiguities.

Grammatical relations were encoded by establishing a one-to-one correspondence between the (syntactic) arguments of a verb and its thematic entailments as indicated in (7-28) with the tag $\boxed{2}$.

$$
(7\text{-}28)\quad
\left[\begin{array}{ll}
\textbf{phon} = & \left[\begin{array}{l}\textbf{ord} = \mathrm{LC}\\ \textbf{phon1} = \textit{walks}\\ \textbf{phon2} = \boxed{1}\end{array}\right]\\
\textbf{catn} = & \left[\textbf{catn} = \textit{sent}\right] / \left[\begin{array}{l}\textbf{phon} = \boxed{1}\\ \textbf{catn} = \left[\textbf{catn} = \textit{np}\right]\\ \textbf{sem} = \boxed{2}\end{array}\right]\\
\textbf{sem} = & \left[\begin{array}{l}\textbf{ind} = \left[\begin{array}{l}\textbf{var} = \boxed{3}\\ \theta\textbf{-dom} = \left\langle \boxed{2}\left[\begin{array}{l}\textbf{pred} = \textit{p-agt}\\ \textbf{arg1} = \boxed{3}\\ \textbf{arg2} = [\,]\end{array}\right]\right\rangle\end{array}\right]\\ \textbf{pred} = \textit{walk}\\ \textbf{args} = \boxed{3}\,e\end{array}\right]
\end{array}\right]
$$

The association of a verb with one of its subcategorized arguments was characterized as removal of both the active sign from the category structure of the verb, and the first thematic entailment from the verb $\theta$-DOM. The removed thematic entailment is combined with the semantics of the verb to yield a complex formula which is the semantic representation of the newly formed phrasal sign; in addition, the current verb $\theta$-DOM becomes the $\theta$-DOM of this complex formula. An informal example of this approach to the relationship between a predicate and its subcategorized arguments is given in (7-29) ($\Theta$ is a variable over thematic formulae).

(7-29)

$$\Big[[e_1 : \Lambda][hit(e_1) \wedge p\text{-}pat(e_1, john) \wedge p\text{-}agt(e_1, bill)]\Big]_S$$

$$\Big[[e_1 :< \Theta_1 >][A_1 \wedge P_1(e_1, bill_1)]\Big]_X \Big/ \Big[[e_1 :< P_1(e_1, bill_1) \circ \Theta_1 >]A_1\Big]_{X/NP}$$

$$\Big[[e_1 :< p\text{-}agt(e_1, X_1) >][hit(e_1) \wedge p\text{-}pat(e_1, john)]\Big]_{S/NP}$$

$$\Big[[e_1 :< \Theta_2 >][A_2 \wedge P_2(e_1, john_1)]\Big]_X \Big/ \Big[[e_1 :< P_2(e_1, john_1) \circ \Theta_2 >]A_2\Big]_{X/NP}$$

$$\Big[[e_1 :< p\text{-}pat(e_1, X2) \circ p\text{-}agt(e_1, X_1) >]hit(e_1)\Big]_{S/NP/NP}$$

This process as a whole is induced through a single step of functional application by structuring subject and object phrases as polymorphic type-raised complements (e.g. $C/(C/np)$, where $C$ may instantiate either a basic or complex category), as shown in (7-30) for the NP *John*. (The tag "$\boxed{6}$" in (7-30) allows any additional elements within the $\theta$-DOM of the active verb/verb-phrase sign to be transmitted to the $\theta$-DOM of the resulting verb-phrase/sentential sign.)

$$(7\text{-}30)\quad \left[\begin{array}{l} \mathbf{phon} = \boxed{4} \\ \mathbf{cat} = \boxed{5}\,C/\left[\begin{array}{l} \mathbf{phon} = \boxed{4} \\ \mathbf{cat} = \boxed{5}\,C/\left[\begin{array}{l}\mathbf{phon} = John \\ \mathbf{catn} = [\mathbf{catn} = np] \\ \mathbf{sem} = \boxed{2}\end{array}\right] \\ \mathbf{sem} = \left[\begin{array}{l} \mathbf{ind} = \left[\begin{array}{l}\mathbf{var} = \boxed{3} \\ \theta\text{-}\mathbf{dom} = \langle \boxed{2} \circ \boxed{6} \rangle\end{array}\right] \\ \mathbf{pred} = \boxed{7} \\ \mathbf{args} = \boxed{8}\end{array}\right]\end{array}\right] \\ \mathbf{sem} = \left[\begin{array}{l} \mathbf{ind} = \left[\begin{array}{l}\mathbf{var} = \boxed{3} \\ \theta\text{-}\mathbf{dom} = \langle \boxed{6} \rangle\end{array}\right] \\ \mathbf{pred} = \mathit{and} \\ \mathbf{arg1} = \left[\begin{array}{l}\mathbf{ind{:}var} = \boxed{3} \\ \mathbf{pred} = \boxed{7} \\ \mathbf{args} = \boxed{8}\end{array}\right] \\ \mathbf{arg2} = \boxed{2}\left[\begin{array}{l}\mathbf{pred} = [\,] \\ \mathbf{arg1} = \boxed{3} \\ \mathbf{arg2} = \mathit{john}\end{array}\right]\end{array}\right]\end{array}\right]$$

For example, the result of combining the verb sign in (7-28) with the type-raised NP above is the sentential sign shown in (7-32). In this case the $\theta$-DOM of the resulting sign is empty since the original $\theta$-DOM of the verb contained a single thematic entailment. More precisely, when the argument $\theta$-DOM of the sign in (7-30) (i.e. $\langle \boxed{2} \circ \boxed{6} \rangle$) unifies with the $\theta$-DOM of the verb sign in (7-28), the tag $\boxed{6}$ will instantiate an empty sequence; this is because the $\theta$-DOM of the verb can be rewritten with the addition of a final empty string by virtue of the identity axiom in (7-27), e.g.

$$(7\text{-}31)\quad \left\langle \left[\begin{array}{l}\mathbf{pred} = [\,] \\ \mathbf{arg1} = \boxed{3} \\ \mathbf{arg2} = \mathit{john}\end{array}\right] \circ \boxed{6} \right\rangle \sqcap \left\langle \left[\begin{array}{l}\mathbf{pred} = \mathit{p\text{-}agt} \\ \mathbf{arg1} = \boxed{3} \\ \mathbf{arg2} = [\,]\end{array}\right] \right\rangle$$

$$\Downarrow \ (\text{by } (7\text{-}28))$$

$$\left\langle \left[\begin{array}{l}\mathbf{pred} = [\,] \\ \mathbf{arg1} = \boxed{3} \\ \mathbf{arg2} = \mathit{john}\end{array}\right] \circ \boxed{6} \right\rangle \sqcap \left\langle \left[\begin{array}{l}\mathbf{pred} = \mathit{p\text{-}agt} \\ \mathbf{arg1} = \boxed{3} \\ \mathbf{arg2} = [\,]\end{array}\right] \circ \Lambda \right\rangle = \left\langle \left[\begin{array}{l}\mathbf{pred} = \mathit{p\text{-}agt} \\ \mathbf{arg1} = \boxed{3} \\ \mathbf{arg2} = \mathit{john}\end{array}\right] \circ \Lambda \right\rangle$$

The empty string will then be merged with the preceding formula in the sequence according to the identity axiom in (7-27b). The resulting $\theta$-DOM will thus contain the agent entailment only; e.g.

$$(7\text{-}32)\quad \left\langle \begin{bmatrix} \textbf{pred} & = & \textit{p-agt} \\ \textbf{arg1} & = & \boxed{3} \\ \textbf{arg2} & = & \textit{john} \end{bmatrix} \right\rangle$$

This thematic entailment is then removed, leaving the $\theta$-DOM of the sentential sign empty as indicated in (7-33).

$$(7\text{-}33)\quad \begin{bmatrix} \textbf{phon} = \begin{bmatrix} \textbf{ord} & = & \text{LC} \\ \textbf{phon1} & = & \textit{walks} \\ \textbf{phon2} & = & \textit{John} \end{bmatrix} \\ \textbf{catn} = \textit{sent} \\ \textbf{sem} = \begin{bmatrix} \textbf{ind} = \begin{bmatrix} \textbf{var} = \boxed{4} \\ \theta\textbf{-dom} = \Lambda \end{bmatrix} \\ \textbf{pred} = \textit{and} \\ \textbf{arg1} = \begin{bmatrix} \textbf{pred} = \textit{walk} \\ \textbf{arg1} = \boxed{4}\,e \end{bmatrix} \\ \textbf{arg2} = \begin{bmatrix} \textbf{pred} = \textit{p-agt} \\ \textbf{arg1} = \boxed{4} \\ \textbf{arg2} = \textit{john} \end{bmatrix} \end{bmatrix} \end{bmatrix}$$

This treatment of predicate-argument association can be briefly summarized by saying that argument phrases have the following properties:

1. satisfy the subcategorization requirements of a verb;
2. instantiate participant roles in the thematic domain of the verb;
3. integrate the instantiated roles with the semantics of the verb, and
4. reduce the domain of thematic entailments of the verb through removal of the instantiated roles.

As in the previous chapters, thematic instantiation is computed on the basis of four basic types of thematic roles: *proto-agent*, *proto-patient*, *prepositional* and *propositional* roles.

### 7.2.2 Clitics as *Quasi-Arguments*, Dislocated Phrases as *Quasi-Adjuncts*

Our first step towards an analysis of dislocation is to provide a characterization of clitics as *quasi-arguments*. More precisely, we are going to assume that pronominal clitics satisfy the subcategorization requirements of verbs and instantiate participant roles in their $\theta$-DOM, but may neither reduce the thematic domain of a verb nor integrate the instantiated roles with the semantics of the verb. The basic idea behind this assumption is that syntactically clitics behave exactly as argument phrases do, while with respect to semantic interpretation they may only provide further specification (e.g. agreement information) relative to the thematic entailments they instantiate, and postpone the discharge of such entailments. For example, the UCG representation for the sentence in (7-34a) where both direct and indirect objects are realized as pronominal clitics will be a sentential sign where the roles corresponding to these arguments are still encoded as thematic entailments of the verb, as shown in (7-34b). These de-linked thematic entailments have the status of anaphoric expressions, i.e. their treatment would be akin to that of personal pronouns within a DRT approach to anaphora resolution. In addition the individual argument variable of such roles will carry the agreement information contributed by the object clitics (*m3* is a sorted variable for third person objects which are both male and singular, and *x3* a sorted variable for third person objects).

| | | | | |
|---|---|---|---|---|
| (7-34) | a | *gliel'* | ha presentato | Maria |
| | | to-him(CLITIC)-him(CLITIC) | has introduced | Maria |
| | | "Maria introduced him to him" | | |

b

$$\begin{bmatrix} \textbf{phon} = \textit{gliel'ha}^\frown\textit{presentato}^\frown\textit{Maria} \\ \textbf{catn} = \textit{sent} \\ \textbf{sem} = \begin{bmatrix} \textbf{ind} = \begin{bmatrix} \textbf{var} = \boxed{1} \\ \theta\textbf{-dom} = \left\langle \begin{bmatrix} \textbf{pred} = \textit{p-pat} \\ \textbf{arg1} = \boxed{1} \\ \textbf{arg2} = \textit{m3}\end{bmatrix} \circ \begin{bmatrix}\textbf{pred} = \textit{to}\\ \textbf{arg1}=\boxed{1} \\ \textbf{arg2} = \textit{x3}\end{bmatrix}\right\rangle \end{bmatrix} \\ \textbf{pred} = \textit{and} \\ \textbf{arg1} = \begin{bmatrix}\textbf{pred} = \textit{introduce} \\ \textbf{arg1} = \boxed{1}\,e\end{bmatrix} \\ \textbf{arg2} = \begin{bmatrix}\textbf{pred}=\textit{p-agt}\\ \textbf{arg1}=\boxed{1}\\ \textbf{arg2}=\textit{maria}\end{bmatrix}\end{bmatrix}\end{bmatrix}$$

This result is attained by treating cliticization as a morphosyntactic operation on the category structure of verbs which has the effect of removing subcategorized arguments as indicated in (7-35) in the case of direct object cliticization (see chapter 5).

(7-35) **rule** = DIRECT OBJECT CLITICIZATION

$$\mathbf{in} = \left[ \mathbf{cat} = \left[ \mathbf{catn} = \mathit{sent} \right] / \left\{ \begin{bmatrix} \mathbf{catn} = \mathit{np} \\ \mathbf{sem} = \left[ \mathbf{pred} = \mathit{p\text{-}agt} \right] \end{bmatrix}, \begin{bmatrix} \mathbf{catn} = \mathit{np} \\ \mathbf{sem} = \left[ \mathbf{pred} = \mathit{p\text{-}pat} \right] \end{bmatrix} \right\} \right]$$

$$\mathbf{out} = \left[ \mathbf{cat} = \left[ \mathbf{catn} = \mathit{sent} \right] / \begin{bmatrix} \mathbf{catn} = \mathit{np} \\ \mathbf{sem} = \left[ \mathbf{pred} = \mathit{p\text{-}agt} \right] \end{bmatrix} \right]$$

The complementary distribution between clitics and concordant argument phrases noted earlier — here shown in (7-36a) and (7-36b) — can thus be made to follow from the fact that both clitics and argument phrases seek to perform an equivalent argument-satisfaction operation on the category structure of verbs.

| | | | | | | |
|---|---|---|---|---|---|---|
| (7-36) | a | *Maria | *lo* | vedrà | *Carlo* | domani |
| | | Maria | him(CLITIC) | will see | Carlo | tomorrow |
| | b | *Maria | *gli* | scrive | *a Carlo* | ogni mese |
| | | Maria | to-him(CLITIC) | writes | to Carlo | every month |

Consider next the behavior of dislocated phrases. Prima facie the ungrammaticality of sentences such as the one in (7-37) where the same argument position is shared by a dislocated phrase and an object NP *in situ* might lead us to conclude that dislocated phrases are arguments.

(7-37) *Carlo, Maria vedrà Carlo domani
Carlo, Maria will-see Carlo tomorrow
"Carlo, Maria will see Carlo tomorrow"

However as noted earlier, this conclusion is at variance with the fact that dislocated phrases may cooccur with concordant pronominal clitics, and that the cooccurrence of clitics and concordant argument phrases is not allowed in environments other than dislocation as shown in (7-38) and (7-39).

(7-38) a *Carlo*, Maria *lo* vedrà domani
Carlo. Maria him(CLITIC) will see tomorrow
"Carlo, Maria will see him tomorrow"

b *A Carlo*, Maria *gli* scrive ogni mese
To Carlo Maria to-him(CLITIC) writes every month
"To Carlo, Maria writes to him every month"

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| (7-39) | a | *Maria | *lo* | vedrà | *Carlo* | domani | |
| | | Maria | him(CLITIC) | will see | Carlo | tomorrow | |
| | b | **CARLO* | Luigi | *l'* | ha incontrato ieri, | non Maria | |
| | | CARLO | Luigi | him(CLITIC) | has met yesterday, | not Maria | |
| | c | **Chi* | *l'* | hai incontrato ieri? | | | |
| | | Who | him(CLITIC) | have-you met yesterday? | | | |
| | d | *L'uomo | *il quale* | Gianni | *l'* | ha incontrato ieri ... | |
| | | The man | whom | Gianni | him(CLITIC) | has met yesterday ... | |

Moreover, at least with dislocated direct objects the occurrence of pronominal clitics is mandatory, e.g.

| | | | | | |
|---|---|---|---|---|---|
| (7-40) | *Carlo*, | Maria | *(*lo*) | vedrà | domani |
| | Carlo, | Maria | him(CLITIC) | will see | tomorrow |
| | "Carlo, Maria will see him tomorrow" | | | | |

In short, dislocated phrases exhibit only some of the distributional properties of true arguments in that they can freely cooccur with concordant clitics within the same clausal domain. This fact can be formally captured by treating dislocated phrases as *quasi-adjuncts*, i.e. sentential modifiers (expressions of category type *sent/sent*) whose semantic properties are nevertheless akin to those of argument phrases as specified in (7-41).

(7-41) DISLOCATED PHRASES AS QUASI-ADJUNCTS
Dislocated phrases instantiate thematic roles in the thematic domain of a sentence, remove the instantiated roles, and integrate them with the semantics of the sentence.

This treatment can be implemented by means of a lexical rule which modifies the category and phonology attributes of argument phrases as shown in (7-42).[11]

[11] For ease of exposition, reference to semantic differences between dislocated and argument phrases which arise with respect to discourse functionality is omitted.

(7-42) **rule** = DISLOCATED PHRASE FORMATION

$$\mathbf{in} = \begin{bmatrix} \mathbf{phon} = \boxed{1} \\ \mathbf{cat} = \boxed{2}\, C \Big/ \begin{bmatrix} \mathbf{phon} = \boxed{1} \\ \mathbf{cat} = \boxed{2}\, C \Big/ \begin{bmatrix} \mathbf{phon} = \boxed{3} \\ \mathbf{catn} = np \\ \mathbf{sem} = [\,] \end{bmatrix} \\ \mathbf{sem} = \boxed{4} \end{bmatrix} \\ \mathbf{sem} = \boxed{5} \end{bmatrix}$$

$$\mathbf{out} = \begin{bmatrix} \mathbf{phon} = \begin{bmatrix} \mathbf{ord} = \text{LC} \sqcup \text{RC} \\ \mathbf{phon1} = \boxed{3} \\ \mathbf{phon2} = \boxed{1} \end{bmatrix} \\ \mathbf{cat} = \begin{bmatrix} \mathbf{catn} = sent \end{bmatrix} \Big/ \begin{bmatrix} \mathbf{phon} = \boxed{1} \\ \mathbf{catn} = sent \\ \mathbf{sem} = \boxed{4} \end{bmatrix} \\ \mathbf{sem} = \boxed{5} \end{bmatrix}$$

The sign in (7-43) below provides a concrete example of how the rule in (7-42) maps an argument phrase structured as in (7-34) into a dislocated phrase.[12]

(7-43)

$$\begin{bmatrix} \mathbf{phon} = \begin{bmatrix} \mathbf{ord} = \text{LC} \sqcup \text{RC} \\ \mathbf{phon1} = \textit{Carlo}, \\ \mathbf{phon2} = \boxed{1} \end{bmatrix} \\ \mathbf{cat} = \begin{bmatrix} \mathbf{catn} = sent \end{bmatrix} \Big/ \begin{bmatrix} \mathbf{phon} = \boxed{1} \\ \mathbf{catn} = sent \\ \mathbf{sem} = \begin{bmatrix} \mathbf{ind} = \begin{bmatrix} \mathbf{var} = \boxed{2} \\ \theta\text{-}\mathbf{dom} = \langle \boxed{3} \circ \boxed{4} \rangle \end{bmatrix} \\ \mathbf{pred} = \boxed{5} \\ \mathbf{args} = \boxed{6} \end{bmatrix} \end{bmatrix} \\ \mathbf{sem} = \begin{bmatrix} \mathbf{ind} = \begin{bmatrix} \mathbf{var} = \boxed{2} \\ \theta\text{-}\mathbf{dom} = \langle \boxed{4} \rangle \end{bmatrix} \\ \mathbf{pred} = and \\ \mathbf{arg1} = \begin{bmatrix} \mathbf{pred} = \boxed{5} \\ \mathbf{args} = \boxed{6} \end{bmatrix} \\ \mathbf{arg2} = \boxed{3} \begin{bmatrix} \mathbf{pred} = [\,] \\ \mathbf{arg1} = \boxed{2} \\ \mathbf{arg2} = carlo \end{bmatrix} \end{bmatrix} \end{bmatrix}$$

[12]The disjunction in the order attribute of the phonology is intended to indicate that the sign in (7-43) is suitable for both right or left clitic dislocation.

The association of a dislocated phrase with a sentence will essentially involve the same operations which characterize the association of a verb with one of its subcategorized arguments, with the exception that dislocated phrases leave the category type of the sign with which they combine unchanged. For example the association of the sentential sign in (27b) with the dislocated phrase in (7-43) will yield a sign whose semantics results from

- removing the top thematic entailment from the $\theta$-DOM of the input sentential sign, and
- conjoining it with the semantics of the verb and its subject argument

as indicated in (7-44).

$$(7\text{-}44)\quad \left[\begin{array}{lll}
\textbf{phon} & = & \textit{Carlo,}^\frown\textit{gliel'ha}^\frown\textit{presentato}^\frown\textit{Maria}\\
\textbf{catn} & = & \textit{sent}\\
\textbf{sem} & = & \left[\begin{array}{lll}
\textbf{ind} & = & \left[\begin{array}{lll} \textbf{var} & = & \boxed{1}\\ \theta\textbf{-dom} & = & \left\langle \left[\begin{array}{lll}\textbf{pred} & = & \textit{to}\\ \textbf{arg1} & = & \boxed{1}\\ \textbf{arg2} & = & x3\end{array}\right]\right\rangle \end{array}\right]\\
\textbf{pred} & = & \textit{and}\\
\textbf{arg1} & = & \left[\begin{array}{lll} \textbf{pred} & = & \textit{and}\\ \textbf{arg1} & = & \left[\begin{array}{lll}\textbf{pred} & = & \textit{introduce}\\ \textbf{arg1} & = & \boxed{1}\end{array}\right]\\ \textbf{arg2} & = & \left[\begin{array}{lll}\textbf{pred} & = & \textit{p-agt}\\ \textbf{arg1} & = & \boxed{1}\\ \textbf{arg2} & = & \textit{maria}\end{array}\right]\end{array}\right]\\
\textbf{arg2} & = & \left[\begin{array}{lll}\textbf{pred} & = & \textit{p-pat}\\ \textbf{arg1} & = & \boxed{1}\\ \textbf{arg2} & = & \textit{carlo}\end{array}\right]
\end{array}\right]
\end{array}\right]$$

More generally, the association of a dislocated phrase and a sentence will succeed whenever the role introduced by the dislocated phrase has access to a compatible role within the thematic domain of the sentence. Provided this condition is satisfied, there are no restrictions as to how many dislocated phrases can be combined with a sentence. The occurrence of multiple displacements in dislocated sentences such as the one in (7-45) (cf. (7-21a)) will therefore follow from the possibility of combining the sentential sign in (7-44) with an additional dislocated phrase, i.e. a dislocated indirect object introducing the prepositional role *to*, whose individual object argument is third person as schematically shown in (7-46) ($A$ is a variable over formulae).

(7-45) *A Gianni,* *Carlo,* *gliel'* ha presentato Maria
To Gianni, Carlo, to-him(CLITIC)–him(CLITIC) has introduced Maria
"To Gianni, Carlo, Maria introduced him to him"

(7-46)

$$\left[ [e_1 : \Lambda][introduce(e_1) \wedge p\text{-}agt(e_1, maria) \wedge p\text{-}pat(e_1, carlo) \wedge to(e_1, gianni)] \right]_S$$

$$\left[ [e_1 :< \Theta_1 >][A_1 \wedge P_1(e_1, gianni_1)] \right]_S \Big/ \left[ [e_1 :< P_1(e_1, gianni_1) \circ \Theta_1 >]A_1 \right]_S$$

$$\left[ [e_1 :< to(e_1, X_2) >][introduce(e_1) \wedge p\text{-}agt(e_1, maria) \wedge p\text{-}pat(e_1, carlo)] \right]_S$$

$$\left[ [e_1 :< \Theta_2 >][A_2 \wedge P_2(e_1, carlo_1)] \right]_S \Big/ \left[ [e_1 :< P_2(e_1, carlo_1) \circ \Theta_2 >]A_2 \right]_{S/S}$$

$$\left[ [e_1 :< p\text{-}agt(e_1, X_1) \circ to(e_1, X2) >][introduce(e_1) \wedge p\text{-}agt(e_1, maria)] \right]_S$$

Such a possibility is granted by the presence of an accessible role entailment in the thematic domain of the sentential sign in (7-44).

Moreover, the notion of thematic accessibility adopted hitherto can be minimally extended so as to provide an account of crossed dislocation dependencies as in (7-47) (cf. (7-19)).

(7-47) *Carlo*$_1$, *a Gianni*$_2$, *gliel'*ha presentato Maria $\_\_\__1$ $\_\_\__2$
"Carlo, to Gianni, Maria introduced him to him"

The extension needed consists in weakening the requirement that the role which a dislocated phrase seeks to instantiate be the first thematic formula of the argument $\theta$-DOM. To represent this weaker notion of thematic accessibility a variable is added as the first member of the argument and result $\theta$-DOM in the sign for dislocated phrases. as indicated below with the tag $\boxed{3}$ for the dislocated indirect object *a Gianni*.

$$(7\text{-}48)\quad \left[\begin{array}{l} \mathbf{phon} = \left[\begin{array}{l} \mathbf{ord} = \text{LC} \cup \text{RC} \\ \mathbf{phon1} = \textit{a Gianni} \\ \mathbf{phon2} = \boxed{1} \end{array}\right] \\ \mathbf{cat} = \left[\mathbf{catn} = \textit{sent}\right] \Big/ \left[\begin{array}{l} \mathbf{phon} = \boxed{1} \\ \mathbf{catn} = \left[\mathbf{catn} = \textit{sent}\right] \\ \mathbf{sem:ind:}\theta\mathbf{\text{-}dom} = \left\langle \boxed{3} \circ \left[\begin{array}{l} \mathbf{pred} = \textit{to} \\ \mathbf{arg2} = \textit{gianni} \end{array}\right] \right\rangle \end{array}\right] \\ \mathbf{sem:ind:}\theta\mathbf{\text{-}dom} = \langle \boxed{3} \rangle \end{array}\right]$$

The addition of this variable tag will allow the dislocated indirect object in (7-48) to combine with the sentential sign in (7-37b) either before or after the proto-patient entailment has been removed from the $\theta$-DOM of the sentence. The option of delaying the removal of the first entailment from the sentence $\theta$-DOM will give rise to a sentence structure with crossed dislocation dependencies as the one in (7-47). In this case the tag $\boxed{3}$ in the $\theta$-DOM of the sign in (7-48) will instantiate the proto-patient role encoded in the $\theta$-DOM of the sentential sign in (7-37b). Otherwise, if the proto-patient entailment has already been removed — as in the sentential sign in (7-44) — the tag $\boxed{3}$ in (7-48) will instantiate an empty sequence which according to the identity axiom in (7-31b) will be merged with the following element in the sequence (i.e. the prepositional role).

### 7.2.3 Island Constraints and $\theta$-DOM Inheritance

In section 1 we saw that in Italian dislocation may give rise to violations of the *wh*-island constraint, while it obeys the CNPC. Within the present framework this behavior can be made to follow from a regime of $\theta$-DOM inheritance according to which the active entailments of a complement are included in the thematic domain of its subcategorizing expression as indicated in (7-49b). The rationale underlying such a regime of inheritance is a natural consequence of the transitive nature of entailment relations, and can therefore be derived as a corollary of the notion of thematic domain developed earlier, here briefly summarized in (7-49a).

(7-49) a *θ*-DOM *Constituency*

The *θ*-DOM of a lexical item consists of participant roles which the lexical item necessarily entails.

b *θ*-DOM *Inheritance Corollary*

If an expression A has in its thematic domain some expression B whose thematic domain contains an expression C, then C is also an element of A's thematic domain; e.g.

$$\texttt{sem} = \boxed{A}\left[\texttt{ind:}\theta\texttt{-DOM} = \left\langle \boxed{B}\begin{bmatrix} \texttt{ind} = \begin{bmatrix} \texttt{var} = \\ \theta\texttt{-dom} = \boxed{C} \end{bmatrix} \\ \texttt{pred} = \\ \texttt{args} = \end{bmatrix} \ldots\circ \right\rangle\right]$$

$$\Downarrow$$

$$\texttt{sem} = \boxed{A}\left[\texttt{ind:}\theta\texttt{-DOM} = \left\langle \boxed{B}\begin{bmatrix} \texttt{ind} = \begin{bmatrix} \texttt{var} = \\ \theta\texttt{-dom} = \boxed{C} \end{bmatrix} \\ \texttt{pred} = \\ \texttt{args} = \end{bmatrix} \ldots\circ \boxed{C} \right\rangle\right]$$

Consider for example the case of a sentence such as (7-50).

(7-50) Chi sa chi l' ha visto?
who knows who him(CLITIC) has seen
"Who knows who saw him(CLITIC)?"

Given the *θ*-DOM Inheritance Corollary in (7-49b), the *θ*-DOM of the matrix verb *sa* in (7-50) will include any active role entailment encoded in the complement *θ*-DOM. This is simply because the matrix predicate has in its *θ*-DOM a propositional role whose *θ*-DOM includes the *θ*-DOM of its argument proposition. In other words, the thematic entailments of the complement sentence percolate up to the *θ*-DOM of the matrix verb through the *θ*-DOM of the prepositional role.[13] As shown in (7-51), this result is obtained by entering the elements of the complement *θ*-DOM (represented by the tag $\boxed{6}$) in the matrix verb *θ*-DOM.

[13]The fact that the thematic domain of the propositional role inherits the thematic entailments of its argument proposition can also be regarded as a consequence of the *θ*-DOM Inheritance Corollary, since a propositional predicate (necessarily) entails a proposition.

(7-51)

$$\left[\begin{array}{lll}
\mathbf{phon} & = & \boxed{1}{}^\frown sa^\frown\boxed{2} \\
\mathbf{cat} & = & \left[\mathbf{catn} = sent\right] \Big/ \left[\begin{array}{lll}\mathbf{phon} & = & \boxed{1} \\ \mathbf{catn} & = & np \\ \mathbf{sem} & = & \boxed{3}\end{array}\right] \Big/ \left[\begin{array}{lll}\mathbf{phon} & = & \boxed{2} \\ \mathbf{catn} & = & sent \\ \mathbf{sem} & = & \boxed{4}\left[\begin{array}{lll}\mathbf{ind} & = & \left[\begin{array}{lll}\mathbf{var} & = & \boxed{5} \\ \theta\text{-}\mathbf{dom} & = & \langle\boxed{6}\rangle\end{array}\right] \\ \mathbf{pred} & = & prop \\ \mathbf{arg1} & = & \boxed{5} \\ \mathbf{arg2} & = & \left[\mathbf{sem{:}ind{:}}\theta\text{-}\mathbf{dom} = \langle\boxed{6}\rangle\right]\end{array}\right]\end{array}\right] \\
\mathbf{sem} & = & \left[\begin{array}{lll}\mathbf{ind} & = & \left[\begin{array}{lll}\mathbf{var} & = & \boxed{5} \\ \theta\text{-}\mathbf{dom} & = & \left\langle \boxed{4}\circ\boxed{3}\left[\begin{array}{lll}\mathbf{pred} & = & p\text{-}agt \\ \mathbf{arg1} & = & \boxed{5} \\ \mathbf{arg2} & = & x3\end{array}\right]\circ\boxed{6}\right\rangle\end{array}\right] \\ \mathbf{pred} & = & know \\ \mathbf{args} & = & \boxed{5}\ e\end{array}\right]
\end{array}\right]$$

In keeping with our analysis of subject and object phrases, sentential complements are treated as polymorphic type-raised arguments (eg *C/C/sent*)) which reduce the subcategorization frame and $\theta$-DOM of their matrix verb, and integrate the semantics of the verb with a propositional role (see §4.3.2). The first argument of this propositional role is the eventuality variable of the matrix verb, while its second argument corresponds to the semantics of the complement verb, including its dependents. For example the semantic representation for a sentence like *John heard that Mary arrived* will correspond to the first order formula in (7-52).

(7-52) $\exists e[hear(e) \wedge prop(e,\ \exists e'[arrive(e') \wedge p\text{-}pat(e',\ mary)]) \wedge p\text{-}agt(e,\ john)]$.

Consequently, the sign for a sentential complement such as *that John left* will be as in (7-53).

$$
(7\text{-}53)\quad
\begin{bmatrix}
\mathbf{phon} = \boxed{1} \\
\mathbf{cat} = \boxed{2}\, C \Big/ \begin{bmatrix}
\mathbf{phon} = \boxed{1} \\
\mathbf{cat} = \boxed{2}\, C \Big/ \begin{bmatrix}
\mathbf{phon} = \textit{that}^\frown \textit{John}^\frown \textit{left} \\
\mathbf{catn} = \textit{sent} \\
\mathbf{sem} = \boxed{3}
\end{bmatrix} \\
\mathbf{sem} = \begin{bmatrix}
\mathbf{ind} = \begin{bmatrix} \mathbf{var} = \boxed{4} \\ \theta\text{-}\mathbf{dom} = \langle \boxed{3} \rangle \end{bmatrix} \\
\mathbf{pred} = \boxed{6} \\
\mathbf{args} = \boxed{4}
\end{bmatrix}
\end{bmatrix} \\
\mathbf{sem} = \begin{bmatrix}
\mathbf{ind} = \begin{bmatrix} \mathbf{var} = \boxed{4} \\ \theta\text{-}\mathbf{dom} = \langle\,\rangle \end{bmatrix} \\
\mathbf{pred} = \textit{and} \\
\mathbf{arg1} = \begin{bmatrix} \mathbf{pred} = \boxed{6} \\ \mathbf{arg1} = \boxed{4} \end{bmatrix} \\
\mathbf{arg2} = \boxed{3} \begin{bmatrix}
\mathbf{ind} = \begin{bmatrix} \mathbf{var} = \boxed{4} \\ \theta\text{-}\mathbf{dom} = \Lambda \end{bmatrix} \\
\mathbf{pred} = \textit{Prop} \\
\mathbf{arg1} = \boxed{4} \\
\mathbf{arg2} = \begin{bmatrix}
\mathbf{pred} = \textit{and} \\
\mathbf{arg1} = [\mathbf{pred} = \textit{leave}] \\
\mathbf{arg2} = [\mathbf{pred} = \textit{p-agt}]
\end{bmatrix}
\end{bmatrix}
\end{bmatrix}
\end{bmatrix}
$$

Consider next the sentential complement *chi l'ha visto* in (7-50). Because the object of the complement verb *ha visto* is realized as a clitic, the $\theta$-DOM of the complement sentence will consist of the proto-patient role associated with that object as shown in (7-54).[14]

$$
(7\text{-}54)\quad
\begin{bmatrix}
\mathbf{phon} = \boxed{1} \\
\mathbf{cat} = \boxed{2}\, C \Big/ \begin{bmatrix}
\mathbf{phon} = \boxed{1} \\
\mathbf{cat} = \boxed{2}\, C \Big/ \begin{bmatrix}
\mathbf{phon} = \textit{chi}^\frown \textit{l'ha}^\frown \textit{visto} \\
\mathbf{catn} = \textit{sent} \\
\mathbf{sem} = \boxed{3} \left[ \mathbf{ind}{:}\theta\text{-}\mathbf{dom} = \left\langle \begin{bmatrix} \mathbf{pred} = \textit{p-pat} \\ \mathbf{arg2} = \textit{m3} \end{bmatrix} \right\rangle \right]
\end{bmatrix} \\
\mathbf{sem}{:}\mathbf{ind}{:}\theta\text{-}\mathbf{dom} = \langle \boxed{3} \circ \boxed{4} \rangle
\end{bmatrix} \\
\mathbf{sem}{:}\mathbf{ind}{:}\theta\text{-}\mathbf{dom} = \langle \boxed{4} \rangle
\end{bmatrix}
$$

When the matrix verb in (7-52) combines with the sentential complement in (7-54), the proto-patient entailment of the complement sentence will instantiate the tag $\boxed{6}$ in the $\theta$-DOM of the matrix verb as schematically shown in (7-55).

[14]The tag "$\boxed{4}$" in (7-54) allows thematic entailments of the matrix verb $\theta$-DOM other than the propositional role introduced by the sentential complement to be transmitted to the result $\theta$-DOM.

$$\text{(7-55)}\quad \begin{bmatrix} \textbf{phon} = \boxed{1}\, sa^\frown chi^\frown l'ha^\frown visto \\ \textbf{catn} = [\textbf{catn} = sent] \Big/ \begin{bmatrix}\textbf{phon} = \boxed{1}\\ \textbf{catn} = np \\ \textbf{sem} = \boxed{3}\end{bmatrix} \\ \textbf{sem}:\textbf{ind}:\theta\text{-DOM} = \left\langle \begin{bmatrix}\textbf{pred} = p\text{-}agt \\ \textbf{arg2} = x3\end{bmatrix} \circ \begin{bmatrix}\textbf{pred} = p\text{-}pat\\ \textbf{arg2} = m3\end{bmatrix}\right\rangle\end{bmatrix}$$

The fact that the complement object is inside a *wh*-island will have no effect on the inheritance of the role entailment associated with it. Notice in fact that according to (7-49b) the only prerequisite for entailment inheritance is that the expression from which the entailment is inherited be contained within the $\theta$-DOM of the inheriting expression. This condition holds of a verb and its sentential complement regardless of whether the complement is a *wh*-island or not. The $\theta$-DOM of the sentence in (7-50) will therefore contain the embedded proto-patient entailment as shown in (7-56), and will thus be amenable to combination with a dislocated object, giving rise to a dislocated structure such as the one in (8a) here repeated as (7-56b).

$$\text{(7-56)}\quad \text{a}\quad \begin{bmatrix} \textbf{phon} = chi^\frown sa^\frown chi^\frown l'ha^\frown visto \\ \textbf{catn} = sent \\ \textbf{sem}:\textbf{ind}:\theta\text{-dom} = \left\langle \begin{bmatrix}\textbf{pred} = p\text{-}pat \\ \textbf{arg2} = m3\end{bmatrix}\right\rangle \end{bmatrix}$$

| | | | | | | |
|---|---|---|---|---|---|---|
| b | *Carlo*, | chi | sa | chi | *l'* | ha visto? |
| | Carlo, | who | knows | who | him(CLITIC) | has seen |

"Carlo, who knows who saw him?"

Because the relation of role inheritance can essentially be established only between an expression and its subcategorized arguments, it follows that the active entailments of sentential adjuncts cannot be transmitted to the $\theta$-DOM of the phrase which they modify. For example the object entailment of the relative clause in (7-57) (cf. (7-17)) will not be inherited by the $\theta$-DOM of its head noun since the relative clause is not a complement of the noun.

(7-57) il $\left[_{\Lambda}\ \text{giornalista} \left[_{\langle p\text{-}pat(e,\ m3)\rangle}\ \text{che l'ha intervistato}\right]\right]$
"the reporter who interviewed him(CLITIC)"

The $\theta$-DOM of the noun will therefore act as a barrier with respect to the inheritance of such thematic role. Consequently the $\theta$-DOM of the complex noun phrase in (7-57) will be empty, and the matrix verb in (7-58) will not be in a position to inherit the active entailment of the relative clause; ultimately the sentence as a whole will not have an accessible thematic entailment in its $\theta$-DOM.

(7-58) $\Big[_{\Lambda}$ Maria $\Big[_{\langle p\text{-}agt(e,\ x3)\rangle}$ ha conosciuto $[_{\Lambda}$ il giornalista che l'ha intervistato$]\Big]\Big]$
"Maria met the reporter who interviewed him(CLITIC)"

Insofar as dislocated phrases require the presence of an accessible role within the $\theta$-DOM of the sentence with which they combine, the occurrence of a dislocated object in this case is ruled out, even though somewhere inside the sentence there is an active entailment. The ungrammaticality of the sentence in (7), here repeated as (7-59), is thus accounted for.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| (7-59) | **Carlo*, | Maria | ha conosciuto | il giornalista | che | l' | ha |
| | Carlo, | Maria | has met | the reporter | who | him(CLITIC) | has |
| | intervistato | | | | | | |
| | interviewed | | | | | | |

In conclusion, the sensitivity of dislocation dependencies to the CNPC in Italian follows from the impossibility of transmitting thematic entailments across adjuncts. Interestingly enough this treatment will also account for the impossibility of relating a dislocated object and a verb across an adjunct clause as shown in (7-60).

| | | | | |
|---|---|---|---|---|
| (7-60) | **A Giorgio*, | Grazia | si è preoccupata | perchè/quando |
| | to Giorgio, | Grazia | got worried | because/when |
| | gliel' | | hanno detto | |
| | to-him(CLITIC)-it(CLITIC) | | have-they told | |

## 7.3 Towards a Parametric Account

The basic idea developed in the previous section is that relevant constraints on clitic dislocation dependencies can be expressed in terms of access to the thematic domain of a sentence as indicated in (7-61).

(7-61) CLITIC DISLOCATION
A dislocated phrase must have access to a compatible participant role within the domain of active thematic entailments of the sentence with which it combines.

According to our treatment of pronominal clitic as quasi-arguments, the availability of a thematic entailment in the $\theta$-DOM of a sentence is a consequence of how cliticization works. The restricted occurrence of clitic doubling in Italian follows from the fact that only argument phrases which exhibit the prosodic properties of dislocated phrases can be realized as quasi-arguments. Clitic doubling can thus be seen as arising from the interaction of dislocation and cliticization.

However, this account is too restrictive for languages such as Spanish where clitic doubling occurs in environments other than dislocation, as was discussed in the introduction (cf. (1a)). In addition, our notion of thematic accessibility as developed in the $\theta$-DOM *Inheritance Corollary* is also going to be too strong if generalized to languages other than Italian. Recall in fact that in Spanish (at least in the dialect considered by [Rivero 80]) Clitic Dislocation may violate the CNPC as shown in (7-62).

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| (7-62) | *El dinero,* | acepto | la pretensión | de que | *lo* | tienen | ya |
| | the money | accept-I | the pretension | of that | it(CLITIC) | have-they | already |
| | "The money, I accept the pretension that they have it already" [Rivero 80] | | | | | | |

In this section I would like to provide an indication of how the account of clitic doubling and dislocation developed hitherto can be extended to languages other than Italian, and how the treatment of CLLD can be extended to LD dependencies.

### 7.3.1 Clitic Doubling

In §7.2.2 we saw that the complementarity between clitics and argument phrases in Italian can be derived from the assumption that both clitics and argument phrases seek to perform an equivalent argument-removal operation on the category structure of verbs. This means that only those object phrases which have the prosodic properties of dislocated phrases may be realized as quasi-adjuncts. However, this correspondence between syntactic and prosodic properties does not seem to hold across grammatical relations. It is well known for example that dialects of Italian such as Piedmontese which have subject clitics allow non-dislocated subject phrases to partake of clitic doubling constructions as shown in (7-63) (data for Piedmontese are adapted from [Burzio 86]).

| | | | |
|---|---|---|---|
| (7-63) | *Giuanin* | *a* | mangia |
| | Giuanin | he(CLITIC) | eats |
| | "Giuanin eats" | | |

Note also that the relation between subject clitics and overt subject phrases in Piedmontese exhibits significant similarities to the relation between pronominal clitics and dislocated phrases in standard Italian: in both cases the overt phrase may be omitted, while the clitic is mandatory[15] as shown in (7-64) and (7-65).

| | | | |
|---|---|---|---|
| (7-64) | a | *A* | mangia |
| | | he(CLITIC) | eats |
| | | "He eats" | |
| | b | **Giuanin* | mangia |
| | | Giuanin | eats |
| | | "He eats" | |

| | | | | | |
|---|---|---|---|---|---|
| (7-65) | a | Maria | *lo* | vedrà | domani |
| | | Maria | him(CLITIC) | will see | tomorrow |
| | | "Maria will see him tomorrow" | | | |
| | b | *Carlo, | Maria | vedrà | domani |
| | | *Carlo* | Maria | will see | tomorrow |
| | | "Carlo, Maria will see him tomorrow" | | | |

It would then seem appropriate to treat non-dislocated subject phrases in Piedmontese as quasi-adjuncts.

Even in standard Italian where there are no subject clitics, the cooccurrence of an overt subject with subject agreement inflection on the verb may be regarded as a form of clitic doubling. This is simply because subject agreement inflection in Italian has pronominal properties; e.g. a tensed verb phrase alone may form a sentence as shown in (7-66) (AGR stands for "subject agreement inflection").

(7-66) Arriva*no*
arrive-they(AGR)
"they are arriving"

Subject agreement morphemes could then be treated as pronominal clitics (i.e. quasi-arguments), and tensed verb phrases as sentences.[16] For example, the UCG representation for the tensed verb in (7-66) would be as in (7-67): a sentential sign whose $\theta$-DOM still contains the proto-agent entailment of its constituent verb. (*pl3* is a sort for third person plural individuals).

[15] In standard Italian, this generalization does not hold with respect to dislocation of indirect and oblique phrases where the occurrence of a concordant pronominal clitic is not mandatory, e.g.

(i) A Carlo, Maria (gli) scrive ogni mese
"To Carlo, Maria (to-him(CLITIC)) writes every month"

[16] A similar proposal is made in [Beaven 90] for Spanish.

(7-67)
$$\left[\begin{array}{lll}
\textbf{phon} & = & \textit{arrivano} \\
\textbf{catn} & = & \textit{sent} \\
\textbf{sem} & = & \left[\begin{array}{lll}
\textbf{ind} & = & \left[\begin{array}{lll}
\textbf{var} & = & \boxed{2} \\
\theta\textbf{-dom} & = & \left\langle \left[\begin{array}{lll}
\textbf{pred} & = & \textit{p-agt} \\
\textbf{arg1} & = & \boxed{2} \\
\textbf{arg2} & = & \textit{pl3}
\end{array}\right] \right\rangle
\end{array}\right] \\
\textbf{pred} & = & \textit{arrive} \\
\textbf{args} & = & \boxed{2}\, e
\end{array}\right]
\end{array}\right]$$

Consequently, dislocated subjects can be characterized as quasi-adjuncts on par with dislocated objects. This extension is empirically motivated by the fact that subjects may occur as dislocated phrases without intervention of a pronominal element other than subject agreement itself as shown in (7-68).

| | | | |
|---|---|---|---|
| (7-68) | Arrivera*nno* | domani, | *i libri che hai ordinato* |
| | will-arrive-they(AGR) | tomorrow | the books which have-you(AGR) ordered |
| | "They will arrive tomorrow, the books which you ordered" | | |

In addition, dislocated subject and object phrases exhibit identical distributional properties with respect to island constraints (eg obedience to the CNPC, violation of the *wh*-island constraint) as shown in (7-69).

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| (7-69) | a | *Carlo*, | chi | sa | dov' | *è* | andato? |
| | | Carlo, | who | knows-he(AGR) | where | is-he(AGR) | gone |
| | | "Carlo, who knows where he has gone?" | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| b | **Sciascia*, | Maria | ha letto | tutti i libri | che |
| | Sciascia, | Maria | has-she(AGR) read | all the books | which |
| | *ha* | scritto | | | |
| | has-he(AGR) | written | | | |
| | "Sciascia, Maria has read all the books which he wrote" | | | | |

Crucially, non-dislocated subjects in Italian appear to share some of the distributional properties which qualify dislocated phrases as quasi-adjuncts. For example, non-dislocated subjects may give rise to violations of the *wh*-island constraint in canonical extraction environments,[17] while they generally obey the CNPC as shown in (7-70) and (7-71).

[17]There might be some variation among native speakers with respect to the acceptability of the sentence in (7-70c). This may be due to the fact that multiple *wh*-questions are usually disfavored in Italian (see [Rizzi 82]).

(7-70) a CARLO mi domando come abbiano scoperto
CARLO to-myself ask-I(AGR) how have-they(AGR) discovered
dove si nasconde, non Gianni
where himself hides-he(AGR), not Gianni
"CARLO I wonder how they discovered where (he) hides, not Gianni"

b L'uomo che ti domandi come abbiano
the man who to-yourself ask-you(AGR) how have-they(AGR)
scoperto dove si nasconde ...
discovered where himself hides-he(AGR)
"The man who you wonder how they discovered where (he) hides ..."

c ? Chi ti domandi come abbiano scoperto
who to-yourself ask-you(AGR) how have-they(AGR) discovered
dove si nasconde
where himself hides-he(AGR)
"Who do you wonder how they discovered where (he) hides"

(7-71) a *Chi hai letto tutti i libri che
who have-you(AGR) read all the books which
ha scritto?
has-he(AGR) written
*"Who did you read all the books which wrote?"

b *SCIASCIA ho letto tutti i libri che
Sciascia have-I(AGR) read all the books which
ha scritto, non Calvino
has-he(AGR) written not Calvino
*"SCIASCIA I read all the books which wrote, not Calvino"

c *L'autore il quale hai letto tutti i libri che
the author who have-you(AGR) read all the books which
ha scritto ...
has-he(AGR) written
*"The author who you read all the books which wrote ..."

It would thus be a natural step to extend our treatment of dislocated subject and object phrases to non-dislocated subjects as well. Subject phrases would always be treated as quasi-adjuncts regardless of whether or not they display the prosodic properties which characterize dislocated phrases, as in the Piedmontese dialect discussed above.[18]

[18] Free inverted subjects should nevertheless be treated as subcategorized arguments. Locality conditions on free inversion are in fact considerably stricter that those for clitic dislocation. For example, free inversion may not operate across sentence boundaries as shown below (free inverted subjects are in bold face):

(i) *Fummo avvisati che sarebbero arrivati tardi da Paola **i tuoi amici**
We $[_{VP}$were-we(AGR) warned $[_{S}$ that would-they(AGR) arrive — late] by Paola] **your friends**

(ii) *Ci informó che sarebbero arrivati tardi Paola **i tuoi amici**
$[_{S}$us(CLITIC) informed-she(AGR) $[_{S}$ that would-they(AGR) arrive — late] Paola] **your friends**

In addition, a dislocated phrase may not intervene between the verb and its inverted subject as shown in (iii), a restriction which holds of a subcategorized object as indicated in (iv) .

I would like to suggest that the possibility of fixing the range of phrasal types which can be characterized as quasi-adjuncts can be made to provide a parametric account of clitic doubling. For example, the difference between Spanish and Italian with respect to the occurrence of clitic doubling with non-dislocated indirect objects noticed earlier in (7-4a) — here repeated as (7-72) — would follow under the assumption that in Spanish non-dislocated indirect objects can occur as quasi-arguments, while in Italian such a possibility is limited to subjects.

| | | | | | |
|---|---|---|---|---|---|
| (7-72) | María | *le* | dio | el libro | *a Juan* |
| | Maria | to-him(CLITIC) | gave | the book | to Juan |
| | "Maria gave the book to Juan" | | | | |

The extent to which clitic doubling is allowed within a given language will therefore be dependent on the number of non-head constituents which allow for a quasi-argumental characterization. As was shown in section 2 (cf. (7-45)) this characterization can be expressed as a lexical operation on argument phrases.

### 7.3.2 Dislocation

The approach to clitic doubling and dislocation developed in section 2 is based on a functional classification of phrasal types (as well as clitics) according to which the traditional distinction between arguments and adjuncts is enriched with the addition of the two categories "quasi-argument" and "quasi-adjunct" as intermediate terms. This classification is obtained by taking as parameters the removal of thematic entailments from the $\theta$-DOM of predicates ($\theta$-DOM REDUCTION), and removal of subcategorized signs from the category structure of functor categories (ARGUMENT REMOVAL) as indicated in (7-73).

---

(iii) *L'ha letto. il giornale Gianni
it(CLITIC) has read the newspaper$_{[OBJ,DSL]}$ Gianni$_{[SUBJ,INV]}$

(iv) *Ha letto, Gianni il giornale
has read Gianni$_{[SUBJ,DSL]}$ the newspaper$_{[OBJ,IN_SITU]}$

The contrast between dislocated and inverted subjects can be related to two distinct functional manifestations of agreement inflection: pronominal and non-pronominal agreement. The characterization of inverted subjects as subcategorized arguments is obtained by treating free inversion as a lexical rule which switches off the pronominal setting of agreement inflection in null-subject languages by reintroducing subject subcategorization ([Sanfilippo 90c]).

(7-73)

| | ARGUMENT REMOVAL | $\theta$-DOM REDUCTION |
|---|---|---|
| argument phrases | + | + |
| quasi-arguments | + | − |
| quasi-adjuncts | − | + |
| adjuncts | − | − |

It is only natural to ask at this point whether the quatripartite classification in (7-73) yields an exhaustive characterization of functional properties for non-head constituents. If we consider dislocation in Spanish the answer is that it does not. Recall that quasi-arguments can only have access to the thematic entailments contained in the $\theta$-DOM of the sentence with which they combine. According to our definition of $\theta$-DOM constituency and the $\theta$-DOM *Inheritance Corollary*, the thematic domain of a complex expression may only include the thematic entailments of its head predicate and those of the complements of the head predicate. In the case of a complex noun phrase complement, percolation of the thematic entailments of the noun sentential adjunct will thus be blocked. Consequently, no account for instances of CNPC violation as in (54) will be possible on the assumption that dislocated phrases in Spanish are quasi-adjuncts. What is needed then is a type of quasi-adjunct which has access to any thematic entailment occurring within the sentence with which it combines, and not just those roles contained within the $\theta$-DOM of the sentence. A phrasal type of this sort will obviously require the addition of a further parameter to the classification in (7-73) concerning the removal of thematic entailments introduced by adjunct constituents (henceforth ADJ-$\theta$-DOM reduction). The resulting classification will yield eight phrasal types as shown in (7-74) where the specification *quasi-adjunct** in 7 characterizes a quasi-adjunct which has the faculty of removing thematic entailments introduced by adjuncts.

(7-74)

| | ARGUMENT REMOVAL | $\theta$-DOM REDUCTION | ADJ-$\theta$-DOM REDUCTION |
|---|---|---|---|
| 1. ? | + | + | + |
| 2. argument phrases | + | + | − |
| 3. ? | + | − | + |
| 4. ? | − | + | + |
| 5. quasi-arguments | + | − | − |
| 6. quasi-adjuncts | − | + | − |
| 7. quasi-adjuncts* | − | − | + |
| 8. adjuncts | − | − | − |

Of the remaining seven specifications, those in 2, 5, 6 and 8 correspond to the phrasal types which can be defined solely in terms of the two parameters ARGUMENT REMOVAL and $\theta$-DOM REDUCTION (cf. (7-73)).

Prima facie, the additional three phrasal type specifications in 1, 3 and 4 would appear to create gaps in the classification. For example, 1 should be ruled out as a violation of the *biuniqueness* condition — in LFG terms — as it allows an argument phrase to be functionally related to two distinct roles (i.e. one through $\theta$-DOM REDUCTION, and the other through ADJ-$\theta$-DOM REDUCTION). However, I believe that if we consider dependencies such as those involving parasitic gaps where biuniqueness is known to fail (at least in theories of grammar which do not allow empty operators to bind argument positions), the kind of phrasal functionality expressed in 1 cannot be ruled out. In sentences containing parasitic gaps such as the one in (7-75), a *wh*-phrase is allowed to satisfy the argument position of the main clause and to bind an argument position in the adjunct clause; this configuration matches exactly the phrasal type specification in 1.

(7-75) *Which article* did you file __ without reading __?

Moreover, if we take into account the occurrence of parasitic gap constructions in languages where the displaced phrase which acts as a bivalent operator is a quasi-adjunct, there is a clear sense in which the specification in 4 where joint occurrence of $\theta$-DOM and ADJ-$\theta$-DOM reduction involves no argument removal is also needed. Finally, the phrasal type specification in 3 may provide a characterization of "subcategorized adjuncts" — i.e. obligatory adverbial phrases — as in the English middle construction, e.g. *Bureaucrats bribe*(with little effort)*. Therefore it may well be the case that none of the specifications in (7-74) are superfluous, as indicated in (7-76) by filling the question marks of the chart with illustrative instances of the seemingly dubious functional specifications.

(7-76)

| | ARGUMENT REMOVAL | $\theta$-DOM REDUCTION | ADJ-$\theta$-DOM REDUCTION |
|---|---|---|---|
| 1. parasitic gaps with argument filler | + | + | + |
| 2. argument phrases | + | + | − |
| 3. parasitic gaps with quasi-adjunct filler | + | − | + |
| 4. obligatory adjuncts | − | + | + |
| 5. quasi-arguments | + | − | − |
| 6. quasi-adjuncts | − | + | − |
| 7. quasi-adjuncts* | − | − | + |
| 8. adjuncts | − | − | − |

The functional classification presented in (7-76) requires that thematic entailments introduced by adjuncts be represented in the sign structure of the expressions which they modify. To do so, the $\theta$-DOM attribute of a sign could be encoded as a subdomain of a larger structure which includes the thematic entailments of all the expressions contained in the sign (e.g. complement as well as adjuncts). This larger structure will be referred to as D-$\theta$-DOM, short for 'discourse domain of thematic entailments'. As shown in (7-77), the D-$\theta$-DOM of a sign is defined as a binary structure consisting of a $\theta$-DOM and an ADJ-$\theta$-DOM (i.e. the domain of entailments introduced by adjunct phrases).

$$(7\text{-}77)\quad \textit{complex\_ind} \Rightarrow \begin{bmatrix} \textbf{var} & = \textit{sort} \\ \text{D-}\theta\text{-DOM} & = \begin{bmatrix} \theta\text{-DOM} & = \langle \ldots \rangle \\ \text{ADJ-}\theta\text{-DOM} & = \langle \ldots \rangle \end{bmatrix} \end{bmatrix}$$

The inheritance of thematic entailments introduced by adjunct phrases involves a transfer of roles from the $\theta$-DOM of the adjunct to the ADJ-$\theta$-DOM of the head expression. Consider again the Spanish example in (7-10), here repeated as (7-78).

(7-78) *El dinero,* acepto la pretensión de que *lo* tienen ya
the money accept-I the pretension of that it(CLITIC) have-they already
"The money, I accept the pretension that they have it already" [Rivero 80]

Following the account of relative clause formation commonly adopted in categorial grammar, a restrictive relative clause is treated as a noun modifier, and the head noun is type raised as schematically shown in (7-79).

(7-79) a

$$\begin{bmatrix} \textbf{phon} = \boxed{1} \\ \textbf{cat} = \left[\textbf{catn} = \textit{noun}\right] \Big/ \begin{bmatrix} \textbf{phon} = \boxed{1} \\ \textbf{catn} = \left[\textbf{catn} = \textit{noun}\right] \Big/ \begin{bmatrix} \textbf{phon} = \textit{pretensión} \\ \textbf{catn} = \textit{noun} \end{bmatrix} \\ \textbf{sem:ind:}\text{D-}\theta\text{-DOM:}\theta\text{-DOM} = \langle \boxed{2} \rangle \end{bmatrix} \\ \textbf{sem:ind:}\text{D-}\theta\text{-DOM:ADJ-}\theta\text{-DOM} = \langle \boxed{2} \circ \ldots \rangle \end{bmatrix}$$

b
$$\begin{bmatrix} \textbf{phon} = \boxed{3} \frown \textit{de} \frown \textit{que} \frown \textit{lo tienen} \frown \textit{ya} \\ \textbf{cat} = \textit{noun} \Big/ \begin{bmatrix} \textbf{phon} = \boxed{3} \\ \textbf{catn} = \textit{noun} \end{bmatrix} \\ \textbf{sem:ind:}\text{D-}\theta\text{-DOM:}\theta\text{-DOM} = \left\langle \left[\textbf{pred} = \textit{p-pat}\right] \right\rangle \end{bmatrix}$$

Because the object of the relative clause is realized as a clitic, the $\theta$-DOM of the relative clause sign in (7-79b) encodes a proto-patient entailment. When the two signs in (7-79) combine, the role entailment of the relative clause will instantiate the tag $\boxed{2}$ in the argument $\theta$-DOM of the head noun sign, and will therefore become a member of the ADJ-$\theta$-DOM in the resulting complex noun sign, e.g.

$$\text{(7-80)} \quad \begin{bmatrix} \textbf{phon} = \textit{de} \frown \textit{que} \frown \textit{lo tienen} \frown \textit{ya} \\ \textbf{catn} = \textit{noun} \\ \textbf{sem:ind:}\text{D-}\theta\text{-DOM:ADJ-}\theta\text{-DOM} = \left\langle \left[\textbf{pred} = \textit{p-pat}\right] \right\rangle \end{bmatrix}$$

This is because the thematic entailments contained in the argument $\theta$-DOM of the head noun are included in the result ADJ-$\theta$-DOM, as indicated in (7-79a) by repeated occurrence of the tag $\boxed{2}$. From now on the percolation of the proto-patient entailment will proceed from ADJ-$\theta$-DOM to ADJ-$\theta$-DOM until reaching the ADJ-$\theta$-DOM for the sentential sign in (7-81).

$$\text{(7-81)} \quad \begin{bmatrix} \textbf{phon} = \textit{acepto} \frown \textit{la} \frown \textit{pretensión} \frown \textit{de} \frown \textit{que} \frown \textit{lo tienen} \frown \textit{ya} \\ \textbf{catn} = \textit{sent} \\ \textbf{sem:ind:}\text{D-}\theta\text{-DOM:ADJ-}\theta\text{-DOM} = \left\langle \left[\textbf{pred} = \textit{p-pat}\right] \right\rangle \end{bmatrix}$$

All that is needed at this point to provide an account of the CNPC violation in (7-78) is to allow dislocated phrases in Spanish to be characterized as quasi-adjuncts*. This can be easily done by introducing a unary rule which turns quasi-adjuncts (as resulting from application of rule (35) to argument phrases) into quasi-adjuncts*, as shown in (7-82) for the dislocated phrase *el dinero*.

(7-82) a.

$$\left[\begin{array}{l} \text{phon} = \left[\begin{array}{l} \text{ord} = \text{RC} \\ \text{phon1} = \textit{el dinero} \\ \text{phon2} = \boxed{1} \end{array}\right] \\ \text{catn} = \text{name} = \textit{sent} \Big/ \left[\begin{array}{l} \text{phon} = \boxed{1} \\ \text{catn} = [\text{catn} = \textit{sent}] \\ \text{sem:ind:D-}\theta\text{-DOM} = \left[\begin{array}{l} \theta\text{-DOM} = \langle \ldots \boxed{2} \ldots \rangle \\ \text{ADJ-}\theta\text{-DOM} = \langle \boxed{3} \rangle \end{array}\right] \end{array}\right] \\ \text{sem:ind:D-}\theta\text{-DOM} = \left[\begin{array}{l} \theta\text{-DOM} = \langle \ldots\ \ldots \rangle \\ \text{ADJ-}\theta\text{-DOM} = \langle \boxed{3} \rangle \end{array}\right] \end{array}\right]$$

$$\Downarrow$$

b.

$$\left[\begin{array}{l} \text{phon} = \left[\begin{array}{l} \text{ord} = r \\ \text{phon1} = \textit{el dinero} \\ \text{phon2} = \boxed{1} \end{array}\right] \\ \text{catn} = [\text{catn} = \textit{sent}] \Big/ \left[\begin{array}{l} \text{phon} = \boxed{1} \\ \text{catn} = [\text{catn} = \textit{sent}] \\ \text{sem.ind:D-}\theta\text{-DOM} = \left[\begin{array}{l} \theta\text{-DOM} = \langle \boxed{4} \rangle \\ \text{ADJ-}\theta\text{-DOM} = \langle \ldots \boxed{2} \ldots \rangle \end{array}\right] \end{array}\right] \\ \text{sem:ind:D-}\theta\text{-DOM} = \left[\begin{array}{l} \theta\text{-DOM} = \langle \boxed{4} \rangle \\ \text{ADJ-}\theta\text{-DOM} = \langle \ldots\ \ldots \rangle \end{array}\right] \end{array}\right]$$

The rule applies by default following unification failure. If the $\theta$-DOM of the sentence with which the dislocated phrase combines contains a thematic entailment which is compatible with the role introduced by the dislocated phrase, the rule in (7-82) will not apply. In this case, the quasi-adjunct specification in (7-82a) will be chosen; dislocation will involve $\theta$-DOM reduction, as in (7-83) where the proto-patient entailment accessed by the dislocated phrase originates from a complement phrase.

(7-83) *El dinero,* acepto que pretendan que *lo*
the money accept-I that should-pretend-they that it(CLITIC)
tienen ya
have-they already
"The money, I accept that they should pretend that they have it already"
[Rivero 80]

If no compatible thematic entailment is found in the $\theta$-DOM of the sentential sign, the rule in (7-82) will apply enabling the dislocated phrase to function as a quasi-adjunct* (cf. (7-82b)). Dislocation will thus involve reduction of the argument ADJ-$\theta$-DOM (eg the ADJ-$\theta$-DOM of the sentential sign in (7-81)). In this case, the dislocated phrase will be related to a thematic entailment which originates from an adjunct constituent, as in the Spanish sentence in (7-78) where the left dislocated object is functionally related to the relative clause across a complex noun phrase island. The different behavior of dislocated phrases in Spanish and Italian with respect to strong island constraints can therefore be reduced to the question of which areas of a sentence D-$\theta$-DOM a dislocated phrase can access, as stated in (7-84).

(7-84) a *Italian clitic dislocation*
A dislocated phrase must have access to a compatible participant role within the $\theta$-DOM of the sentence with which it combines.

b *Spanish clitic dislocation*
A dislocated phrase must have access to a compatible participant role within the D-$\theta$-DOM of a sentence (i.e. either the $\theta$-DOM or ADJ-$\theta$-DOM of the sentence).

Note that the characterization of dislocation in Spanish given in (7-84b) can potentially be utilized to provide an account of LD dependencies. In particular, the immunity of LD dependencies to strong island constraints would be derived in terms of thematic access to the ADJ-$\theta$-DOM. Of course, a few modifications of (7-84b) are necessary to give a precise characterization of LD, e.g. to secure that only NPs (e.g. not PPs) may partake of LD structures and to prevent multiple displacements. The integration of these modifications with (7-84b) is nevertheless straightforward in that it does not involve destructive changes. We may thus conclude that the approach to verb semantics developed in the previous chapters minimally augmented with the notion of D-$\theta$-DOM can be made to provide a parametrized characterization of all major dislocation phenomena.

## 7.4 Summary

Clitic doubling and dislocation provide a clear example of how the traditional distinction between arguments and adjuncts alone fails to provide an exhaustive characterization of non-head constituents. In this chapter the proposal was broached to bridge this gap by allowing the syntactic and semantic properties of arguments and adjuncts to interleave freely so as to obtain a richer functional classification of non-head constituent types. This proposal was shown to have a precise syntactic, semantic and computational interpretation within the UCG framework developed in the previous chapters. The resulting approach provides an analysis of clitic doubling and dislocation for Italian which can be easily parametrized to account for analogous phenomena in other languages, and which can be profitably extended to yield a treatment of null-subject phenomena.

# Chapter 8

# Conclusion

The main objective of this thesis has been to develop an approach to verb semantics, category specification, and predicate-argument combination where the typology of sentence-level syntactic dependencies found in natural languages can be largely rendered by interleaving information relative to thematic and subcategorization properties of lexical predicates. In the last four chapters, the properties of this approach to grammatical relations were demonstrated with reference to specific phenomena across a variety of languages. To conclude, I would like to highlight the core themes developed in these chapters and provide an overall picture of the resulting framework.

The idea which has served as leitmotive throughout this work is that grammatical relations are syntactic reflexes of thematic properties of verb meanings and combinatory relations which form the basis for the semantic compositionality of sentences. In the thesis, these concerns are expressed by developing a treatment of verb semantics in which thematic roles provide a necessary layer of semantic interpretation in combining verbs with their arguments. This treatment is realized within an event-based system of semantic interpretation where verbs denote properties of eventualities, and thematic roles are relations between eventualities and individuals or propositions. Thematic properties of verbs are encoded as necessary thematic entailments of verb meanings. Accordingly, the thematic structure of a predicate is defined as the domain of participant roles entailed by the predicate. The combination of a verb with one of its arguments involves instantiation and removal of a participant role in thematic domain of the verb, and integration of the instantiated thematic entailment with the semantics of the verb.

Thematic instantiation is computed on the basis of four basic types of thematic roles: *proto-agent*, *proto-patient*, *prepositional* and *propositional* roles. The proto-agent and proto-patient roles are defined in terms of lexical entailments which distinguish between the most and least agentive argument roles of a predicate by reproducing the basic insights of Dowty's treatment of thematic roles as semantic defaults ([Dowty 87]) within a neo-Davidsonian approach to verb semantics. Prepositional roles correspond to prepositional predicates (e.g. *to, in, from*), while the propositional role encodes the thematic relation between a matrix verb and its sentential complement as a relation between eventualities and propositions, e.g. $[e_1]prop(e_1, [walk(e_2) \wedge p\text{-}agt(e_2, john)])$. The identification of proto-roles is established for each choice of predicate by imposing an ordering on thematic entailments such that the proto-agent is the innermost role entailment in the thematic domain of the predicate and the prepositional role the outermost, e.g. $<$ @PREP $\circ$ @P-PAT $\circ$ @P-AGT $>$, $<$ @P-PAT $\circ$ @P-AGT $>$.

Subcategorization properties of verbs are derived through linking conventions which establish a relation between the thematic entailments in the thematic domain of a verb and its category structure. The specification of category structure is modelled according to a categorial grammar calculus. This approach to category specification makes it possible to relate the ordering of role entailments encoded in the thematic domain of a verb to the order in which predicate and argument phrases are combined in syntax, e.g.

$$(8\text{-}1)\quad \begin{bmatrix} \mathbf{cat} = \begin{bmatrix}\mathbf{catn} = sent\end{bmatrix} / \begin{bmatrix}\mathbf{catn} = np \\ \mathbf{sem} = \boxed{1}\end{bmatrix} / \begin{bmatrix}\mathbf{catn} = np \\ \mathbf{sem} = \boxed{2}\end{bmatrix} / \begin{bmatrix}\mathbf{catn} = np \\ \mathbf{sem} = \boxed{3}\end{bmatrix} \\ \mathbf{sem{:}ind{:}}\theta\mathbf{\text{-}dom} = \langle \boxed{3}\text{@PREP} \circ \boxed{2}\text{@P-PAT} \circ \boxed{1}\text{@P-AGT} \rangle \end{bmatrix}$$

The projection of order relations from the thematic domain of a predicate to the category structure of the predicate defines grammatical relations such as subject, direct and indirect/oblique object:

- the subject is the innermost active sign in the category structure of a verb
- the direct object is the next outer active sign in the category structure of a verb
- the indirect/oblique object is outermost active sign in the category structure of a verb which instantiates a prepositional predicate

The linking conventions which realize this projection are defined in terms of functional specifications induced by morphosyntactic rules and argument selection constraints. Argument selection constraints consists of *role association* and *role realization* constraints. Role association constraints establish links between thematic entailments and subcategorized argument. In English, for example, role association constraints establish a one-to-one relation between thematic entailments and subcategorized argument phrases:

(8-2) ROLE ASSOCIATION *English*
All syntactic arguments of a predicate must be linked to a unique role, and all entailed roles to a unique syntactic argument.

The range of linking options available through role association (i.e. alternative orderings of thematically linked arguments in the category structure of verbs) is reduced through operations on predicate signs induced by morphosyntactic rules. Role realization constraints ensure that the links established through the intersection of functional specifications derived from role association and morphosyntactic rules reflect the ordering of roles in the thematic domain of verbs:

(8-3) a PROTO-AGENT ROLE REALIZATION (P-AGT REAL)
If the Proto-Agent role of a predicate is syntactically realized, then it must be linked to innermost active sign in the category structure of a verb sign

b PROTO-PATIENT ROLE REALIZATION (P-PAT REAL)
If the Proto-Patient role of a predicate is syntactically realized, then it must be linked to the innermost subcategorized NP immediately following the active sign linked to the Proto-Agent role, if there is one.

An account of cross-linguistic variation concerning the syntactic realization of entailed roles is obtained by parameterizing argument selection constraints. For example, role association constraints can be formulated in such a way that the range of thematic entailments which are encoded as subcategorized argument can be made sensitive to language-specific requirements. In syntactically ergative languages — where the ergative phrase can be analyzed as a thematically bound adjunct on the basis its oblique status, omissability and similarity to the agent phrase of passives ([Wierzbicka 81, Kiparsky 87]) — role association is not encoded for the proto-agent role:

(8-4) ROLE ASSOCIATION (*ergative languages*)
All syntactic arguments of a predicate must be linked to a unique role, and all entailed roles other than the proto-agent to a unique syntactic argument

In null-anaphora languages such as Japanese where a verb alone can form a sentence without the intervention of agreement markers which function as arguments, role association can be dispensed with altogether. The central idea is that the relation between a predicate and its entailed participant roles can be realized either through an adjunct or argument mode of syntactic combination. Alongside the traditional argument-adjunct distinction, a new functional category is thus introduced which expresses the relation between a predicate and a syntactic adjunct which satisfies one of the predicate's thematic entailments (a *quasi-adjunct*).

The definition of thematic domain developed in the thesis provides also a partial characterization of locality conditions on syntactic dependencies. For example, sensitivity to strong island constraints for both arguments and quasi-adjuncts is derived by enforcing a regime of inheritance according to which the thematic domain of a predicate includes the thematic entailments of its entailed participant roles (i.e. the $\theta$-DOM Inheritance Corollary of §7.2). In addition, the range of functional dependencies is extended by augmenting the thematic structure of a predicate with an *adjunct thematic domain* (ADJ-$\theta$-DOM) containing thematic entailments which the predicate inherits from its adjuncts and the ADJ-$\theta$-DOM of its entailed roles. This augmentation makes it possible to characterize thematic dependencies which are not sensitive to strong island constraints. The resulting framework provides a rich typology of functional dependencies based on three parameters: satisfaction of a syntactic argument, satisfaction of a role entailment contained the thematic domain, satisfaction of a role entailment contained in the adjunct thematic domain:

(8-5)

| | ARGUMENT REMOVAL | $\theta$-DOM REDUCTION | ADJ-$\theta$-DOM REDUCTION |
|---|---|---|---|
| 1. parasitic gaps with argument filler | + | + | + |
| 2. arguments | + | + | − |
| 3. parasitic gaps with quasi-adjunct filler | + | − | + |
| 4. obligatory adjuncts | − | + | + |
| 5. quasi-arguments (e.g. cliticization, agreement in NSLs) | + | − | − |
| 6. quasi-adjuncts (e.g. clitic dislocations, agent phrases, argument-verb dependencies) in null-anaphora languages) | − | + | − |
| 7. quasi-adjuncts* (e.g. dislocation) | − | − | + |
| 8. adjuncts | − | − | − |

For most of the categories resulting from this classification, there is no accepted name; their identification can only be exemplified in terms of specific constructions. This is partly because the dependencies they instantiate have either been dealt with in terms of extraction (often with questionable results), or ignored altogether. The framework developed in this thesis provides an alternative view according to which all these dependencies can be encoded at the lexical level.

With respect to argument dependencies, a refinement of the subject/object distinction is obtained by bringing aspectual information to bear on the assignment of proto-roles to predicates. The basic idea is that argument roles can be classified into those which promote an object-to-event homomorphism and those which do not. The deciding factor is stated in terms of compatibility with a thematic specification which is lower than that of a proto-agent. This characterization involves the assignment of a default proto-role to the subject of unaccusatives; this assignment is driven by aspectual considerations:

(8-6) PROTO-ROLE ASSIGNMENT TO UNACCUSATIVE PREDICATES
The proto-role of an intransitive verb whose aktionsart is either stative or eventive and unspecified with respect to telicity is a default proto-agent.

Consequently, three thematic varieties of subject phrases can be distinguished:

- subject phrases linked to a proto-agent role (e.g. transitive and unergative subjects)
- subject phrases linked to a proto-patient role (e.g. passive subjects)
- subject phrases linked to a default proto role (e.g. unaccusative subjects)

This tripartite distinction was proved to be linguistically motivated both with respect to syntactic and morpholexical functionality.

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