Determination and Quantification*

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1 Coverage

The notion of 'determination' to be investigated in the present chapter concerns the occurrence (or lack, in 'Ø-determination' conditions) of morpho-syntactic items of a given class, the determiners, acting as dependents of nominal heads [1]. Precisely, the elements of that class as intended here are adnominal expressions that share an intuitively uniform semantic function:

> Determiners ...specify the range of reference of a noun in various ways, e.g. by making it definite (*the boy*), indefinite (*a boy*), or by indicating quantity (*many boys*).
>
> Leech & Svartvik (1975: p. 225)

Of course, referential and quantificational properties and their interrelations are far from being clear a priori and their account may vary according to the philosophical views and the theoretical framework assumed. We will come back to the issue afterwards, drawing on research results available from formal semantics, especially in section 2.1. For the moment, we take for granted some pre-theoretical understanding of the semantic function mentioned above and we characterize informally our determination coverage in terms of a relevant typology of morpho-syntactic items, on the lines of the well-established

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[1] We will stick to the traditional, although not uncontroversial assumption that the constituent made up by a determiner and its nominal sister be nominally headed. For criticism against the alternative view (the so-called 'DP Hypothesis'), see Coppen (1991), Payne (1993), Pollard & Sag (1994: § 9.4.3), Sadler & Arnold (1994), Van Langendonck (1994), Allegranza (in press), among others.

descriptive grammar of English by Quirk et al. (1985) and related work (e.g. Leech & Svartvik 1975). Mutatis mutandis, the feasibility and usefulness of applying the same classificatory apparatus to the determination systems of various other languages has been confirmed by a cross-linguistic investigation that we have carried out within the project MLAP 93-15 and in collaboration with language-specific projects, covering altogether a broad selection of Germanic and Romance languages of the European Union [2].

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A reasonable coverage of the English determiners, essentially as they are understood in the descriptive linguistic literature in question, should consider at least the following six 'paradigmatic' varieties [3]:

articles – *the*, *a*(*n*);

demonstratives – *this*, *that*, *these*, *those*;

possessives – *my*, *your*, *his*, *her*, *its*, *our*, *their*;

quantitatives [4] – the universal (e.g. *every*), existential (e.g. *some*), negative (e.g. *no*) and degree (e.g. *many*) determiners of quantity/amount;

cardinals – the numerals *one*, *two*, *three*, ...;

ordinals – the numerals *first*, *second*, *third*, ..., and the non-numeral ordinals [5].

Articles apart, these varieties can be extended to items whose distribution is pronominal rather than adnominal, inasmuch as they appear to occur without the nominal head they should depend on. In English, the same forms are used both ways in the case of demonstratives, cardinals, ordinals and a subset of quantitatives, whereas possessives and other quantitatives distinguish

[2]In the current chapter we will have nothing to say about EU languages of other families. The readers interested in the determination systems of Finnish and Greek are referred to Chesterman (1991) and Kolliakou (1996), respectively.

[3]We are using 'paradigmatic' as opposed to 'syntagmatic', in a broad Saussurian sense, without implying that the varieties under consideration must be morphological paradigms proper. Moreover, it is worth noticing that Quirk and his co-workers include among the determiners also **multipliers** (*double*, *twice*, *three times*, etc.), **fractions** (*one-third*, *two-fifths*, etc.) and **wh-determiners** (*whose*, *what*, *whichever*, etc.); we think these further varieties and their peculiarities, such as compounding and *wh* properties, can be left out of the present coverage without altering the overall scenario, but in principle they are compatible with future extensions of our work.

[4] The denomination commonly used by Quirk and his co-workers is 'quantifiers', but we prefer to avoid any danger of confusion with the logico-semantic notion of quantifiers (cf. section 2.1 below).

[5]Namely, "'general ordinals' ...like *next*, *last*, *past*, (*an*)*other* ..., which resemble the ordinal numerals grammatically and semantically" (Quirk et al. 1985: p. 262) and thus are simply grouped with the latter here.

specific pronominal forms from the corresponding adnominal ones (e.g. *mine* vs. *my*, *everybody* vs. *every*). If a pronominal occurrence/form is literally taken as heading or replacing the noun phrase, then it is out of our determination coverage, because its function is not that of determiner according to the characterization adopted at the beginning[6]. On the other hand, if 'empty elements' with suitable syntactic and semantic properties were postulated, the treatment that we will offer here for the determiners of overt nominal heads could equally be applied to 'pronominal' items of the same varieties as implicitly adnominal – that is, determiners of empty nominal heads (cf. Nerbonne et al. 1989, for instance). The alternative holds also for *of*-partitives introduced by the pronominal counterpart of some determiner (like *all of...*, *none of...*, *many of...*, *two of...*, *the first of...*, etc.), since the *of*-PP can be viewed as dependent either of the pronominal itself or of an empty nominal head, according to the treatment[7]. We postpone a discussion of these issues to future work.

Furthermore, it has to be remarked that in the current contribution we do not take up a definite position concerning the question as to how the six-term classification above bears on the morpho-syntactic notion of 'part of speech'[8]. E.g., we identify a certain empirical variety of expressions by the pre-theoretical term 'cardinal', whether this or some hyperonym represents their part of speech. More generally, we would like to emphasize that the determiner notion too need not have part-of-speech status in our approach, being meant to identify a class of expressions ultimately on semantic grounds, as we mentioned at the beginning. Thus, one should not be surprised if determiners were morpho-syntactically heterogeneous like some other semantically identifiable class of expressions occurring within the noun phrase, say the restrictive adnominal modifiers, which belong to or, rather, are projected by different parts of speech (there are at least restrictive adjectives, PPs and relative clauses). Indeed, in the descriptive grammatical and lexicographic

[6]There are obviously various referential and quantificational aspects in common, but this holds for ordinary nouns too (v. sections 2.3 and 3.2 below).

[7]Moreover, the role of such an *of*-PP should be discussed in relation to partitive-like expressions with a 'quantitative noun', e.g. "the *majority* of...", "*lots* of...", "two *bottles* of...", "all the *rest* of...", "a great *number* of...", etc. We agree with Zelinsky-Wibbelt (1988) that constructions of the kind ('classifier constructions' in her terminology) form syntactically a plain noun phrase projected by the quantitative noun, whose predicate-argument structure one should investigate to shed light on the semantics of the relation between the noun itself and its *of*-PP dependent. We don't think the assumption is contradicted by examples like *Lots of food was on the table*, where the verb agrees with the second noun and not with the first, since this can be considered just an instance of 'short-distance concord' by-passing dependency relations (as shown in completely different constructions: cf. *Neither they nor Jack was able to come*).

[8]That is, "an $\bar{X}$-theory category stripped of bar level information" (Pollard & Sag 1994: p. 22), such as Noun, Verb, Adjective, etc.

tradition of various languages, only the article is considered a specific part of speech [9], while the remaining determiners are generally reckoned among adjectives or pronouns. An alternative approach is found in more recent studies based on generative grammar, where a category Determiner, Det or D, with part-of-speech status, is commonly taken for granted, although there appears to be no received characterization comparable to those of other parts of speech, so that the relevant coverage varies quite considerably depending on the authors. For the purpose of the present volume, it seems only wise to eschew such a controversial subject and leave to the people working on a given language the task of deciding the part(s) of speech of determiners in that language [10].

Now, let us look at determination data in a 'syntagmatic' perspective, based on the left-to-right ordering of two or more co-occurring items with determinative function relative to (projections of) the same noun. In this connection, as shown for English by Quirk et al. (1985), the determiners of the six varieties assumed before can be distributed in three positional classes, I. **predeterminers**, II. **central determiners** and III. **postdeterminers**:

> The three classes of determiners have been set up on the basis of their position in the noun phrase in relation to each other. Thus we do not find central determiner + predeterminer (* *their all trouble*), or postdeterminer + central determiner + predeterminer (* *five the all boys*), but only the order I + II + III given above: *all their trouble*, *all the five boys*. (ibid., p. 253)

To sum up, predeterminers can precede but cannot follow the determiners of other classes, postdeterminers can follow but cannot precede the determiners of other classes, and the relative position of central determiners results as a consequence. On the other hand, the three positional classes need not be equally restrictive as regards the co-occurrence of members of the same class: as mentioned by Quirk et al. (1985: p. 254), central determiners "are mutually exclusive with each other, i.e. there cannot be more than one occurring before the noun head", whereas the constraint does not hold at least for post-determiners (cf. our discussion in section 2.2 below). Lack of space prevents us from offering an exhaustive description of how determiners get classified according to the three-position pattern in the various EU languages that we have taken into account for our research, but some examples should suffice to give a fairly clear idea of both the constants and the range of variation in the field.

[9]It was already one of the eight classical parts of speech acknowledged by the ancient Greek grammarians.

[10]E.g., as done by Allegranza (in press) for Italian, where a distinction can be drawn between the determiners with adjectival behaviour and the articles or similar.

To start with, the articles are the most typical central determiners in Germanic and Romance languages [11], so that the mutual exclusion constraint previously mentioned implies that the only central determiner that a noun can take as dependent is either the definite / indefinite article or some alternative determination item with the same distribution. Normally, the central determiner precedes the noun, whether immediately or not. A partial exception is the definite article of Danish, which occurs as an enclitic form affixed to the head noun (see (1b) below) when there is no preceding central determiner, postdeterminer or qualifying adjective. However, the standard prenominal position of central determiners, which is the only possible position for the indefinite article (cf. (1a)), is required for an alternative form of the definite article, used when another adnominal expression interposes before the noun (in (1c-d), e.g.) [12].

(1) a. et hus (= a house)
b. huset (lit. 'house-the' = the house)
c. det røde hus (= the red house)
d. det første hus (= the first house)

Being in mutual exclusion with the prenominal articles and the other central determiners of Danish (such as demonstratives, possessives, etc.), the enclitic article can be considered a central determiner despite its peculiarity; moreover, central determiner status is compatible with the previous occurrence of a predeterminer, as in *alle drangene* (lit. 'all boys-the' = all the boys).

Although the classification system that we have adopted works somehow for all the languages we deal with, the positional class of determiners belonging to a certain 'paradigmatic variety', such as the possessives, may differ depending on the language. Cf. these data:

(2) a. (*the) my book
b. (*my) the book

(3) a. (*le) mon livre
b. (*mon) le livre

(4) a. il mio libro
b. (*mio) il libro

[11] Of course, many languages of other families lack the articles altogether, but we will not address the issue, as the only EU language without article – namely Finnish – is not part of our current coverage (v. also fn. 2).

[12] A more complex solution is adopted by Swedish, because in the same situation the prenominal form of the definite article is used not as an alternative, but in addition to the occurrence of the enclitic form. This phenomenon (and Swedish in general) will be neglected here, but could be accounted for by allocating to different positional classes the two article forms in that language.

In English and French, as the examples (2) and (3) show, possessive determiners are distributionally equivalent to the article, hence central. But their postdeterminer status in Italian is revealed by (4) since the equivalent of (2a) and (3a), i.e. (4a), is grammatical when the possessive co-occurs with the definite article, whereas in the same conditions (4b) remains as ungrammatical as (2b) and (3b). Referentially, possessive determination in central position makes the noun phrase definite; that is to say, *my book* corresponds to *the book of mine*, not *a book of mine*. On the contrary, possessive postdetermination is referentially compatible with all sorts of central determiners (cf. "*questo/ogni/un/nessun/*... mio libro" = this/every/a/no/... book of mine). Note also that possessive postdeterminers in Italian can follow the noun (v. "il libro *mio*") and this indeed is their only position in Spanish. Spanish is particularly interesting, as it makes available two alternative systems of possessive determination:

- *mi*, *tu*, *su*, ... are central determiners ("*mi* casa"= my house);
- *mío*, *tuyo*, *suyo*, ..., when used adnominally, are postnominal postdeterminers ("aquellos/unos amigos *tuyos*" = those/some friends of yours).

The possibility that determination items belonging to a certain paradigmatic variety in a given language may differ from each other as regards syntagmatic behaviour, being distributed in different positional classes, is normally exploited by quantitative determiners. For instance, in English:

- quantitatives with 'universal' logical meaning [13] are central determiners, like *each*, or predeterminers, like *all*;
- other quantitative central determiners are logically 'existential', like *some*, or negative, like *no*;
- quantitative degree/proportion of various sorts is expressed by postdeterminers, like *few*, and again by central determiners, like *enough*.

In other languages, the corresponding determiners look equally heterogenous w.r.t. positional options, though with some language-specific variations. So, French typically translates English quantitative degree determiners like *many* and *few* as *de*(= of)-partitive constructions with degree adverbs: *beaucoup de...*, *peu de...* . It remains to be seen whether such French constructions can be treated as a case of determination, modulo adnominal rather than

[13] The logicians' universality notion pertinent here is always relative to the 'world model' under consideration, which may well be rather small, depending on the context. Furthermore, quantification in natural language is restricted to the domain denoted by the nominal the determiner applies to, as we will show in section 2.1. Then also the predeterminer *both* can be assigned 'universal' meaning, under the presupposition that the quantification domain be a set of two elements (Barwise & Cooper 1981).

pronominal interpretation of the degree item, but this is a kind of issue that we have decided to leave aside in the present work, as already made clear for English *of*-partitives.

Compared with quantitatives, cardinals are considerably more homogeneous in positional terms, being generally postdeterminers, although in various languages the singular cardinal – expressing 1 – takes the same form as the indefinite article and tends to behave in the same way also syntagmatically, their (subtle) difference being essentially a semantic matter[14]. A common feature of cardinal and quantitative determiners is that both can easily be expanded into more or less complex phrases by 'adverbial' dependents, as in *almost seven/every*, *at least five/some*, *approximately twenty*, *very many*, *hardly any*, *not one/all*, etc. (cf. also Van Eynde 1994: § 3.1.1). Other cases of phrasal structure projected by these determination items result from coordination (especially of cardinals, but see also *all and only*), or because suitable quantitatives are combined with cardinals in comparative constructions like (*no*) *more/less than twenty* (v. Pollard & Sag 1994: § 9.4.3, for discussion). However, the focus here will be on the syntactic and semantic role that a full determiner plays within the NP, irrespective of the internal complexity of that determiner in terms of word or phrase structure. Thus the above-mentioned phenomena of phrasal structure of a determination expression, as well as those found with other varieties of determiners, such as the use of a Saxon genitive phrase with the same distribution and function of a possessive determiner, will be neglected in this contribution, although basically compatible with the approach that we will propose[15]. In the following, we will keep on referring just to 'determiners' or 'determination items/expressions' without distinguishing between words of the kind and phrases projected by these words, unless the difference is relevant to the argumentation.

2 Theoretical and Empirical Issues

2.1 Background

In formal semantic approaches to natural language that are based on standard First-Order Logic (FOL), quantifiers are variable-binding operators that can be taken to correspond to quantitative determiners like *every* and *some*, but are prefixed to a formula qua counterpart of a whole clause. Hence the

[14]On the contrary, English draws a clear-cut formal distinction between the cardinal *one* and the article *a*(*n*). Besides, the former can follow the definite article, as in *the one book I like best*, and therefore is a postdeterminer rather than a central determiner (Quirk et al. 1985: § 5.21).

[15]On Saxon genitives in HPSG, see Pollard & Sag (1994: pp. 53-54.)

need for a considerably non-compositional mapping from the grammatical form of relevant sentences to the corresponding logical form, if the result is represented through 'logical translations' of the traditional FOL kind. For a more compositional and uniform account of natural language quantification, one needs a quantifier notion corresponding to the interpretation of a noun phrase, as noticed by Barwise & Cooper (1981). Drawing on the branch of mathematical logic known as Generalized Quantifier Theory (GQT), they basically proposed the following correspondences for noun phrases with a determiner and a nominal head as immediate syntactic constituents:

natural language	GQT language
noun phrase	generalized quantifier
syntactic determiner	semantic determiner
nominal head	restriction

The notion of 'generalized quantifier' is ambiguously used to indicate both the logical language counterpart of NP and its denotation according to some model-theoretic interpretation. A denotation is an entity defined within a world model and assigned to a natural or logical language expression in order to elicit the contribution of that expression to the composition of the truth-conditions of the sentences or formulae in which the expression occurs. In mainstream model-theoretic accounts, a generalized quantifier qua denotation is a set of properties, where a property can be accounted for intensionally (following Montague 1974) or, alternatively, through the set of individuals that make up the property's extension (as in the treatment of generalized quantifiers as sets of sets in Barwise & Cooper 1981). Here are some informal examples of NP interpretations conceived accordingly:

> *every man* is interpreted as denoting the set of all properties which every man has; *the king* as denoting the set of all properties such that there is a unique entity which is a king and he has those properties; *a fish* as denoting the set of all properties which some fish has (the union af all the properties of all the fish there are). Partee (1975)

How to relate all of this to truth-conditions, as originally worked out by Montague (1974), appears clearly for a subject-predicate sentence, whose meaning makes it true when the predicate denotation – say, the property of running in the case of *runs* – belongs to the set denoted by the subject. As regards the interpretation of a determiner, it yields a generalized quantifier Q from the denotation A of the nominal head, under the extensional constraint that Q 'lives on' A, i.e., for any set X of elements of the universe of discourse, $X \in Q$ iff $(X \cap A) \in Q$ (Barwise & Cooper 1981). Different determiners bring about different referential effects modulo corresponding ways of 'living on' the denotation of a common noun or distributionally equivalent nominal, thus reflecting the intuitive semantic function of determination as mentioned at the beginning of the chapter.

A related advantage is the broader coverage that generalized quantification achieves, not confined to first-order-definable determiners:

> The transformations employed in standard logic to handle "every" and "some" depend on the fact that any statement about every P or some P is logically equivalent to a statement about everything or something; for example, "Some P is Q" is equivalent to "Something is P and Q". What Barwise and Cooper show is that there is no such transformation for determiners like "most" or "more than half". That is, statements about most P's or more than half P's cannot be rephrased as statements about most things or more than half of all things. Moore (1981)

Hence the impossibility of providing a FOL translation for sentences like *most men run*, whereas a translation with GQT-style quantification restricted to *men* reflects the intended meaning correctly. Moreover, quantification as a mechanism of NP interpretation goes much beyond the explicit occurrence of quantitative determiners, or similar, and can be naturally extended – at least for uniformity's sake – to NPs with Ø-determination, like proper names, mass terms and bare plurals (see below section 2.3). E.g., instead of being treated as a purely referential term denoting an individual, the proper name *John* can be lexically assigned a translation as GQT quantifier, roughly 'the x such that x is John', interpreted as denoting the set of all properties that John has (Montague 1974). A full account of individual reference will additionally involve the "presupposition that the referent ... be identifiable in the utterance context by means of the name *John*" (Pollard & Sag 1994: p. 27), but a comparable need for some pragmatic component – about which we will have little to say here – indeed arises also for handling the deictic properties of determiners, especially demonstratives and possessives (cf. section 3.2 below).

In the HPSG approach by Pollard & Sag (1987; 1994), the essential ideas of generalized quantification are retained, though adapted to a semiotic framework inspired by Situation Theory with its ontology including 'realistic' intensional objects (cf. Barwise & Perry 1983). Actually, the main differences from unrestricted first-order quantification that are emphasized by Pollard and Sag, in their sketch of a logical language for translating the semantic representations of HPSG, need not require any situation-theoretic interpretation:

> First, the variables over which we quantify are always *restricted*: instead of 'for every x, x howls', we have 'for every cat x, x howls'. ... And second, in addition to the determiners 'exists' and 'forall' countenanced by first-order logic, we have a full range of generalized

determiners such as 'most', 'no', 'exactly three', 'more-than-two-but-less-than-seven', etc.

Pollard & Sag (1987: p. 89)

These two, in essence, correspond to the main distinguishing characteristics of Barwise & Cooper's (1981) GQT, even in a purely extensional interpretation (v. the discussion above).

What matters for our purposes, then, is not the issue of how the interpretation of quantification assumed (mostly informally) by Pollard and Sag matches the ontology of situation semantics[16]. Rather, we are interested in the way generalized quantifiers can be expressed by means of the data structures for semantic representation that HPSG offers. The data structures themselves are not ontologically committed, allowing alternative styles of model-theoretic interpretation, as Fenstad et al. (1987) already noticed for their related formalism of 'situation schemata', i.e. "attribute-value pairs where the attributes name things which situations are analyzed in terms of, i.e. RELation, ARGument, POLarity, LOCation, etc. The values are either atoms, which stand for relations, individuals and properties, or situation schemata" (ibid., p. 21). In the same fashion, HPSG representations of type *psoa* ('parameterized state of affairs'), which originate from situation semantics and play a major role in Pollard & Sag's (1994) outline of CONTENT information, will be viewed here just as an unconventional encoding of 'logical form'.[17]

Let us start up with the CONTENT of nouns and their projections (ultimately NPs), that is, a semantic 'nominal object' organized according to the attributes INDEX and RESTR (Pollard & Sag 1994: Ch. 1). The INDEX values are comparable to bound variables of more conventional logical forms, but additionally include semantic agreement features – NUMBER, PERSON and GENDER – which can be assimilated with a system for classifying variables into different 'referential sorts', e.g. variables over individuals vs. variables over 'plural entities'. The fact that such agreement features in HPSG are internal to indices implies that coindexed elements, i.e. elements sharing their INDEX value, always agree[18]. The other information that a nominal CONTENT can include, via the attribute RESTR, is a set of 'psoas' (in the sense mentioned above) expressing a semantic restriction on the index/variable. For a slightly simplified example, see in (5) the *nominal-object*

[16]See Richard Cooper (1990: pp. 125-126, 170) for a critical discussion of that issue. On quantification in situation semantics, cf. also Fenstad et al. (1987), among others.

[17]On the parallelism between situation schemata and logical forms, see further Fenstad et al. (1987: pp. 3-6).

[18]As Pollard & Sag (1994: Ch. 2) discuss in detail, agreement may also involve syntax and pragmatics, in ways that are often largely language-specific. For convenience, here we will neglect such distinctions and enforce agreement by means of the semantic features only.

taken as CONTENT value of the common noun "book". In this case, the restriction set includes a single *psoa*, roughly corresponding to the atomic formula $book(x_1)$.

(5)
$$\boxed{2}\,{}_{\text{nom-obj}}\begin{bmatrix} \text{INDEX } \boxed{1}\,{}_{\text{ref}}\begin{bmatrix} \text{PERSON } \textit{3rd} \\ \text{NUMBER } \textit{sing} \\ \text{GENDER } \textit{neut} \end{bmatrix} \\ \text{RESTR } \left\{ {}_{\text{psoa}}\begin{bmatrix} \text{RELATION } \textit{book} \\ \text{INSTANCE } \boxed{1} \end{bmatrix} \right\} \end{bmatrix}$$

Thus, it is sufficient to add a DET feature with *semantic-determiner* values such as *forall* (∀), *exists* (∃), *most*, etc., depending on the meaning of the syntactic determiner at issue, to get a generalized quantifier of Pollard & Sag's (1994) HPSG, that is, a *quant*-type feature structure, embedding the NP's *nom-obj* as value of a RESTIND feature. E.g.:

(6)
$${}_{\text{quant}}\begin{bmatrix} \text{DET } \textit{forall} \\ \text{RESTIND } \boxed{2} \end{bmatrix}$$

Unlike previous versions of HPSG (cf. Pollard & Sag 1987), the approach in Pollard & Sag (1994) is similar to the revision of Montague Grammar developed by Cooper (1983) in that 'quantifier storage' is applied to deal with quantifier scope ambiguities:

> the storage technique involves putting an NP interpretation on ice for a while until you have interpreted enough of the tree to represent the scope you want to give the NP. At that point you may take the NP-interpretation out of storage and quantify it in. Cooper (1983: p. 55)

In HPSG, what used to be an NP-interpretation according to the classical Montagovian/GQT treatment, that is, a generalized quantifier, starts out in storage as element of the QSTORE set-value of the determiner acting as 'specifier' daughter of NP, in a sense to be made clear soon. Stored quantifiers are transmitted along the structure of a linguistic description according to the Quantifier Inheritance Principle (part of a broader Semantics Principle), which prescribes that the QSTORE value of a mother node is the union of the QSTORE values of the daughter nodes less those quantifiers that are retrieved in a list as RETRIEVED value of the mother node. The scope of quantifiers depends on the node they are retrieved at and on their relative position in the RETRIEVED list (in case of more than one quantifier retrieved at the same node). The retrieved quantifiers are then introduced into the CONTENT of the relevant node modulo the scope-preserving list-value of a QUANTS attribute. The result is a (quantified) *psoa* with the two attributes QUANTS and NUCLEUS, where the value of QUANTS is a list of quantifiers and the value of NUCLEUS is of type *qfpsoa* ('quantifier-free psoa').[19]

Let us now briefly survey the syntactic determination basis of the HPSG treatment of quantification. As we mentioned, a stored *quant* object is transmitted to the NP node from the NP's specifier. The specifier notion stems from Chomsky-style configurational X-bar Theory, but Pollard & Sag (1994: Ch. 9) characterize it in valence terms: a specifier is the non-argumental dependent a head may subcategorize for via the list-valued feature SPR, discharging the element from the SPR list when it is structurally realized. This is relevant to determiners under the assumption that "N′s [i.e. N̄s] are the heads of NPs and subcategorize for their determiners" (Pollard & Sag 1994: p. 50). Following Pollard & Sag (1987: pp. 139-141), the proposed subcategorization accounts for the empirical requirement that singular count nouns, as opposed to mass nouns and plural count nouns, obligatorily take an article or another overt determiner with the same distribution, in English and other languages. Here are some German data from Netter (1994)[20]:

(7) a. der Wein / die Weine / Wein / Weine
 b. das Auto / die Autos / *Auto / Autos

In standard HPSG, the relevant information is simply encoded by the lexical entries (e.g. in the format [SPR< [...] >] for a singular count noun vs. [SPR<([...])>] – with optionality – for a plural or mass noun) and applied through the same Valence Principle that handles argumental dependents.

Appealing though such an approach to determination may look at first sight, there is a related technical issue which deserves further discussion here:

> How does it come about that ... the RESTIND value ... within the content of the determiner is token-identical to the content of the noun? At first blush it might be thought that this identity could be lexically specified within the ... value of the noun['s SPR]. This will not work, however, since if the head noun were modified (say, by relative clauses or attributive adjectives), the semantic contribution of the modifiers would not be taken into consideration in the content of the determiner... Under present assumptions, it is clear that the determiner must in some sense be able to select its N′ sister, in order to 'have its hands on' the N′ sister's content. Pollard & Sag (1994: p. 50)

The result, according to Pollard and Sag's treatment, is a cyclic feature structure in which the head noun and the determiner qua specifier reciprocally select each other. This can be criticized from various angles, as also noticed

[19]This removes a simplification we have implicitly made in our figures, where the QUANTS and NUCLEUS attributes of a *psoa* are omitted. What is shown as *psoa* is actually the NUCLEUS value, i.e. a *qfpsoa*, and [QUANTS< >] must be assumed in addition.

[20]See also Allegranza (in press) on Italian.

by Netter (1994). For one thing, cyclic graphs were explicitly excluded from the HPSG formalism by Pollard & Sag (1987: p. 37). Logical and computational systems compatible with HPSG linguistics and allowing cyclicity have been developed in the while (v. Carpenter 1992), but this property is far from being standardly available, e.g. the ALEP system lacks it (as noticed also by Van Genabith et al. 1994). In general, methodological considerations should favour the formally more restrictive and conceptually simpler acyclic graphs, especially if one can show that the extension of expressive power is not strictly necessary for achieving linguistic adequacy. Linguistically, the prima facie appeal of treating SPR as a valence/subcategorization feature, with consequent exploitation of independently available mechanisms, is weakened inasmuch as also a feature SPEC on the specifier and a corresponding selection principle (the 'SPEC Principle', Pollard & Sag 1994: p. 51) are required because SPR proves insufficient for the purpose of relating head and specifier. Indeed, SPEC lends itself to enforce agreement and other constraints on the two constituents, so that the subcategorization power of SPR becomes rather redundant: all what is needed is a feature to distinguish nominals that lack a specifier (whatever) from the others, as shown by Netter (1994). We will develop an approach of the kind in section 3.

2.2 On Multiple Determination

Despite framework-dependent technical differences, the assumption that a determiner yields a generalized quantifier qua NP-level interpretation from the interpretation of the adjacent nominal head is common to mainstream GQT and HPSG work as discussed so far. However, a problem in this connection (which is simply not addressed by Pollard & Sag 1987; 1994) is how to accommodate multiple determination, that is, the case of two or more co-occurring items with determinative function relative to (projections of) the same noun. In Barwise & Cooper's (1981) GQT system for a fragment of English, e.g., article-numeral combinations as in "*the five* books" are covered by interpreting each *the n* like an unanalyzed determiner whose two parts are purely orthographic. Therefore, two series of cardinals are listed in the basic vocabulary of the system – those with an 'internal prefix' *the* (*the 1*, *the 2*, ...) and those without (*1*, *2*, ...) – while the stand-alone definite article in the singular is disposed of as a mere abbreviation for *the 1*. Such a treatment is clearly ad hoc and cannot be extended in a sensible way to more complex combinations (which are neglected by Barwise & Cooper 1981), as in "*the first five* books", "*all the five* books", "*all the first five* books", etc. (Cf. Hoeksema 1983 for related criticism.) A less simplistic version should aim at treating multiple determination through a correspondingly complex phrase combining the determination items. It would be up to the whole phrase to play the role of 'specifier' within the NP (cf. section 2.1 above) and thus behave semantically as a proper determiner in the GQT sense, though one that would require a compositional interpretation according to the interpretations of the component expressions.

On the other hand, even leaving semantic issues aside, a major problem with the putative 'complex specifier phrase' to be constructed is its uncertain internal syntax, due to the lack of reliable criteria for deciding dependency and phrase-structure relations between the component expressions. If only binary branching is considered, a combination of predeterminer, central determiner and postdeterminer as in "*all the five* books" allows a priori 8 alternative analyses, depending on whether the article is attached to the left or to the right and on which lexical head projects the embedded two-word constituent and/or the whole specifier: [[ALL the] five], [[all THE] five], [[ALL the] FIVE], [[all THE] FIVE], [all [THE five]], [all [the FIVE]], [ALL [THE five]], [ALL [the FIVE]] (we have highlighted candidate lexical heads by capitals). If structures with more than one sister per head are not excluded, there are other 3 options, according to the head to be assumed for the resulting 'flat' three-word phrase: [ALL the five], [all THE five], [all the FIVE]. Therefore one has to investigate 11 possible alternatives [21]; a rather puzzling situation, considering that standard syntactic criteria for a choice among alternative patterns of dependency and phrase structure do not look very helpful in this case. Indeed, all the three determiner words in the putative specifier phrase *all the five* are equally good candidate heads, inasmuch as they can be considered distributionally equivalent to it (cf. the NPs "*all* books", "*the* books", "*five* books"). Furthermore, their part of speech is far from clear a priori (as previously mentioned in section 1), so one can hardly discriminate here by looking at the type of morpho-syntactic category that characterizes a phrasal projection according to the lexical head.

Finally, the hypothesis that the multiple determination of a given NP comes down to a corresponding specifier phrase does not only imply quite arbitrary decisions concerning syntactic relations between the co-occurring determination items, but cannot reasonably handle data showing an interposing qualifying adjective, as possible at least in some languages. Cf. the following Italian examples, where postdeterminers such as a cardinal and a possessive combine with each other and a qualifying adjective, practically in any order after the article [22]:

(8) a. i tuoi due famosi libri

[21] Which is still a simplified picture, because it is not obvious that non-heads in *all the five* should always play the same dependency role, e.g. as modifier. We have equally neglected related issues of 'bar' labelling.

[22] The examples (8) are all grammatical and acceptable modulo appropriate (but not necessarily emphatic) intonation patterns, and the intuitive judgements of Italian speakers here hardly distinguish 'marked' and 'unmarked' orders, or do that rather subjectively. On the postdeterminer status of determinative possessives in Italian, see section 1 above.

(lit. 'the your two famous books')

b. i due tuoi famosi libri
(lit. 'the two your famous books')

c. i due famosi tuoi libri
(lit. 'the two famous your books')

d. i tuoi famosi due libri
(lit. 'the your famous two books')

e. i famosi tuoi due libri
(lit. 'the famous your two books')

The determination items in the examples (8c)-(8e) could be part of a single specifier phrase only if the qualifying adjective too were included in that phrase. But this would give rise to implausible dependency relations with adjacent determinative expressions, whereas intuitively *famosi* is a direct modifier of the nominal head, in (8c)-(8e) as much as in (8a)-(8b). Another kind of data that create a problem for the approach in question is found when the nominal head itself interposes between determination items, because one of them occurs postnominally (v. section 1 above for examples in some languages). In such circumstances, it is plainly impossible to group all the items that determine the NP into a single phrase playing the specifier role.

The syntactic problems we have mentioned simply do not arise if one adopts a different approach to multiple determination, according to which the attachment of determiners is entirely dictated by the nominal headedness of the NP. That is, assuming binary branching, co-occurring determiners attach directly to the nominal backbone, one at a time, yielding a new nominal projection in each case without combining with each other first. Heuristically, this approach has the advantage of a drastic reduction of alternatives, resulting in just one structural option to be investigated: [all [the [five ...]]], for our typical example [23]. It should go without saying that we are not implying that the determiners to be thus attached are necessarily devoid of internal phrase structure. Although the determiners with adverbial dependents, the coordinations of determiners, etc., are not in the focus of the present article (v. section 1 above), they are quite compatible with our approach and do not affect the conclusion that multiple (pre- / central / post-) determination in the pertinent sense is not adequately treated as a single corresponding phrase, but requires a binary right-recursive NP analysis, whether dealing only with one-word determiners, as in the example above, or also with genuinely complex determiners, as in [[*not all*] [the [[*five or six*] ...]]].

[23] Other 3 structures – [all the [five ...]], [all [the five ...]], [all the five ...] – would become possible if non-binary branching were also considered, nevertheless the reduction would be confirmed, resulting in 4 options against 11 (as previously calculated for the 'specifier phrase approach'). Anyway, it is the binary version which we will adopt, as maximally restrictive working hypothesis on heuristic grounds.

Now, it is time to introduce fine-grained distinctions in terms of projection level labelling and related dependency roles. As a first approximation, the following X-bar Theory version of the proposed structural analysis of the NP (where NP is $\bar{\bar{\text{N}}}$) looks appealing to account for multiple determination:

(9) $[^{\text{NP}}\ \alpha\ [^{\text{NP}}\ \beta\ [^{\bar{\text{N}}} \ldots [^{\bar{\text{N}}}\ \gamma\ [^{\bar{\text{N}}} \ldots]]]]$
α = predeterminer
β = central determiner
γ = postdeterminer

According to standard ways of characterizing syntactic functions within X-bar Theory, β in (9) plays the role of 'specifier' of the NP, i.e. it is the dependent whose attachment changes an intermediate projection into a maximal one, whereas α and γ are 'adjuncts', implying that their attachments (to a maximal and an intermediate projection respectively) are bar-preserving. Hence the different behaviour of the article and the postdeterminers in the Italian examples (8) above. The article qua central determiner is bound to the single specifier position (the leftmost position in such NPs without predeterminer), whereas the fact that $\bar{\text{N}}$-to-$\bar{\text{N}}$ adjunction can be recursive – as in the treatment of uncontroversial adjuncts like the attributive adjectives (see e.g. Radford 1981) – allows the relatively free occurrence of multiple postdeterminers and interposition of adjectival qualifiers with analogous syntactic status [24]. English appears to enjoy less freedom in this connection, because of some language-specific constraint implying that postdeterminers always precede the other $\bar{\text{N}}$-to-$\bar{\text{N}}$ adjuncts, but the availability of multiple postdeterminers in different orders is confermed: cf. "the *last two* books" / "the *two last* books", "the *other few* books" / "the *few other* books".

The distinction between specifier and adjunct is also relevant for the issue of optionality in determination. Non-central (i.e. pre- or post) determiners are always optional, as predicted by the above schema (9) inasmuch as they are assigned the syntactic function of adjuncts; optionality indeed follows in view of the 'zero' case of adjunct recursion. On the other hand, if vacuous projection by unary branching is disallowed (see section 3.1 below for this constraint), a specifier is necessary for yielding an $\bar{\bar{\text{X}}}$ from an $\bar{\text{X}}$. As a matter of fact, the specifier notion was already appealed to in section 2.1 in order to account for the obligatory selection of central determiners by singular count nouns in various languages. However, obligatoriness as a general property of specifiers is challenged in the same languages, because 'bare nominal' NPs lacking any determiner are found with mass nouns, plural nouns and proper names. A typical way of restoring the property is to postulate an 'empty

[24] It is a behaviour that can be seen also as part of the evidence that the syntactic category of Italian postderminers is actually adjectival (Allegranza, in press). In the same vein, (9) above can be easily parameterized for Italian so as to allow γ to be postnominal (if this is lexically appropriate), just like other adjectives.

determiner' occurring as the specifier in cases of the kind, essentially as done for the treatment of bare plurals by Link (1987) and Carpenter (in press), among others. But empty elements are a notorious source of computational inefficiency and, moreover, their status for the treatment of Ø-determination is particularly dubious: according to Netter (1994), e.g., "empty nouns ... are well-motivated and necessary for anaphoric interpretation; on the other hand, ... empty determiners which are postulated purely for the sake of maintaining a uniform structural representation ... appear to be motivated exclusively by theory-specific considerations".

The use of an empty element as specifier is made superfluous in versions of X-bar Theory like the one adopted by Pollard & Sag (1994: Ch. 9), where examples like "*pictures of Mary* ... are perfectly good X″ [i.e. $\bar{\bar{\mathrm{X}}}$] even though *pictures* (in this case) does not require a specifier" (ibid., pp. 362-363). In a way reminiscent of Gazdar et al. (1985: p. 50) and Chomsky (1986: pp. 4, 47), the result is achieved by allowing phrase structure configurations in accordance with the X-bar template $\mathrm{X}^m \rightarrow \ldots\ \mathrm{X}^n \ldots$, for $m \geq n$, so that X° may project $\bar{\bar{\mathrm{X}}}$ directly, skipping the $\bar{\mathrm{X}}$ step if unnecessary. We refer to section 3.1 below for further discussion and elaboration of the technical aspects within a variant of HPSG that enforces a complete ban on unary-branching projections[25]. Informally, let us simply assume here that although every X° is a terminal node of the phrase structure, the opposite need not hold, so that we take categories of any bar level to be legitimate as terminal nodes. For instance, (10a) below is not shorthand for the corresponding version (10b) with unary-branching projections[26], but a well-formed terminated phrase structure in its own right, whereas (10b) is ruled out.

(10) a. $[^{\mathrm{S}}\ [^{\mathrm{NP}}\ [^{\mathrm{Art}}\ \text{the}\ ]\ [^{\bar{\mathrm{N}}}\ \text{horse}\ ]]\ [^{\mathrm{VP}}\ [^{\mathrm{V}}\ \text{kicks}\ ]\ [^{\mathrm{NP}}\ \text{Bill}\ ]]]$

b. $[^{\mathrm{S}}\ [^{\mathrm{NP}}\ [^{\mathrm{Art}}\ \text{the}\ ]\ [^{\bar{\mathrm{N}}}\ [^{\mathrm{N}}\ \text{horse}\ ]]]\ [^{\mathrm{VP}}\ [^{\mathrm{V}}\ \text{kicks}\ ]\ [^{\mathrm{NP}}\ [^{\bar{\mathrm{N}}}\ [^{\mathrm{N}}\ \text{Bill}\ ]]]]]$

Given the scenario that we have sketched, bare nominal NPs can be terminal nodes, in the case of a complementless noun, or direct projections of N°, in the case of a noun with complement(s). Furthermore, the lack of $\bar{\mathrm{N}}$ level entails that bare nominals including some modifier that would otherwise adjoin to $\bar{\mathrm{N}}$ are NPs deriving from adjunction of that modifier to an embedded specifierless NP – see, e.g., $[^{\mathrm{NP}}$ nice $[^{\mathrm{NP}}$ pictures (of Mary) $]]$. As noticed by Netter (1994) when discussing German data like (11) below, an

[25]That is, consistently with the conception of phrase structure adopted elsewhere in this volume, we will dispense also with the residual case of unary branching used by Pollard & Sag (1994: Ch. 9) to change the sort of sign from *word* into *phrase* when the lexical head takes no complement.

[26]Focussing on the noun phrase (with $\bar{\bar{\mathrm{N}}}$ abbreviated as NP as usual), we omit for convenience the X-bar analysis of non-nominal categories in the examples. Also the label 'Art' is purely conventional, since we have not committed ourselves to any specific position as regards the part of speech of determiners (v. section 1 above).

additional marking of the NP node is thus required to distinguish between bare nominals and NPs with specifier, so as to reject incorrect adjunction to the latter (cf. * $[^{NP}$ nice $[^{NP}$ the pictures (of Mary)]]).

(11) der gute Wein / guter Wein / * gute(r) der Wein

In section 3.1 we will argue that the proposed marking is just a particular instance of a system of 'node decorations' with far-reaching implications for HPSG syntax. By way of conclusion, suffice it to notice here that our approach elegantly accounts also for the co-occurrence restrictions concerning the enclitic article of Danish (v. section 1 above), under the assumption that a 'definite noun' like *huset* (lit. 'house-the') results from a morphological cliticization process [27] and syntactically works as a terminal node with NP category, but marked differently from terminal-node NPs of the bare nominal (hence articleless) kind. So, what prevents adnominal expressions other than a predeterminer to precede a definite noun is exactly the same reason that prevents them to precede a complex NP introduced by a prenominal specifier, in Danish as much as in other languages.

2.3 On the Interpretation of Plurals

We have already seen (in section 2.2) how bare plurals allow a syntactic treatment without resorting to empty determiners or unary-branching projections. Of course, another issue to be considered is what are the consequences for semantics. Essentially two sorts of alternative approaches are available within a semantic framework of the kind assumed in section 2.1 above:

- in absence of the usual syntactic structure overtly reflecting the determiner-restriction form of a generalized quantifier, one could opt for a non-quantificational, 'purely referential' analysis of bare plurals;

- with a view to preserve a uniform quantificational analysis for all NPs, one could take an appropriate generalized quantifier to be lexically associated with the bare plural noun, in much the same way this is done with proper names in classical Montague Grammar.

To be in a position to assess the two options, let us start from some remarks on the semantic behaviour of bare plurals in English.

As noticed by Carlson (1977) and others (see e.g. Diesing 1992), an existential and a generic interpretation are available for English bare plurals, depending on factors such as the occurrence of the NP as syntactic subject or object and the semantic typology of selecting predicates. The genericity involved appears to be predominantly subject-oriented, so that bare plural

[27] Whatever this means, depending on the approach to morphology (cf. Pollard & Sag 1987 and Van Eynde 1994, for instance).

objects mostly allow the existential interpretation alone, but there are exceptions such as generic bare plural objects of verbs whose semantics implies an 'experiencer' role for the subject, e.g. *like*, *fear*, *hate* and similar. As for bare plural subjects, those selected by a predicate expressing an activity or temporary state allow both interpretations, as in the example (12a), unless other factors – relating to tense, modality, deixis, etc. – override one of the two, as in the example (12b), which is only existential[28]. By contrast, bare plural subjects selected by a predicate expressing a permanent or tendentially stable state can only be interpreted generically, see examples (13).

(12) a. Policemen are available in case of need

b. Carpenter ants destroyed my table

(13) a. Brussels sprouts are unsuitable for eating

b. Opera singers know Italian

Now, Carlson's original proposal was to treat bare plurals not quantificationally but rather as referential terms denoting 'kinds', being up to the semantics of the selecting predicate, in the given context, to determine what the predication is about. That is, the predication can express a collective property of the individuals making up the relevant kind K (in the generic interpretation) or be restricted to a specific 'realization' of K at some spatio-temporal stage (in the existential interpretation). This approach to bare plurals as behaving like proper names of kinds was said to be confirmed – inter alia – by the fact that existentially interpreted bare plurals do not show the scope ambiguities typical of quantified existential NPs. See the following example:

(14) Every boy noticed (some) spiders in Mary's bed

where the direct object can be interpreted with wide scope (implying that every boy noticed the same spiders) only if *some* is expressed.

However, Carlson's approach does not appear to be really adequate for Italian. Italian bare plural subjects like those occurring in the examples (15), translating literally (12) above, are only assigned the existential interpretation, also in the case (15a) where other factors do not interfere; furthermore, the examples (16) fail to convey the generic meaning of their English counterparts (13) and sound more or less inacceptable to Italian speakers[29].

(15) a. Poliziotti sono disponibili in caso di bisogno

b. Formiche rodilegno hanno distrutto la mia tavola

(16) a. ?? Cavoletti di Bruxelles sono immangiabili

b. ?? Cantanti d'opera sanno l'italiano

[28]But cf. *Carpenter ants destroy everything*, where the ambiguity is restored.

[29]The non-genericness of Italian bare plurals is confirmed also for object NPs of 'experiencer' verbs: cf. En. *She hates chocolate cookies* / It. ?? *Lei odia biscotti al cioccolato.*

Clearly, under Carlson's predicational account of the generic vs. existential ambiguity of constructions with bare plurals, Italian predicates would mysteriously lack a predication option available to the corresponding English predicates, although the former obviously express temporary or permanent states of affairs just like the latter. On the other hand, an approach retaining his analysis for English, while accounting for the lack of genericness of the acceptable Italian bare plurals by assuming that they are (implicitly) quantified existential NPs, would make the prediction that they should differ from their English counterparts in allowing scope ambiguities. But Italian bare plurals behave like English ones in this respect. E.g. (17) is interpreted consistently with what was said about its counterpart (14):

(17) Ogni ragazzo notò (alcuni) ragni nel letto di Maria

So, if Italian bare plurals are treated quantificationally to explain their exclusive existential reading, they also require some quantificational account of narrow scope, and it is not clear why the same should not be available for their English counterparts, thus offering in general an alternative to the treatment of bare plurals as referential terms.

In fact, it is well known that wide scope is not equally possible with all quantified NPs, as these can be classified along a preference scale according to their determiners' tendency towards wide or narrow scope (cf. Ioup 1975). Therefore, as proposed by Diesing (1992: p. 64), one could simply extend the scale by classifying implicitly quantified plural NPs as tending towards narrower scope. The extreme case perhaps, but not so inherently different from explicitly quantified cases whose narrow scope reading is strongly preferred (see e.g. "Every boy noticed *quite a few spiders* in Mary's bed"). In this work we have to leave aside the issue of a preference-based system of lexical, structural and contextual constraints on quantifier scoping, but we believe what has been said so far is enough to show that the putative evidence in favour of Carlson's (1977) approach to bare plurals as referential terms is rather dubious[30].

In section 3.2 below we will develop an HPSG treatment of bare plurals based on the 'storage' of appropriate generalized quantifiers in the lexical entries of relevant nouns, inter alia. Adnominal expressions will be functionally interpreted as yielding an 'updated' version of the quantifier from the one associated with the adjacent nominal head. For example, qualifying adjectives have no quantificational force of their own and when they modify a bare plural will just preserve the 'default' in this respect, while modifying the embedded predicate-argument structure according to their meaning. In other cases the situation looks less clear, though. Typical is the case of an

[30]See also Chierchia (1982), Diesing (1992) and Gerstner-Link & Krifka (1993), among others, for more discussion of revisions and alternatives to Carlson's original treatment.

NP-initial cardinal determiner, which is treated as specifier with quantificational force in some approaches or as modifier of a bare plural in other approaches. It is therefore worth discussing which of the two hypothesis is confirmed by the intuitive semantic interpretation and syntactic behaviour of such expressions.

For one thing, traditional treatments of cardinals as determiners with inherent existential force – say, 'there are five x' – are insufficient because cardinals occur also in NPs that are differently quantified by some preceding determiner(s), as in (*almost all*) *the five books*. In section 2.2 we have seen that these combinations were not adequately treated by Barwise & Cooper (1981). Alternatively, cardinals are argued to be adjective-like modifiers within the framework of formal semantic treatments of plurality as varied as those developed by Hoeksema (1983), Link (1987), Ojeda (1993) and Carpenter (in press). In its simplest formulation, which highlights the parallelism with (extensional) qualifying adjectives, the idea is to interpret a cardinal as 'intersective' in the sense that its combination with a nominal head denotes the intersection of the set denoted by the modifier and the set denoted by the head. As a first approximation, e.g., *five books* denotes the set of all sets of 5 books, if *five* denotes the set of all sets of 5 individuals and *books* the set of all sets of 2 or more books[31]. Other treatments of plurality differ in the way of characterizing the content of the sets at issue, as in 'mereological' approaches with a structured universe of discourse including both atomic and plural/molecular individuals (v. Link 1983, 1987, Ojeda 1993, and in HPSG, Kolliakou 1996). For our purposes, suffice it to say that *five*, in a way strictly conform to the HPSG treatment of restrictive adjectival modifiers (Pollard & Sag 1994: pp. 55-56), can be lexically assigned a *nominal-object* like the one represented in (18), where the tag $\boxed{2}$ stands for the restrictions to be incorporated from the nominal head[32].

(18)
$$\left[\begin{array}{l} \text{INDEX } \boxed{1}_{\text{ref}}\left[\text{NUMBER } \textit{plur}\right] \\ \text{RESTR} \left\{ {}_{\text{psoa}}\left[\begin{array}{l} \text{RELATION } \textit{5} \\ \text{ARG } \boxed{1} \end{array}\right] \right\} \cup \boxed{2} \end{array}\right]_{\text{nom-obj}}$$

[31]One will then need also quantification over sets (possibly extended to individuals represented as singletons) and some version of GQT with plural generalized quantifiers. Cf. Scha (1981), Hoeksema (1983), Ojeda (1993) and Carpenter (in press) for discussion of related issues.

[32]For convenience, we are neglecting the QUANTS / NUCLEUS distinction as before (see fn. 19). Note also the use of set union, which does not contradict the intersective nature of cardinals (or extensional modifiers in general), because what is meant to be unioned in (18) are sets of representations and not denotations. As discussed by Allegranza (in press), the result can be translated into an order-free conjunctive formula of some predicate logic, where conjunction is interpreted by intersection of the relevant denotations.

At this point, it is tempting to follow Link (1987), Carpenter (in press) and others in assuming that cardinal determiners are modifiers also when they occur NP-initially, that is, modifiers of bare plurals. In fact, the result is accordingly ambiguous, because "numeral-noun combinations may have a generic reading, just like ordinary bare plurals" (Hoeksema 1983). For example:

(19) Twenty policemen are available in case of need

is interpretable equally well as an existential statement about some 'historical' situation, in which twenty specific policemen are available, and a generic statement relative to the cardinality of any group of policemen that is expected to be available (although its members may vary on different occasions). As usual, the ambiguity can be resolved in one way or another because of various factors, cf. Link's (1987) examples:

(20) a. Three men lifted the piano
b. Three men can lift the piano

where the past tense in (20a) enforces an existential reading and the modalized present tense in (20a) makes preferable a generic reading.

A problem arises, however, because the prediction concerning the correspondence between permanent-state predicates and lack of existential interpretation for bare plural subjects is not confirmed by the examples with cardinals. E.g. (21) below allows the existential interpretation, which is actually preferential (although the generic interpretation can be recovered in a context where the sentence is uttered – with appropriate stress on the verb – as a 'law-like' reply by some opera singer to somebody doubting that the same singer and a colleague know Italian).

(21) Two opera singers know Italian

The problem becomes even worse if one considers a language like Italian, where bare plurals lack the generic interpretation. In Italian, if a cardinal is added and no overriding factors intervene, what used to be an existential bare plural allows also the generic interpretation (cf. the ambiguous example "*Venti poliziotti* sono disponibili in caso di bisogno" with the unambiguously existential (15a) above) and what used to be an inacceptable bare plural becomes existentially or generically interpretable (cf. the ambiguous example "*Due cantanti d'opera* sanno l'italiano" with the inacceptable (16b) above). But then the easiest solution is to assume that the ambiguity in examples introduced by cardinals arises from these determiners as their inherent quantificational force and is not a matter of bare plural interpretation.

Indeed, there appears to be syntactic evidence that a cardinal in Italian NPs without central determiner is not an adjunct to a bare plural, but rather a specifier. This is so because examples of the kind become ungrammatical if the cardinal is preceded by a qualifying adjective. Compare:

(22) a. gli splendidi due cavalli
(lit. 'the splendid two horses')

b. * splendidi due cavalli
(lit. 'splendid two horses')

c. splendidi cavalli
(lit. 'splendid horses')

Examples like (22a) above (or also (8d)-(8e) in section 2.2) show that in Italian there is nothing wrong in a qualifying adjective preceding a cardinal within the NP. And examples like (22c) above (or, in this case, also equivalent English examples) show that there is nothing wrong in a qualifying adjective introducing a bare plural NP. But the ungrammaticality of (22b) is explained, if we accept that a cardinal can be either an adjunct or a specifier and becomes the specifier in absence of a determiner that requires that role. Under this hypothesis, (22b) is analyzed as [^{NP} splendidi [^{NP} due [$^{\bar{N}}$ cavalli]]] and its ungrammaticality follows from the same reasons that hold when the cardinal is replaced by the article (* *splendidi i cavalli*); v. again section 2.2. On the other hand, it is sufficient to assume that cardinals always apply to an embedded $\bar{N}$, irrespective of the number of bars of the resulting projection, to rule out a bare plural analysis and ensure that the only remaining alternative is [$^{\bar{N}}$ splendidi [$^{\bar{N}}$ due [$^{\bar{N}}$ cavalli]]], a nominal that must combine with some specifier in order to yield a full NP.

The question now is whether the availability of a cardinal for both specifier and $\bar{N}$-level adjunct uses is just a matter of the same lexical entry 'switching' its role according to the syntactic context, or requires the distinction between two lexical readings encoded by corresponding entries [33]. We find the former option preferable, because it avoids enlarging the size of the lexicon and does not call for any lexical rule in order to express the generalization that every cardinal specifier can be changed into a modifier, or vice versa. The problem is that our line of reasoning does not work within the standard HPSG linguistic theory by Pollard & Sag (1994), where some duplication of lexical readings would be unavoidable: two alternative features – SPEC and MOD – would be used for selection of the nominal head by a cardinal specifier and a cardinal adjunct, respectively; also the CONTENT in the two cases would be different, insofar as the specifier would be assigned a generalized quantifier, not (only) a 'nominal-object' as in the case of the adnominal modifier. In section 3, however, we will avoid additional lexical readings and rules by developing a revised version of HPSG, one in which the structuring

[33]Although we are focussing on cardinals, the same kind of alternative appears to be relevant to other cases of determination. E.g., quantitative postdeterminers in Italian show essentially the same syntactic behaviour as cardinals (Allegranza, in press). Moreover, English predeterminers like *all* and *both* can be argued to allow both specifier and NP-level adjunct uses.

of linguistic information and the underspecification of lexical entries are such as to allow the same entry of a cardinal determiner to be/project a specifier or a modifier, depending on the syntactic context.

3 A Sample Formal Treatment

3.1 Syntactic Component

The grammatical framework which we assume, with a view to develop more formally the approach to determination and NP structure that was sketched and discussed in the previous sections, is a variant version of Pollard & Sag's (1994) HPSG. The information at the topmost level of organization of the *sign* is indeed the same as theirs, so that we find the attributes PHONOLOGY, SYNSEM, QSTORE, RETRIEVED, and – in case the sign is a *phrase* – DAUGHTERS (DTRS). Looking now into the SYNSEM|LOCAL information[34], again standardly organized in terms of the attributes CATEGORY, CONTENT and CONTEXT, let us sketch in particular our feature geometry for CATEGORY values[35]:

(23)
$$
{}_{\text{category}}\left[\begin{array}{ll}
\text{HEAD} & \textit{head} \\
\text{VALENCE} & {}_{\text{valence}}\left[\begin{array}{l} \text{SUBJ } \textit{list}(\textit{synsem}) \\ \text{COMPS } \textit{list}(\textit{synsem}) \end{array}\right] \\
\text{DECORATED} & {}_{\text{decorations}}\left[\begin{array}{l} \text{SPR } \textit{boolean} \\ \text{MARKING } \textit{marking} \\ \quad\vdots \end{array}\right]
\end{array}\right]
$$

The approach to the formalization of dependency relations adopted in Ch. 9 of Pollard & Sag's (1994) book is revised here inasmuch as only SUBJ and COMPS are (*list*-valued) VALENCE features, relevant to the Valence Principle. As shown at length by Allegranza (in press) for the treatment of Italian determination, the feature SPR – which (23) above includes in an bundle of various *decorations* for categories – can be assumed without loss to be *boolean*-valued, i.e. binary, in a way comparable to Netter's (1994) FCOMPL encoding the 'functional (in)completeness' of signs. The resulting treatment will avoid the ciclicity of Pollard and Sag's original (cf. section 2.1 above) while keeping in essence to the same view of X-bar Theory. We recall that the 'Ch. 9 approach' defines bar projections by combining the *word* vs. *phrase* sort distinction with the saturation degree w.r.t. SPR as

[34]NONLOCAL aspects will not be considered in the current chapter.

[35]We take for granted a proper statement (in the style of Pollard & Sag 1994: App.) of the various feature declarations entailed by (23).

a valence attribute (Pollard & Sag 1994: p. 362). So, words are X° (null projections) irrespective of the saturation degree; phrases with [SPR<[...]>] are $\bar{X}$ (intermediate projections); phrases with [SPR<>] are $\bar{\bar{X}}$ (maximal projections). As a first approximation, the same kind of definition can be maintained in the revision we propose, though replacing [SPR<[...]>] and [SPR<>] with [SPR–] and [SPR+], respectively. That is, adapting Netter's (1994) terminology to X-bar Theory as conceived here, maximal projections are phrases that display the information of their 'functional completeness' relative to specifiers and therefore cannot combine with a sign fulfilling that function, unlike intermediate projections, which are expected to combine with some ('functional incompleteness').

It is worth noting that in the phrase structure system by Pollard & Sag (1994: Ch. 9), every phrase is [COMPS<>], but not every [COMPS<>] sign is a phrase, and the only vacuous, unary-branching projection results precisely from application of the Head-Complement Schema in case of a [COMPS<>] word to be mapped syntactically into a phrase. All other vacuous projections – e.g. from $\bar{N}$ to $\bar{\bar{N}}$ in a specifierless NP – are avoided, because X° may project $\bar{\bar{X}}$ directly, skipping any intermediate $\bar{X}$ node if unnecessary (cf. section 2.2 above). This is achieved by virtue of the HPSG definition of bar levels previously mentioned: the [SPR<>] (or, in our variant, [SPR+]) information shared between a suitable *word*-type head and the immediately dominating *phrase* node makes ipso facto the latter a maximal projection. Such an approach is further developed hereafter by dispensing with the residual case of unary branching[36]. In practice, (a) we prevent the application of the Head-Complement Schema to any structure with a *word*-type head and an empty list of complements and (b) we compensate for the excluded unary-branching constituent by a corresponding syntactically 'terminal' (i.e. daughterless) constituent. A very simple way of achieving the result (a) is to restrict the COMP-DTR value in a head-complement structure to a non-empty list (*nelist*). Concerning (b), the problem for us is how to avoid blurring dependency notions embodied in X-bar Theory; e.g., if a head-adjunct structure with a word as HEAD-DTR were allowed, the previously mentioned identification of *word*-type signs with X° and *phrase*-type signs with $X^{m\geq 1}$ would make the resulting phrase not bar-preserving, contrary to the standard X-bar Theory characterization of 'adjunct'[37].

[36]On the other hand, at least for convenience, we will keep the constraint that all phrases be complement-saturated (Pollard & Sag 1994: p. 346), thus excluding a recursive, binary-branching analysis of head-complement constructions, suitable for the interleaving of complements and adjuncts. But our treatment could be re-elaborated so as to allow that kind of analysis, roughly as shown for Italian in the MLAP project COLSIT.

[37]Cf. section 2.2 above. The usefulness of sticking to the standard characterization will be particularly evident when we will show how to replace the ADJ-DTR attribute with a more general one.

The solution we put forward consists in providing a richer system of sorts for signs, namely (24), so as to re-express the HPSG definition of bar levels accordingly.

(24) Partition of *sign*: *lex-sign*, *syntagma*
Partition of *lex-sign*: *word*, *lex-syntagma*
Partition of *syntagma*: *lex-syntagma*, *phrase*

The sort *word* stands for null projections (i.e. constituents 'with zero bars') as before, but we take them to be just a particular case of 'lexical signs' in the sense of signs that are terminal constituents of the syntax and output of morphological processes; hence the need for a broader sort *lex-sign*. Moreover, the *phrase* sort – which introduces DTRS as usual – is meant as sufficient, but not necessary condition for a sign to be a non-null (intermediate or maximal) projection. Given the ban on all unary-branching projections, a phrase is always a group of at least two constituents, whereas we employ the broader notion of *syntagma* to refer to (i) a phrase in that sense or (ii) a *lex-sign* playing the same syntactic role as a phrase. Case (ii) is accounted for by the sort *lex-syntagma*, common subsort of *lex-sign* and *syntagma*. Then the following is our revised definition of bar projections:

	sort of sign	SPR value
X°	*word*	*boolean*
$\bar{X}$	*syntagma*	–
$\bar{\bar{X}}$	*syntagma*	+

Owing to the existence of lexical, non-phrasal syntagmata (v. (ii) above), constituents 'with more than zero bars' are thus legitimate also as terminal nodes of the syntax, provided they lack DTRS and bear the information [COMPS<>]. The former requirement follows from the fact that DTRS is introduced by *phrase* and *phrase* is an alternative to *lex-syntagma* (v. (24) above). The latter requirement can be satisfied lexically, by directly encoding as *word* all lexical signs with non-empty COMPS list; they will never be available for the alternative sort *lex-syntagma*. Not all *word*-type lexical signs must have a non-empty COMPS list, though. Within the present framework, the so-called 'minor categories' such as articles[38] and complementizers, i.e. the words that cannot project bar levels (cf. Gazdar et al. 1985: p. 25), are simply accounted for by lexical encoding as *word*-type signs with [COMPS<>]; this makes them unsuitable as heads, as desired, by virtue of the already mentioned revision (a) of the Head-Complement Schema. On the other hand, candidate non-phrasal syntagmata will be lexically encoded as *lex-sign*, so as to be ambiguous between a *word* use and a *lex-syntagma* use.

[38] But not other determiners, which are clearly 'major categories' inasmuch as they can take dependents (as we mentioned in section 1). For more discussion on the major/minor distinction applied to determiners, cf. Van Eynde (1994: § 3.1.1) and Allegranza (in press).

Let us give an example relevant to NP structure: the complement-saturated (but functionally incomplete, i.e. [SPR–]) singular count noun "horse" will occur as *word* in compounds like "horse race", "horse laugh", "horse guards", etc., but as $\bar{\mathrm{N}}$ *lex-syntagma* (ready to combine with some specifier) when heading a noun phrase. Neglecting here the case of compounding, our analysis in the other case can be accepted by the phrase structure schemata of HPSG, if those daughters that in the various sorts of syntactic construction were required to be phrases are allowed to be, more generally, syntagmata. In this way, the *lex-sign* "horse" will unify with the relevant *syntagma* slot in a construction, yielding a *lex-syntagma*.

Let us turn to the sort system and constraints related to the DTRS structure of those signs that are phrasal and, in particular, headed. Consistently with the approach developed so far, the feature declaration for the *headed-structure* sort is:

(25) *headed-struc*: $\begin{bmatrix} \text{HEAD-DTR } \textit{sign} \\ \text{SUBJ-DTR } \textit{list}\,(\textit{syntagma}) \\ \text{COMP-DTR } \textit{list}\,(\textit{syntagma}) \end{bmatrix}$

Moreover, as regards the subsorts of *headed-struc* we adopt a partition into *head-subcategorizand-structure* and *head-functor-structure*, not found in Pollard & Sag (1994).

The former subsort stands for all constructions in which the head occurs together with some subject or complement daughter(s) subcategorized for by the head. Thus the maximal sorts *head-comp-struc*, *head-subj-struc* and *head-subj-comp-struc* proposed by Pollard & Sag (1994: Ch. 9), with feature declarations specifying different restrictions[39] on head and nonhead daughters, partition *head-subcategorizand-structure*:

(26) *head-subcat-struc*

a. *head-comp-struc*: $\begin{bmatrix} \text{HEAD-DTR } \textit{word} \\ \text{SUBJ-DTR } \textit{elist} \\ \text{COMP-DTR } \textit{nelist} \end{bmatrix}$

b. *head-subj-struc*: $\begin{bmatrix} \text{HEAD-DTR } \textit{syntagma} \\ \text{SUBJ-DTR } \textit{singleton-list} \\ \text{COMP-DTR } \textit{elist} \end{bmatrix}$

c. *head-subj-comp-struc*: $\begin{bmatrix} \text{HEAD-DTR } \textit{word} \\ \text{SUBJ-DTR } \textit{singleton-list} \end{bmatrix}$

The three maximal sorts correspond to the Head-Complement Schema, the Head-Subject Schema and the Head-Subject-Complement Schema, again in

[39] Possibly revised here as motivated before.

accordance with the standard 'Ch. 9 approach'[40]. These ID schemata can be rather 'impoverished' in some respects, because much X-bar Theory information actually follows from the sort system and from additional constraints imposed by the Head Feature Principle and the Valence Principle. For the purposes of NP-internal analysis, it is enough to show our Head-Complement Schema, licensing complement-saturated phrases with DECORATED value token-identical between mother and head:

(27) **Head-Complement Schema**

$$ {}_{\text{phrase}}\left[\begin{array}{ll} \text{SYNS}\,|\,\text{LOC}\,|\,\text{CAT} & {}_{\text{category}}\left[\begin{array}{l}\text{VALENCE}\,|\,\text{COMPS}\!<\!> \\ \text{DECORATED } \boxed{1}\end{array}\right] \\ \text{DTRS} & {}_{\text{head-comp-struc}}\left[\text{H-DTR}\,|\,\text{SYNS}\,|\,\text{LOC}\,|\,\text{CAT}\,|\,\text{DECORATED } \boxed{1}\right] \end{array}\right] $$

Coming to a more innovative sort of headed structures (originally proposed by Allegranza, in press), the *head-fun-struc* which we envisage simply consists of two daughters[41], viz. a head and a 'functor' in the relevant sense:

(28) *head-fun-struc*:
$$\left[\begin{array}{l} \text{HEAD-DTR } \textit{syntagma} \\ \text{FUN-DTR } \textit{sign} \\ \text{SUBJ-DTR } \textit{elist} \\ \text{COMP-DTR } \textit{elist} \end{array}\right]$$

The syntactic notion of functor represented by FUN-DTR (FUNCTOR-DAUGHTER) is mainly meant to generalize over 'specifier' and 'adjunct'[42], two notions that Pollard & Sag (1994: Ch. 9) take as distinct dependency primitives of the DTRS component, SPR-DTR and ADJ-DTR, despite the strong resemblance these two kinds of non-head bear to each other in that both select the head of a binary structure by token-identity of a feature value with the head's SYNSEM value. Actually, Pollard and Sag's analysis introduces other formal differences besides the distinct SPR-DTR and ADJ-DTR labels: specifiers select the head via SPEC, a feature assigned only to 'functional' parts of speech, whereas adjuncts do the same via MOD, a feature assigned only to 'substantive' parts of speech; moreover, adjuncts select the head but are not selected, unlike specifiers, which are simultaneously

[40] On the other hand, we neglect 'head-filler' structures and schema throughout the chapter. However, one could clearly adapt Pollard & Sag's (1994: App.) assumptions by introducing a further subsort of *headed-struc*, *head-filler-struc*, with feature declarations prescribing a syntagmatic head and empty lists for subject and complements, in addition to a filler.

[41] More precisely, in (28) there are also empty lists for subject and complement daughters (consistently with the characterization of related structures by Pollard & Sag 1994: App.). This allows the Valence Principle to apply to the construction, in order to percolate unchanged from head to mother the SUBJ and COMPS values of the head.

[42] But see also the remarks on 'marker' below.

selected by subcategorization. However, the distinction between 'functional' and 'substantive' collapses in our approach, since also substantive adjuncts such as adjectives, PPs, etc., are functional in a sense, being indeed functors. As for the second difference between specifiers and adjuncts, it is completely theory-internal (with formally undesirable consequences which we have already discussed) and disappears in a system like ours where SPR is boolean, not a subcategorization feature.

Of course, we do not mean that there is no difference between specifiers and adjuncts. Rather, in a way reminiscent of categorial grammar treatments (cf. Bouma 1988), the proposed primitive notion of 'functor' encompassing the two cases allows to deduce the relevant distinction from independent properties:

specifiers are functors yielding $\bar{\bar{X}}$ from $\bar{X}$, i.e. they trigger the change of SPR value from the adjacent head ([SPR–]) to the projected mother node ([SPR+]);

adjuncts are bar-preserving functors, yielding $\bar{X}$ from $\bar{X}$, or $\bar{\bar{X}}$ from $\bar{\bar{X}}$[43], i.e. they percolate the SPR value common to the adjacent head and the projected mother node.

What's more, as proposed at the end of section 2.3 above, we account for the phenomenon of:

switches yielding $X^{m\geq 1}$ from $\bar{X}$, hence functors that can be specifiers in one kind of syntactic context and $\bar{X}$-level adjuncts in another, because they leave unspecified the SPR value on the projected mother node[44].

To achieve the desired results we make use of the following HEAD features of a functor:

- HEAD-SLOT, which replaces SPEC and MOD and takes on their selection task[45];
- DECORATOR, whose value (of sort *decorations*) is token-identical with the DECORATED one on the mother node of the *head-fun-struc* and therefore conveys that node's DECORATED|SPR information, inter alia.

[43]Note that subjects too in 'Ch. 9'-HPSG yield a maximal projection from a maximal projection (Pollard & Sag 1994: pp. 362-363). Yet, they cannot be considered adjuncts, because they are not functors: subjects do not select the head, whereas the head selects them by subcategorization (via SUBJ).

[44]See further section 3.2. It is worth adding that we are equally able to handle 'switches' that leave unspecified the SPR value on the adjacent head, yielding $\bar{\bar{X}}$ from $X^{m\geq 1}$; this could be useful for the analysis of English predeterminers (v. fn. 33).

[45]Let's say the HEAD-SLOT value is of sort *synsem-or-none*, with the obvious partitions *synsem* and *none* (the latter value being the alternative to *synsem* for word readings that do not project functors of any kind). Unlike what was the case with SPEC and MOD, the feature HEAD-SLOT is meant to be appropriate for every value of sort *head*.

Our treatment is applied by the Head-Functor Schema, the ID schema associated with *head-fun-struc* qua maximal sort:

(29) **Head-Functor Schema**

$$
{}_{\text{phrase}}\begin{bmatrix}
\text{SYNS|LOC|CAT|DECORATED } \boxed{1} \\
\text{DTRS} \quad {}_{\text{head-fun-struc}}\begin{bmatrix}
\text{FUN-DTR|\ldots CAT} \quad {}_{\text{category}}\begin{bmatrix}
\text{DECORATED|SPR } + \\
\text{HEAD} \quad {}_{\text{head}}\begin{bmatrix} \text{DECORATOR } \boxed{1} \\ \text{HEAD-SLOT } \boxed{2} \end{bmatrix} \\
\text{VALENCE|COMPS } \langle\rangle
\end{bmatrix} \\
\text{HEAD-DTR|SYNS } \boxed{2}
\end{bmatrix}
\end{bmatrix}
$$

In itself, (29) is a formally simple, non-disjunctive constraint on all phrases with a functor daughter, whether adjunct or specifier, major or minor. Concerning the latter dichotomy, note that the FUN-DTR value is just required to be *sign* by the declaration (28) of *head-fun-struc*, so that (29) allows as functors both maximal and null projections satisfying [COMPS<>] [46], the latter case including minor words as explained before. A side-effect of this scenario is that no special notion of 'marker' is necessary as dependency primitive and/or part of speech, pace Pollard & Sag (1994: p. 45). That notion, in our view, is a hybrid which collapses two different properties – being 'minor' and marking – and at the same time involves an unmotivated restriction of their range of application (cf. also Van Eynde 1994 for partly related criticism). In the present system, so-called 'markers' such as the complementizers are semantically vacuous minor-category functors (of the adjunct kind, inasmuch as they are bar-preserving), whose occurrence in a construction is recorded on the mother node by the MARKING value. Indeed, MARKING is a *decorations* feature (v. (23) above) and carries information which is shared between the DECORATOR value of the functor daughter and the DECORATED value of the mother node, as a result of the Head-Functor Schema.

To sum up, the Head-Functor Schema replaces Pollard & Sag's (1994) Head-Specifier Schema, Head-Adjunct Schema and Head-Marker Schema, in the same way in which *head-fun-struc* qua maximal subsort of *headed-struc* replaces their *head-spr-struc*, *head-adj-struc* and *head-mark-struc*. Our schema incorporates also the selection they envisaged as a separate SPEC Principle (v. section 2.1 above) and the part of marking mechanism concerning 'markers' proper [47]. Furthermore, the property of marking instead of the head be-

[46]The constraint [DECORATED|SPR+] excludes intermediate projections.

[47]The part of marking mechanism pertaining to heads – which mark at least vacuously, i.e. for *unmarked* – is stated directly in the other ID schemata (cf. Pollard & Sag 1994: p. 45). E.g., see the token-identity of the DECORATED values of head and mother in the Head-Complement Schema (27).

comes potentially available to functor-type dependents in general, and this is motivated by empirical evidence concerning determination. A pertinent issue was mentioned in section 2.2, namely the marking of an NP node by the specifier daughter to forbid the adjunction of preceding qualifiers, unlike what is the case when the NP is a bare plural. Another reason why nominal projections should be marked w.r.t. determination is to allow the checking of any co-occurrence restriction between determiners that does not come down to X-bar Theory constraints and cannot be semantically motivated, as discussed at length by Allegranza (in press). Whether the necessary information is expressed by extending the range of values of MARKING proper or by introducing a new *decorations* feature, designed just for 'determination marking' purposes, the relevant requirements on the adjacent nominal head will be stated lexically through the determiner's HEAD-SLOT feature and enforced syntactically by the Head-Functor Schema.

3.2 Semantic Component

Let us redefine the CONTENT values (i.e. the sort *content*) in such a way that they introduce the attributes LOGICAL-FORM (LF) and DISTINGUISHED-QUANTIFIER (DISQUANT). Here Pollard & Sag's (1994) original CONTENT values generally become LF values, whose sort is *logical-form*, partitioned by *nominal-object* and *psoa*[48]; by contrast, *quant* is not a subsort of *content* or *logical-form*, but an independent sort of linguistic objects, belonging to the partition of the *object* root of the whole hierarchy. As regards the feature DISQUANT, it takes an empty or singleton set of *quant* objects as value. Lexically the DISQUANT value is token-identical with the QSTORE value[49] (and both are empty sets for words irrelevant to the quantification mechanism), but very often the two set-values are made distinct on phrasal nodes: QSTORE may collect several quantifiers from the daughters modulo 'quantifier inheritance', whereas DISQUANT, at most, will display the quantifier passed up by the daughter acting as semantic head in a nominal construction. Moreover, the fact that DISQUANT appears within *synsem* objects (unlike QSTORE) makes it accessible to subcategorization, allowing a relevant predicate to lexically encode a constraint of non-existentiality on the generalized quantifier associated with a bare plural subject or similar (v. discussion of English and Italian data in section 2.3 above).

Taking into account the DTRS system that we have outlined in section 3.1, also our notion of 'semantic head' is partly different from that of Pollard & Sag (1994: pp. 322, 402). The case in which the semantic head does

[48]We take these two last sorts to be grammatically defined as in Pollard & Sag (1994), although semantically we do not feel committed to a situation-theoretic interpretation (cf. section 2.1 above).

[49]In the present work we neglect a discussion of possible exceptions.

not coincide with the syntactic head is generalized here from adjuncts to all 'functors' in our sense. Informally:

> The semantic head of a headed phrase is the FUN-DTR if any, the HEAD-DTR otherwise.

Now, the intended quantificational result of the application of a FUN-DTR semantic head to some nominal whose mother node is associated with a distinguished quantifier is to replace this with another quantifier, which 'updates' the former (in some of the ways that we will describe) and becomes the distinguished quantifier on the mother node of the resulting construction. For the correct functioning of the mechanism we must ensure that each distinguished quantifier to be replaced because of an intervening FUN-DTR is also subtracted from the inheritance of stored quantifiers. Therefore, Pollard & Sag's (1994) Semantics Principle has to be revised so as to comply with that requirement, inter alia. While referring to Allegranza (in press) for a formalized and compact version in feature structure notation, we offer below a 'prosaic' statement of the revised principle, organized into three parts, or sub-principles, on the lines of the original presentation by Pollard & Sag (1994: pp. 322-323). As can be readily ascertained, only point (ii) – in the Quantifier Inheritance Principle part – is really new [50].

The Revised Semantics Principle

In a headed phrase:

(Content Principle) the mother and the semantic head share token-identical CONTENT information, the only possible exception being the QUANTS list as specified by the Scope Principle;

(Scope Principle) the mother's QUANTS list is the concatenation of the mother's RETRIEVED list with the QUANTS list of the semantic head;

(Quantifier Inheritance Principle) the QSTORE of the mother is the union of the QSTOREs of the daughters less those quantifiers possibly occurring (i) either on the mother's RETRIEVED list, which is nonempty only if the semantic head is of sort *psoa*, (ii) or in the DISQUANT set of the syntactic head, provided this is not the semantic head.

In the following, we would like to make clear how the novel set-up of CONTENT information concretely works, under the Revised Semantics Principle, by exemplifying in particular the treatment of plurals. We will consider four possible cases of plural NPs:

[50] In fact, the rest subsumes Pollard and Sag's original version of the Semantics Principle. We have just generalized the phrasing of the Content Principle part so as to allow different ways of organizing CONTENT information. For us, the information to be always shared between mother and semantic head includes the DISQUANT feature, besides the NUCLEUS feature.

(A) non-modified bare plurals, e.g. [^{NP} pictures (of Mary)];

(B) modified bare plurals, e.g. [^{NP} new [^{NP} pictures (of Mary)]];

(C) plural NPs with a central determiner as specifier,
e.g. [^{NP} the [$^{\bar{N}}$ (new/two) pictures (of Mary)]];

(D) plural NPs with a 'switch' determiner as specifier,
e.g. [^{NP} two [$^{\bar{N}}$ (new) pictures (of Mary)]].

Let us start from (A), the simplest case. In languages with morphologically realized number distinctions for nouns, the singular and the plural of a count noun are encoded as distinct – though obviously related – lexical signs (Pollard & Sag 1987). Here we need not worry for the specific way of achieving the desired result, that is, we will simply assume that suitable objects of *lex-sign* sort in the sense of section 3.1 above be available, whether they are listed as basic expressions, or derived by HPSG-style lexical rules, or built-up structurally by 'morphotactic' rules / schemata. What matters for us is that the distinction between bare plural and plural calling for a specifier need not require a duplication of the plural noun *lex-sign* nor a corresponding disjunction of values (cf. section 2.1 above), if one exploits lexical underspecification. Adapting to our feature system an idea from Netter's (1994) treatment of German nominals, we leave lexically undetermined the DECORATED|SPR value of the plural noun (to be shared with the immediately dominating phrasal node in case of a complemented noun[51]). It is up to the linguistic contexts of occurrence to instantiate the value, thereby determining the bar-level of the noun according to our version of X-bar Theory; the relevant SPR information is recoverable from the HEAD-SLOT of various functors pertaining to NP structure (v. Allegranza, in press, for detailed exemplification), or at least from the SUBJ / COMPS information of the external heads that subcategorize for NP (verbs, etc.). In the case (A), the latter situation holds, i.e. the noun is not selected by any functor, being a non-modified bare plural, but is subcategorized for by some external head enforcing [SPR+].

In approaches of the kind, a problem (which Netter 1994 does not address) is how to avoid that the need to distinguish two semantic interpretations of the same plural noun – the bare plural interpretation, with its 'default' quantificational force, and the non-quantified, *nominal-object* interpretation – brings about the very distinction of lexical signs that was dispensed with on syntactic grounds. The lexical duplication, besides being a source of computational inefficiency, would require the use of an otherwise unmotivated lexical rule in order to capture obvious generalizations, like the fact that the former interpretation embeds the latter as the quantifier's restriction. Our

[51]Cf. the Head-Complement Schema (27), section 3.1.

solution is to obtain the two interpretations from the same lexical sign by simultaneous encoding of the two types of semantic information, modulo DISQUANT and LF; the linguistic context will ensure that only one of the two feature values be taken as the noun's relevant interpretation. Hence the following lexical features for non-predicative readings of count nouns acting as heads in languages like English or Italian:

- singular nouns call for a specifier and introduce no quantifier, which means they show [DECORATED|SPR+] and [DISQUANT { }];
- plural nouns have lexically undetermined DECORATED|SPR value, but they introduce via DISQUANT a quantifier whose DET value is appropriate for bare plurals in the language under consideration – e.g., in Italian, *exists*, but in English the non-maximal sort *exists-or-gen*, equivalent to the disjunction *exists* ∨ *gen*, where *gen* stands for "an abstract generic operator ...that binds a variable to produce a generic reading" (Diesing 1992: p. 16)[52].

Here is the lexical sign (with usual semplifications) for a sample plural noun in English:

$$\text{(30)}\quad {}_{word}\!\left[\begin{array}{ll} \text{PHONOLOGY} & \texttt{/books/} \\ \text{SYNS}\,|\,\text{LOC} & {}_{loc}\!\left[\begin{array}{ll} \text{CAT}\,|\,\text{HEAD} & \textit{noun} \\ \text{CONTENT} & {}_{cont}\!\left[\begin{array}{ll} \text{LF } \boxed{2} & {}_{nom\text{-}obj}\!\left[\begin{array}{ll} \text{INDEX } \boxed{1} & {}_{ref}\!\left[\begin{array}{l} \text{PERSON } \textit{3rd} \\ \text{NUMBER } \textit{plur} \\ \text{GENDER } \textit{neut} \end{array}\right] \\ \text{RESTR} & \left\{ {}_{psoa}\!\left[\begin{array}{l} \text{REL } \textit{book} \\ \text{INST } \boxed{1} \end{array}\right] \right\} \end{array}\right] \\ \text{DISQUANT } \boxed{3} & \left\{ {}_{quant}\!\left[\begin{array}{l} \text{DET } \textit{exists-or-gen} \\ \text{RESTIND } \boxed{2} \end{array}\right] \right\} \end{array}\right] \end{array}\right] \\ \text{QSTORE } \boxed{3} & \end{array}\right]$$

The case (B) differs semantically from (A) in that the quantifier introduced by the plural noun is not fully confirmed as interpretation of the NP, because the noun is modified and this fact triggers 'quantifier updating' modulo the Revised Semantics Principle. Our strategy implies that we have to generalize DISQUANT with non-empty set to all those constituents that potentially could receive or pass up a given quantifier as NP interpretation. Thus, the DISQUANT set of a lexical sign that may be/project an adjunct

[52]Cf. also Gerstner-Link & Krifka (1993).

of bare plurals must contain a quantifier preserving the 'default' quantificational force of nominals in the language at issue, but with restriction token-identical to the adjunct's LF value (which incorporates that of the nominal head, adapting the assumptions by Pollard & Sag 1994: pp. 55-56). E.g., plural qualifying adjectives of count nouns in Italian will keep *exists* as DET value of the quantifier, consistently with bare plurals in that language. The same treatment can be extended to Italian possessive determiners in the plural, an example of postdeterminers behaving as syntactically ordinary adnominal adjuncts allowed to modify a bare plural (v. Allegranza, in press, for discussion of data). They too preserve the 'default' quantificational force *exists*, but in addition their function of deictic determiners of reference is accounted for by linking up with the context of utterance, modulo a 'possessive' *psoa* contributed to the quantifier restriction (cf. Pollard & Sag 1994: pp. 52-53). See in (31) below the CONTENT-CONTEXT correspondence for *miei* ('my'-plur.-masc.)[53].

(31)
$$
{}_{\text{loc}}\left[\begin{array}{ll}
\text{CONTENT} & {}_{\text{cont}}\left[\begin{array}{ll}
\text{LF } \boxed{3} & {}_{\text{nom-obj}}\left[\begin{array}{ll}
\text{INDEX } \boxed{1} & {}_{\text{ref}}\left[\begin{array}{l}\text{NUMBER } \textit{plur}\\ \text{GENDER } \textit{masc}\end{array}\right]\\
\text{RESTR} & \left\{ {}_{\text{psoa}}\left[\begin{array}{l}\text{REL } \textit{poss}\\ \text{POSSESSOR } \boxed{4}\\ \text{POSSESSED } \boxed{1}\end{array}\right]\right\} \cup \boxed{2}
\end{array}\right]\\
\text{DISQUANT} & \left\{ {}_{\text{quant}}\left[\begin{array}{l}\text{DET } \textit{exists}\\ \text{RESTIND } \boxed{3}\end{array}\right]\right\}
\end{array}\right]\\
\text{CONTEXT}\,|\,\text{C-INDICES}\,|\,\text{SPEAKER } \boxed{4} & {}_{\text{ref}}\left[\begin{array}{l}\text{PERSON } \textit{1st}\\ \text{NUMBER } \textit{sing}\end{array}\right]
\end{array}\right]
$$

Concerning modified bare plurals in English, we have to take into account not only the ambiguity w.r.t. 'default' quantificational force (hence adjuncts will preserve *exists-or-gen*), but also the fact that the English language does not distinguish between singular and plural forms of qualifying adjectives. However, no unmotivated duplication of lexical signs is implied by our approach: one can simply associate the single, uninflected lexical sign of an English adjective of count nouns with the quantifier that is required when that adjective combines with a bare plural. Indeed, when the adjective combines with a nominal calling for a specifier (as mandatory in the singular),

[53]It is worth noting that Italian possessive determiners, unlike English ones, morphologically agree in number and gender with the nominal head referring to the POSSESSED entity; person and number of the POSSESSOR are determined by lexical choice w.r.t. the possessive stem. Thus, e.g., *miei* differs from *mio* ('my'-sing.-masc.), on the one hand, and from *suoi* ('his/her/its'-plur.-masc.) on the other hand.

there will certainly be some functor – the specifier, at least – which will apply to the resulting nominal with adjective, causing the adjective's quantifier to be replaced by another quantifier, according to the Revised Semantics Principle. It is worth noticing that the same problem and the same solution are also relevant in other languages for lexical items that are not inflected for number but may project adjuncts of nominals, e.g. prepositions [54].

We now turn to the analysis of specified plural NPs. When the specifier is a determiner that never plays any other dependency role, hence a central determiner (case (C)), we basically adapt the analysis sketched by Pollard & Sag (1994: pp. 47-54). The difference here is that the determiner has 'semantic head' status and its CONTENT gets uniformely organized like in the other adnominal functors. Therefore, the generalized quantifier that the two HPSG theorists assume as the CONTENT value of a specifier with quantificational force – like *some* or *the*, just to mention two English examples compatible with plurals – is the DISQUANT value for us. On the other hand, the 'nominal object' drawn from the adjacent head does not only act as quantifier restriction, but instantiates the specifier's LF value in order to be transmitted unmodified to the NP node by effect of the Content Principle part of the Revised Semantics Principle [55]. Equally uniform is our analysis of possessive central determiners, e.g. the feature structure of *my* differs semantically from the above (31) just because the DET value equals *the* (so as to yield definite reference) and no agreeement constraint is imposed on the POSSESSED reference index. As a consequence of this set-up, the 'possessive psoa' contributed by the determiner is included into the 'nominal object' percolating up to the NP node in the familiar way [56].

Finally, we have to deal with the case (D), in which the specifier of a plural NP is a 'switch'. That is, in section 2.3 we have argued that cardinal postdeterminers are specifiers when no preceding determiner plays that role in the NP, else $\bar{\text{N}}$-level adjuncts; moreover, the phenomenon is meant to be accounted for without duplication of their lexical entries. In terms of the HPSG syntax already presented in section 3.1, we achieve the result in an optimally simple way, assuming that the relevant functor selects a nominal

[54] Prepositions in HPSG appear to involve a proliferation of lexical entries, but for reasons independent of our approach (v. Pollard & Sag 1994: p. 57). It will be enough to assign the relevant quantifier to the lexical entry of a preposition projecting a postnominal modifier, if this is lexically distinct from the same preposition used differently.

[55] The same kind of LF-preserving information flow can be applied in the interpretation of clause structure via a complementizer, whereas DISQUANT in that case should be irrelevant.

[56] It is thus avoided a counter-intuitive effect of Pollard and Sag's original treatment, which only introduces the 'possessive psoa' into the stored quantifier, causing *my books* to lack any possessive CONTENT, on a par with *books*. However, we refer to Allegranza (in press) for some revisions that our analysis requires in the account of the possessive's behaviour w.r.t. HPSG Binding Theory.

head decorated [SPR−] but its lexical DECORATOR information is undetermined for the SPR value. So, the use as specifier or adjunct is dictated by the syntactic context, modulo the DECORATED|SPR value (hence the number of bars) of the nominal projection the functor attaches to as daughter. However, from a semantic point of view we must obtain two related but not identical interpretations – the quantificational one and the purely numeral one – from the same lexical sign of a cardinal, by simultaneously encoding them through DISQUANT and LF, respectively. Figure (32) shows a way to do that, assuming *for5* to conventionally represent the cross-linguistic quantificational force (ambiguous between existential and generic interpretation) of the cardinal specifier whose corresponding numeral information we exemplified in (18), section 2.3. When such a 'switch' determiner is used as adjunct, the quantifier updating mechanism causes the generalized quantifier with that force to be replaced by a different one, which incorporates the numeral information as part of the restriction.

(32)
$$
{}_{loc}\begin{bmatrix}
\text{CAT}\,|\,\text{HEAD}\,|\,\text{H-SLOT}\,|\,\text{LOC} & {}_{loc}\begin{bmatrix} \text{CAT} & {}_{cat}\begin{bmatrix}\text{HEAD}\ \textit{noun}\\ \text{DECORATED}\,|\,\text{SPR}\ -\end{bmatrix}\\ \text{CONTENT}\,|\,\text{LF}\ \boxed{3} & {}_{nom\text{-}obj}\begin{bmatrix}\text{INDEX}\ \boxed{1}\\ \text{RESTR}\ \boxed{2}\end{bmatrix}\end{bmatrix}\\
\text{CONTENT} & {}_{cont}\begin{bmatrix} \text{LF} & {}_{nom\text{-}obj}\begin{bmatrix}\text{INDEX} & \boxed{1}\,{}_{ref}\begin{bmatrix}\text{NUMBER}\ \textit{plur}\end{bmatrix}\\ \text{RESTR} & \left\{ {}_{psoa}\begin{bmatrix}\text{REL}\ \textit{5}\\ \text{ARG}\ \boxed{1}\end{bmatrix}\right\} \cup \boxed{2}\end{bmatrix}\\ \text{DISQUANT} & \left\{ {}_{quant}\begin{bmatrix}\text{DET}\ \textit{for5}\\ \text{RESTIND}\ \boxed{3}\end{bmatrix}\right\}\end{bmatrix}
\end{bmatrix}
$$

4 Summary

This chapter has offered a comprehensive account of determination and quantification phenomena, based on data from Germanic or Romance languages such as Danish, English, French, German, Italian and Spanish. After a coverage description making clear our notion of 'determiners' (section 1), we have reviewed a number of relevant issues in quantificational semantics and NP syntax (section 2). Building on that, we have detailed a sample HPSG treatment (section 3), which meets our coverage requirements, is formally explicit and takes into account both linguistic adequacy and computational efficiency considerations.

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