Chapter 15
Developing a Generative Lexicon Within HPSG

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15.1 Introduction

Traditionally NLP systems are syntactically centered and tend to use semantics as a complement to syntactic analyses in cases that cannot be handled by syntax alone. It is true that most theoretically oriented approaches to syntax in NLP introduce an abstract level of representation which they label as semantic. This level, however, can hardly be called semantic, if the information that is represented in it is carefully considered. There are basically two aspects that are dealt with under this heading: predicate-argument structure (which also includes modification relations) and quantification. Although quantification is an essential element in semantic analysis, we are not going to be concerned with it here, since it is not a matter of lexical semantics (but rather belongs to the structural component of semantics). Let us just mention in passing that in many cases quantification is treated only to the extent that the problems it brings about can be really avoided in parsing sentences.

Argument structure and modification, however, are both essential to syntactic analysis and central to any approach to lexical semantics. In this paper we are interested in showing that these two perspectives can be integrated into a single approach and that the resulting system behaves better than traditional approaches. We will focus on HPSG because it has become one of the standards for NLP applications, and there are now many projects that use HPSG (or HPSG-like)

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grammars for the syntactic processing of texts.[1] We are convinced however that nothing essential hinges on these choices: that is to say the basic ideas contained in this paper could be implemented with other syntactic theories. Our working language is Catalan, but the analyses can be extended easily to other languages.

In the next section, we start by considering the traditional approach to both argument structure and modification in HPSG, and seeing its limitations. This is done in the light of data that cannot be dealt with by following older versions of HPSG. We develop our proposed revision of the HPSG semantic treatment in Sect. 15.3, and apply it to the cases previously introduced (Sect. 15.4). The last section is devoted to show how the semantic representation that has been provided for lexical entries can be the basis for the generative capability of words in context, within the framework of an effective computational environment.

15.2   Semantic Phenomena with Impact to Syntax

In standard linguistic practice, the relation between heads and their complements is governed by syntax and is generally accounted for by syntactic principles and relations. In HPSG, the valence and head principles account for the well-formedness of syntactic constructs. It is true that phrasal signs have also to conform to the semantics principle, but semantic information is only complementary to the syntactic structure and relations, and helps overcome the inadequacies of a purely surfacy approach to head-complement relations. Thus, the distinction between subcategorisation and argument structure within HPSG signs allows the encoding of general grammatical relations to overcome some of the most well-known form-function mismatches. For example, control relations are expressed by means of the coindexing of argument values in the CONTENT, so that a single element in the VALENCE lists provides the content to two distinct argument positions. And passive is treated as a change in the correlation between elements in the VALENCE lists and elements in the corresponding CONTENT.

In the last versions of HPSG, a further step has been taken towards facilitating the semantic calculation. The different treatment of semantic information for nouns and verbs, traditional in HPSG for many years, has been superseded in more recent works. To list but a few, Badia and Colominas (1998), Sag and Wasow (1999), Asudeh and Crouch (2002), and the MRS work (see, e.g., Copestake et al. 2005), provide a cross-category treatment of semantic representation. In all these works, it is assumed that both nominal and verbal expressions introduce an existential variable, over individuals or events, as the case may be.[2] By this means, noun

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[1]Some relevant references are Van Eynde and Schmidt (1998), Kay et al. (1994), and http://lingo.stanford.edu.

[2]The proposal that events introduce an existential variable comes from Davidson (1967).

arguments and verb modifiers can be easily integrated into equivalent semantic representations, thus providing a consistent typing among all complement classes (arguments and modifiers), irrespective of their syntactic head.

In the following two subsections, however, we point to linguistic data showing that this move is not sufficient to satisfactorily account for head-complement relations. In particular, the data show that lexical semantic information has to be taken into account. We consider first cases concerning argument structure, and then move to cases of modification.

15.2.1 Argument Structure

Generally, only two basic kinds of complements are distinguished: those that are strictly subcategorised by the head (also referred to as "arguments") and those that are not required for by their head – that is, modifiers. However, as it has often been noted, this distinction is not sufficient. Firstly, it cannot account for complement optionality in a satisfactory way, forcing most syntactically-based systems to list distinct lexical entries of verbs in order to encode their multiple realisations. Secondly, it cannot represent those complements that are optional but still semantically selected by their heads, as it is the case with most noun complements. And finally, it does not allow for an adequate treatment of complements that are semantically implied but cannot be expressed at the surface.

Complements to verbs are often optional, but their optionality can be of different sorts. In some cases, distinguishing between two (or more) lexical entries for the same verb might be justified. But very often this is not the case, since the presence or absence of the complement is due to syntactic and semantic properties of the sentence, which have nothing to do with the lexical semantics of the verb. This is so, for example, with direct object elision in generic sentences (1) and object deletion structures (2):

(1) La   meva germana compra a plaça   cada dissabte.
     The my   sister   buys   in farmer's market each Saturday

(2) Aquest noi menja molt de pressa.
     this   boy eats   very of hurry

In addition, Pustejovsky (1995) points out the existence of complements that are clearly optional but whose relation to the head is controlled by the semantics of the verb. This is the case of the so-called *default* (*D-arg*) and *shadow arguments* (*S-arg*). The former are defined as those arguments that participate in the predicate semantics but which do not need to be syntactically expressed (3), whereas the latter are conceived as semantic content that can only be expressed at the surface under specific semantic conditions (cf. the anormality of 4 if the modifier *expensive* would not appear: ??*Mary buttered her toast **with butter***):

(3)   *D-Arg*: John built the house **out of bricks**

(4)   *S-Arg*: Mary buttered her toast **with an expensive butter**

Noun complements are even more optional than verbal ones. As a matter of fact almost every nominal complement can be omitted in some circumstance, as shown here:

(5)   a. Aquesta tarda   un grup de nens   jugava a la plaça
          This   afternoon a group of children played in the square
       b. El   grup   l'   ha acceptat molt bé
          The group him/he has accepted very well

(6)   a. Compraré   dos fulls   de cartolina
          will-buy(1st-sing) two sheets of paperboard
       b. Escriu -ho en un full
          write   -it on a sheet

For noun complements, the strategy of listing every subcategorisation option as a different lexical entry is not very convincing, as there is almost no grammatical cue that may help to choose a particular lexical entry over another. This is even more problematic in languages like Catalan or Spanish, in which the great majority of complements to nouns are introduced by the preposition *de*. Furthermore, choosing between the objective and subjective interpretation of complements of transitive deverbal nouns is very often not possible on simple syntactic grounds. Examples (7–8) illustrate that this choice strictly depends on the complement's semantic value, since their syntactic structure is exactly the same.

(7)   l' estudi de les plantes   (*the study of plants*)

(8)   l' avaluació dels inspectors   (*the evaluation of the inspectors*)

Further arguments in favor of a semantically-oriented treatment of VP and NP optional complements can be derived from examples like those in (9–10). They illustrate that discourse elements can influence the interpretation of complements. Complements that are not explicitly present may serve as antecedent of an anaphoric relation or of a discourse inference. Thus, the use of the definite determiners *el seu* ('her') in (9), and *l'* ('the') in (10), marked in bold face, is licensed by the omitted complements of *mare* ('mother') and *amanir* ('to dress'), respectively.

(9)   Avui ha vingut una mare. Venia   a dir que **el seu** fill no
       podrà   venir a l' excursió
       today has come a   mother. came(3rd-sg) to say that the her son not
       will-be-able come to the excursion

(10)   Hem   amanit l' enciam però l' hem   llençat
       perquè **l'** oli era ranci
       have(1st-pl) dressed the salad   but it have(1st-pl) thrown-away
       because the oil was rancid

Finally, there are arguments that cannot appear at the surface as complements, although they are implied by their predicates. Redescription predicates like *copiar* ('copy'), *analitzar* ('analyse'), or *traduir* ('translate') are an interesting class of predicates in this sense. Semantically, they introduce at least three different entities: the agent (expressed by the subject), the entity that undergoes the process denoted by the verb (expressed by the object), and the entity resulting from the process. The latter one cannot be expressed as a syntactic complement, and yet its identification is relevant for interpreting phrases in which those predicates appear. This is at least relevant in two contexts: when it is denoted by the corresponding verbal nominalisation (11), and when it can be referred to anaphorically after the appearance of the predicate ((12) and (13)) (as pointed out in Badia and Saurí 1998).

(11)   He   llegit la traducció   de Hamlet que em vas deixar
       have(1st-sg) read the translation of Hamlet that me lent(2nd-sg)

(12)   Traduir   aquest pamflet m' ha costat molt però al   final
       crec   que ha quedat   molt natural
       to-translate this   pamphlet me has cost   a-lot but in-the end
       think(1st-sg) that has resulted very natural

(13)   La decoració del   pont   ens ha portat molt de temps, però ha
       quedat   tan bonica!
       the decoration of-the bridge us   has taken much of time, but   has
       resulted so beautiful!

Example (11) shows that the nominalisation *traducció* ('translation') can denote the entity resulting from the process. The verb involved (*llegir*,'to read') causes the nominal to be interpreted as an individual (and not as an event). This individual is not the one undergoing the translation process, but the one resulting from it. Sentences (12–13) exemplify the fact that anaphors can be based on the entity resulting from the process denoted by the predicate, even if this cannot be expressed by any argument of the verb. In the first clause, the redescription predicates (*traduir* and *decoració*) express the process reading, whereas in the second clause they are referred to as denoting the object resulting from the process. Data like that above justify then a more sophisticated approach to lexical semantics.

Redescription predicates present yet another feature that shows the limitations of a standard approach to argument structure, hence pointing to the need of an improved treatment along the lines we are claiming.

(14)   a. En Joan va copiar l'aquarel·la (*Joan copied the watercolour*)
       b. En Joan va copiar molt l'aquarel·la (*Joan copied a lot the watercolour*)

(15)   a. És una aquarel·la molt copiada (*It's a very copied watercolour*)
       b. És una aquarel·la copiada (*It's a copied watercolour*)

In (14a) the denotation of the theme (an original watercolour) undergoes a transformation (that of being copied) and a new object is created after the process

is finished (a new watercolour, which is a copy of the original one). As shown in (14b) the process can be quantified. The quantification does no affect the degree of the transformation of the theme, but it is a real event quantification (a lot of different copies have been painted out of this original watercolour). This interpretation is also available from the participle *copiada* (with the quantifier *molt* ('very')) when used as a noun modifier (15a). Note however that when the participle is not quantified the meaning of the phrase is different: in (15b) the modifier *copiada* indicates that the entity denoted by the whole NP is a watercolour which is not original, but a copy. These two last examples show that passive participles of redescription verbs may relate to either of the two entities involved in the process denoted by the predicate: the theme or the created object. The created object interpretation is usually the preferred one, unless there is some particular specification in the context.

(16) a. És una novel·la traduïda   (*It's a translated novel*)
      b. És una novel·la traduïda del basc

                                              (*It's a novel translated from Basque*)
      c. És una novel·la traduïda al basc

                                              (*It's a novel translated into Basque*)

Sentences above offer additional examples of contextually determined sense variation: the participle interpretation in (16a) (i.e., without modification) is equivalent to the one in (16b); that is, they both relate to the created object. It is only when the goal complement appears (16c) that the participle relates to the theme of the verb (i.e., to the original object being translated). This behaviour asks for a rich semantic treatment capable of both representing the different entities introduced as participants, and accounting for the sense alternations observed here.

15.2.2 Modification Relations

Modifiers can also be difficult to integrate by means of standard approaches. Particularly, non-intersective modifiers are problematic with regard to their interpretation. Most adjectives, for instance, denote differently depending on the context in which they appear. Adjectives in (17) and (18) allow an intersective (let's say, "literal") interpretation, or a non-intersective (or "figurative") one, depending on the noun they modify.

(17) a. un plàstic dur   (*a hard plastic*)
      b. una feina dura   (*a hard job*)

(18) a. una biga llarga   (*a long beam*)
      b. una llarga tradició   (*a long tradition*)

Of course, the difference here concerns the distinction between intersective and non-intersective interpretations of the adjective. But there is sense variation among cases of non-intersective use as well. Consider the adjective *ràpid* ('fast'): it usually

modifies events, and yet it can appear in expressions like those in (19) where it predicates of individuals –thus resulting in a non-intersective use. In these examples, *ràpid* ('fast') denotes differently ('who types fast', 'who drives fast', 'that can be driven fast') depending on the noun with which it is combining (Bartsch 1985).

(19) a. un mecanògraf ràpid   (*a fast typist*)
      b. un conductor ràpid   (*a fast driver*)
      c. un cotxe ràpid   (*a fast car*)

Furthermore, some adjectives can express different properties at the very same local context, hence allowing for both an intersective and a non-intersective interpretation. Example (20) refers to either a red-coloured pencil or a pencil that colours red –being the latter sense the most prominent. Similarly, *trencat* ('broken') in (21) can apply over the whole entity or just over a part of it, which is the preferred reading.

(20) un llapis vermell   (*a red pencil*)

(21) un braç trencat   (*a broken arm*)

To deal with cases like all those above, in the next section we modify and enrich the content description level of HPSG by integrating a component of lexical semantics information along the lines of GL (Pustejovsky 1995).

15.3   Proposed Treatment

15.3.1   The Organisation of Semantic Information

Data in the previous section have shown the need for a new view of HPSG content structure with richer and more semantically-oriented information. This new approach should aim at overcoming two issues in formal and computational semantics: the integration of treatments for verbal and nominal adjuncts, and the representation of nominal predicate structure. Older versions of HPSG were not able to deal with these two problems because of their category-oriented treatment of semantics. On the one hand, the reasonably established approach to nominal adjuncts could not be extended to verbal modifiers because the semantic structure for verbs did not introduce any INDEX attribute to which the possible adjuncts could be linked. On the other, nominal signs had no level where to express their predicate-argument structure, in contrast to verbs. In more recent versions of HPSG, however, these problems have been addressed, and a homogeneous treatment across the different major syntactic categories is proposed. Based on work pioneered by Davidson (1967), in HPSG-related work this has been introduced in Badia and Colominas (1998) and Sag and Wasow (1999), among others. It is also customary in Minimal Recursion Semantics (MRS), the computational semantics framework

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       ⎡ INDEX    index                                                              ⎤
       ⎢ ARGSTR   argument-structure                                                 ⎥
       ⎢                   ⎧ ⎡ EVSTR   event-structure                         ⎤ ⎫  ⎥
       ⎢                   ⎪ ⎢                    ⎡ FORMAL        formal     ⎤ ⎥ ⎪  ⎥
       ⎢ RESTR             ⎨ ⎢         IDENSTR    ⎣ CONSTITUTIVE  constitutive⎦ ⎥ ⎬  ⎥
       ⎢                   ⎪ ⎢ QUALIA                                          ⎥ ⎪  ⎥
       ⎢                   ⎪ ⎢                    ⎡ AGENTIVE   agentive ⎤       ⎥ ⎪  ⎥
       ⎢                   ⎩ ⎢         FUNCSTR    ⎣ TELIC      telic    ⎦       ⎥ ⎭  ⎥
restind⎣                     ⎣restr                                            ⎦      ⎦
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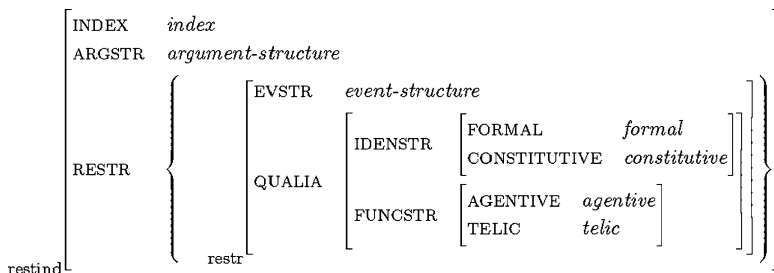
Fig. 15.1 Basic Sign for the content level

developed by A. Copestake (Copestake et al. 2001, 2005; Flickinger and Bender 2003), and in the large grammars development project LinGO (Copestake and Flickinger 2000). The Glue Semantics approach to interpretation within the HPSG framework also opts for a move along similar lines (Asudeh and Crouch 2002).

Our work aims at integrating lexical semantics representations within the HPSG framework, so we start by stating the basic semantic structure for linguistic signs. Based on the proposals just mentioned, we posit a unique semantic structure for all major syntactic categories. As a result, the representation of the CONTENT level of linguistic units is as follows (Fig. 15.1):

The CONTENT level integrates the INDEX and RESTRICTION (RESTR) attributes used in the description of the semantics of nominals, together with ARGUMENT-STRUCTURE (ARGSTR), which would correspond to NUCLEUS, the attribute that introduces the predicate-argument information of verbal signs in standard HPSG. We adopt here the term ARGSTR from GL since, in contrast to NUCLEUS, ARGSTR classifies the arguments according to the distinction among true-, default- and shadow-arguments (cf. examples (3–4)). Some proposals in HPSG introduce an argument structure feature (named arg-st) as attribute at the lexical-sign type (e.g., Davis and Koenig 1999; Koenig and Davis 2003; Ginzburg and Sag 2000). Although it is limited to the description of lexical entries, its functionality can be seen as equivalent to our argstr in that it also manages the correlation between the entities satisfying predicate argument positions and the elements fullfiling the subcategorisation restrictions of a phrasal head.

Given that now predicates introduce an INDEX attribute in the same way as referential categories such as nouns do, an enlargement of the *index* type hierarchy is needed. Thus, the standard divison of the *index* type into *expletive* (*it* and *there*) and *referential* subtypes, is complemented with the distinction among *entity* (*individual* and *eventuality*) and *degree* indexes. The type *individual* subsumes the cases treated by the standard *referential* type; that is, non-predicative nouns. The type *eventuality* is adequate for verbal predicates, adjectives and predicative nouns in general. Finally *degree* is used for quantifiers and certain kind of adverbs. We distinguish here between the types *degree* and *entity* because there are modifiers that select heads that are either individuals or eventualities, such as *in Chicago*. This way, the type *entity* (that includes both individuals and eventualities, but excludes degrees) provides the

Fig. 15.2 Index type hierarchy
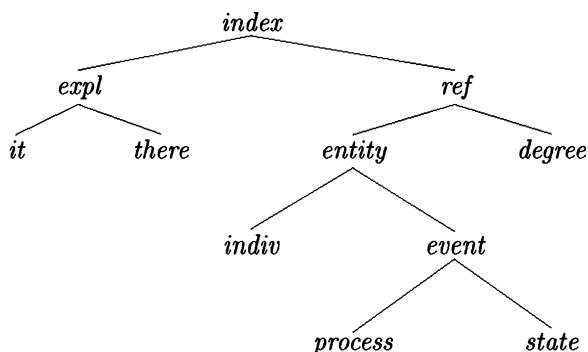
appropriate subspecification that is needed for a neat account of these modifiers.[3] The partial hierarchy for the *index* type is as shown here (Fig. 15.2):

The third attribute in CONTENT, RESTR, is also modified from standard HPSG in order to introduce a component of lexical semantics information. Now it is not a set of *psoas* but a set of *restr* structures, each of them composed of two different information levels: event structure (EVSTR), and qualia structure (QUALIA), which is further subdivided into identity structure (IDENSTR) and functional structure (FUNCSTR). Thus, the semantic restrictions that the denoted entity has to satisfy are not constituted of a single relation or property (one per *psoa*); instead, each description level in the restriction introduces at least one relation that concerns a particular aspect of the word meaning.

Let us now turn to the specific information in the qualia structure. The two attributes represented, IDENSTR and FUNCSTR, group into two levels the four classic qualia roles: FORMAL and CONSTITUTIVE on the one hand, and AGENTIVE and TELIC on the other. We thus incorporate the four specific dimensions that are customary in GL: the properties that classify a given entity within the class it belongs to (the FORMAL role), its constitutive structure (CONSTITUTIVE), its originating process (AGENTIVE), and its purpose (TELIC). The dual distinction within QUALIASTR is based on the lines drawn by the work in GL where special attention is given to the functional qualia levels (Pustejovsky 1998, 1999). The particular formalisation that we adopt here is argued for in Sect. 15.4.6.

Note also that we include the EVSTR level in the *restr* type, at the same level as the qualia structure. In GL, EVSTR is an independent semantic level that represents information of the eventuality expressed by the entity. Here we include EVSTR within the *restr* structure, which is the type appropriate for the RESTR value, because for most kinds of predicative expressions it conveys semantically relevant information that restricts the entity pointed at by the index and that has to be

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[3]Note in addition that if the type hierarchy of Bender, Sag and Wasow (2003) were used, the partial hierarchy of index would differ considerably, since in this new version of Sag and Wasow (1999) *it* and *there* have *none* as value of the feature INDEX.

$$
restind \begin{bmatrix} \text{INDEX} & index \\ \text{ARGSTR} & argstr \\ \text{RESTR} & set\text{-}of\text{-}restr \end{bmatrix} \quad quantifier \begin{bmatrix} \text{DET} & semdet \\ \text{RESTIND} & restind \end{bmatrix} \quad psoa \begin{bmatrix} \text{QUANTS} & list\text{-}of\text{-}quants \\ \text{RESTIND} & restind \end{bmatrix}
$$
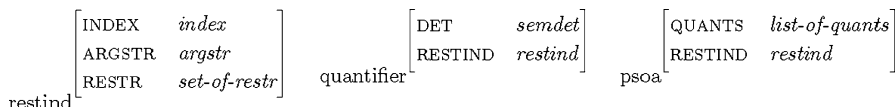
Fig. 15.3 Assumed HPSG subtypes of content

preserved as restrictive information through the processes of phrasal composition.[4] The way how information within qualia structures will be projected to the phrasal head node is presented in the next section.

15.3.2   Basic Semantic Types and Composition of Semantic Information

In order to preserve the cross-category approach to basic lexical meaning, we modify the subtypes of *content* in Pollard and Sag (1994). We restate them taking *restind* as the structure appropriate for the semantic representation of every major part of speech. First, the *restind* type as represented in Fig. 15.3 substitutes *nom_obj*. Secondly, it is established as the value for the RESTIND attribute in the *quantifier* semantic structure as well. And finally, it is also adopted to express the nuclear information in *psoa*, the semantic structure for the description of predicates. We therefore adopt the new *restind* type as the value for the NUCLEUS attribute, which from now on will be renamed RESTIND. Regarding quantification, we follow the treatment given in Pollard and Sag (1994). The three subtypes of *content* in Pollard and Sag (1994) are respectively transformed as shown in Fig. 15.3.[5]

Following Sag and Wasow (1999) in assuring a 'head-driven' character to semantic composition in a parallel way with the syntactic processing, we restate the Semantics Principle in order to adequately account for the composition of semantic information[6]:

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[4]Note that if EVSTR were an attribute of the *restind* type, alongside INDEX, ARGSTR, and RESTR, the event structure information obtained from the different constituents during the compositional process would be unified. On the other hand, keeping it in the *restr* type allows for composing the EVSTR of the different constituents by an operation of union (as ruled by the Semantics Principle, to be restated in the following section) which, in contrast to unification, is preserving by nature.

[5]For practical reasons, from now on we will use the *restind* type to represent not only the semantic structure of non-quantified nominal expressions, but also both quantified and predicative expressions, omitting the other attributes in the *quantifier* and *psoa* types.

[6]Since we have not discussed the HPSG treatment of quantification, we assume that the part of the Semantics Principle that concerns quantification remains unaltered.

In a headed phrase:

1. the RETRIEVED value is as in Pollard and Sag (1994:323); and
2. the INDEX and ARGSTR attributes of the CONTENT value are identical to those of the head daughter, whereas the RESTR set value is composed of the union of each daughter's RESTR set.

15.4   Analysis of the Data

15.4.1   Optional Complements

We will first try to account for optional complements of verbal and nominal predicates, partially following the proposal developed in Badia and Saurí (1998). Given their optionality, the standard HPSG treatment of obligatory complements by means of valence lists is not adequate, because it does not allow a phrase to combine with a head if it is not fully saturated. Treating optional complements as free adjuncts does not work either, since in many cases their semantics is integrated into that of the main predicate, and may be referred to by anaphors even if they are not present. On the other hand, listing lexical entries would result in an undesired increase of lexical items and the missing of fairly productive regularities throughout the lexicon.[7] Thus, we need a treatment that (i) accounts for complement optionality (i.e., that phrases can be saturated even if some complements are not present), (ii) guarantees that, if they are present, their semantics integrates with that of the other elements in the construction (in the same way as obligatory complements do), and (iii) allows the non present complements to be referred to by anaphors, because they are essential components of the meaning of the predicate in which they are involved.

At the moment we know of two possible accounts for optional complements within HPSG. As part of the development of the English Resource Grammar (ERG), a proposal has been put forward (Götz and Meurers 1997; De Kuthy and Meurers 2003) which deals with the optionality of complements without having to resource to the listing of each option in a different lexical entry. Roughly stated, their proposal amounts to allowing for a specific marking of complements indicating whether they are obligatory or optional. The Subcategorisation Principle is then modified so that phrases are saturated if there are no obligatory complements left in the valence lists. This treatment directly complies with conditions (i) and (ii) above.

The second proposal we know for optional complements is Sanfilippo's (1997). For independent reasons he proposes that some complements can be treated as actual adjuncts from a syntactic point of view, even if they are thematically bound to the relation denoted by the head. This complies with the three requirements above, but it has the drawback that complements that can never appear in long-distance contexts

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[7]A nominalisation of a simple transitive verb would have 4 distinct lexical entries: with the two complements, with either of the complements, or without any complement.

(like complements to nouns) are classed at the NONLOC level of information within the linguistic sign. Given that standard HPSG considers members at NONLOC level of obligatory retrieval, in a similar way that those elements in valence lists, Sanfilippo's proposal guarantees the optional retrieval of such complements by partitioning the sort appropriate for nonlocal set members (*local*) into a sort appropriate for structures of obligatory retrieval (*gap*, which becomes the sort for extracted phrases) and a sort for structures of optional realisation (named θ-*adjuncts*, which becomes the sort adequate for thematic adjuncts).

In Badia and Saurí (1998, 2000), we adopt this mechanism and represent optional complements (D- and S-Args) as thematically bound adjuncts, introduced as set members at the nonlocal (NONLOC) information level. In this paper, however, we adopt a more conservative approach to complement optionality. We follow the suggestion in Sag and Wasow (1999) and Flickinger (2000), and tag optional complements with a specific feature. At the same time, we assume that the ARGSTR list contains information about the specific semantics of the complement that allows for maintaining its semantic information even if it is absent in the surface string.

In order to illustrate how this proposal is applied, consider first the creation verb *construir* ('build'), from which an ordinary process-result nominalisation can be derived (*construcció*'building'). As stated in Pustejovsky (1995), this verb subcategorises for two obligatory complements (the agent and the theme resulting of the building process, as usual in creation verbs) and a third argument that expresses the material out of which the resulting entity is built. This third argument is considered a D-Arg because it is syntactically optional but participates in the logical expression of the event (cf. example (3)). Figure 15.4 shows the coexistence of obligatory and optional complements in the syntactic part of the sign: both complements are declared in the VALENCE lists, but optional complements are declared between brackets. Recall that these, in addition, are identified as *default arguments* (D-Args) at the ARGSTR.[8]

In the deverbal nominalisation of *construir*, which is *construcció* ('building'), it is not only the'material' argument but also the agent and result arguments that are optional. Hence all three arguments are considered D-Args and are represented as optional complements in the VALENCE lists. Figure 15.5 represents the process reading of *construcció*.

This treatment is also applicable to the verbs *menjar* ('eat') and *amanir* ('dress (a salad)') in examples (2) and (10) above. Similarly, the treatment also applies to transformation verbs, as shown in Fig. 15.6: it represents the process of *subratllar* ('underline'), referred by the *e1*, which is detailed in the AGENTIVE structure as a process with two participants from ARGSTR: the agent and the theme of the process (the entity being transformed, which corresponds to the complement of the verb).

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[8]In this and the following figures, the *index* subtypes for each entity involved in the semantics of the word being represented will be indicated within boxes and using the following code: *t* for *entity* indices, *d* for *degree*, *i* for *individuals*, and *e* for *eventualities*, which in addition can be split into *s* and *p* (for *states* and *processes*, respectively). Also, the IDENSTR and FUNCSTR attributes within the qualia structure will not be represented unless they are relevant for the discussion.

$$
\begin{bmatrix}
\text{CAT} & \begin{bmatrix}
\text{HEAD} & verb \\
\text{VALENCE} & \begin{bmatrix}
\text{SUBJ} & \left\langle \text{NP}_{\boxed{i1}} \right\rangle \\
\text{COMPS} & \left\langle \text{NP}_{\boxed{i2}}, \left(\text{PP}_{\boxed{i3}} \right) \right\rangle
\end{bmatrix}
\end{bmatrix} \\
\text{CONT} & \begin{bmatrix}
\text{INDEX} & \boxed{e1} \\
\text{ARGSTR} & \begin{bmatrix}
\text{ARG1} & \boxed{i1}\ animate\text{-}ind \\
\text{ARG2} & \boxed{i2}\ artifact \\
\text{D-ARG3} & \boxed{i3}\ material
\end{bmatrix} \\
\text{RESTR} & \left\{ \begin{array}{l}
\text{EVSTR}\ \begin{bmatrix}
\text{EVENT1} & \boxed{e1}\ process \\
\text{EVENT2} & \boxed{e2}\ state \\
\text{RESTR} & \boxed{e1} \left\langle \boxed{e2} \right. \\
\text{HEAD} & \boxed{e1}
\end{bmatrix} \\
\text{QUALIA}\ \begin{array}{l}
\text{FORM}\ \begin{bmatrix}
\text{RELN} & exist \\
\text{ARG1} & \boxed{i2} \\
\text{EVENT} & \boxed{e2}
\end{bmatrix} \\
\text{AGEN}\ \begin{bmatrix}
\text{RELN} & build \\
\text{AGENT} & \boxed{i1} \\
\text{INSTR} & \boxed{i3} \\
\text{EVENT} & \boxed{e1}
\end{bmatrix}
\end{array}
\end{array} \right\}
\end{bmatrix}
\end{bmatrix}
$$

Fig. 15.4 construir ('build')

The process leads to a resulting state *e2*, expressed in the FORMAL role as usual in the GL treatment for accomplishment verbs (Pustejovsky 1995; Johnston 1996). In particular, it denotes the state of being modified of the theme. This is different from creation verbs (Fig. 15.4), in which the theme expresses the newly created object and it is thus introduced by the *exist* relation.[9]

15.4.2   Selectional Constraints on Predicate Arguments

Other types of nouns with semantically implied (optional) complements can be similarly treated. For example, non-deverbal nouns expressing a relation with another entity, like nouns denoting sets or partitions (*grup*'group' in (5) and *full*'sheet' in (6)) or relational nouns (*mare*'mother' in (9)). In the lexical entry for

---

[9] As noted in Pustejovsky (1995:122ff), there are certain verbs that can contextually alternate between a transformation and a creation interpretation (such as 'bake' in 'bake a potato' or in 'bake a cake'), We will address this issue in Sect. 15.5.3.3.

$$
\begin{bmatrix}
\text{CAT} & \begin{bmatrix}
\text{HEAD} & noun \\
\text{VALENCE} & \begin{bmatrix}
\text{SUBJ} & \left\langle \left(\text{PP}_{\boxed{i1}} \right) \right\rangle \\
\text{COMPS} & \left\langle \left(\text{NP}[de]_{\boxed{i2}} \right), \left(\text{PP}_{\boxed{i3}} \right) \right\rangle
\end{bmatrix}
\end{bmatrix} \\
\text{CONT} & \begin{bmatrix}
\text{INDEX} & \boxed{e1} \\
\text{ARGSTR} & \begin{bmatrix}
\text{D-ARG1} & \boxed{i1}\ animate\text{-}ind \\
\text{D-ARG2} & \boxed{i2}\ artifact \\
\text{D-ARG3} & \boxed{i3}\ material
\end{bmatrix} \\
\text{RESTR} & \left\{ \begin{array}{l}
\text{EVSTR} \begin{bmatrix}
\text{EVE1} & \boxed{e1}\ process \\
\text{EVE2} & \boxed{e2}\ state \\
\text{RESTR} & \boxed{e1} \langle\ \boxed{e2} \\
\text{HEAD} & \boxed{e1}
\end{bmatrix} \\
\text{QUALIA} \begin{array}{l}
\text{FORM} \begin{bmatrix}
\text{RELN} & exist \\
\text{INST} & \boxed{i2} \\
\text{EVENT} & \boxed{e2}
\end{bmatrix} \\
\text{AGEN} \begin{bmatrix}
\text{RELN} & build \\
\text{AGENT} & \boxed{i1} \\
\text{INSTR} & \boxed{i3} \\
\text{EVENT} & \boxed{e1}
\end{bmatrix}
\end{array}
\end{array} \right\}
\end{bmatrix}
\end{bmatrix}
$$

Fig. 15.5 construcció (process reading)

mare'mother' in Fig. 15.7, the ARGSTR represents the optional argument required by the noun, which is coindexed with the content part of the complement expressed as optional in the VALENCE attribute, while the relationship between the individual referred to by the noun and its complement is expressed in the formal role of the qualia structure).

The complement of *mare*, although optional, is of sort *shadow argument*. Examples (22–24) show that it cannot be realised at the syntactic surface unless it is more specific than the semantic restrictions provided by the nominal head.

(22) *Ha vingut el pare d'   un fill
      Has come   the father of a   son

(23) Ha   vingut el pare d' un nen canadenc
      Has come   the father of a boy Canadian

(24) Ha   vingut el pare de la Joana
      Has come   the father of the Joana

$$
\begin{bmatrix}
\text{CAT} & \begin{bmatrix}
\text{HEAD} & verb \\
\text{VALENCE} & \begin{bmatrix}
\text{SUBJ} & \left\langle \text{NP} : \boxed{i1} \right\rangle \\
\text{COMPS} & \left\langle \text{NP} : \boxed{i2} \right\rangle
\end{bmatrix}
\end{bmatrix} \\[2em]
\text{CONT} & \begin{bmatrix}
\text{INDEX} & \boxed{e1} \\
\text{ARGSTR} & \begin{bmatrix}
\text{ARG1} & \boxed{i1}\ human \\
\text{ARG2} & \boxed{i2}\ info \cdot phys\_obj
\end{bmatrix} \\[3em]
\text{RESTR} & \left\{ \begin{bmatrix}
\text{EVSTR} & \begin{bmatrix}
\text{EVE1} & \boxed{e1}\ process \\
\text{EVE2} & \boxed{e2}\ state \\
\text{RESTR} & \boxed{e1} \langle\ \boxed{e2} \\
\text{HEAD} & \boxed{e1}
\end{bmatrix} \\[4em]
\text{QUALIA} & \begin{matrix}
\text{FORM} & \begin{bmatrix}
\text{RELN} & modified \\
\text{INST} & \boxed{i2} \\
\text{EVE} & \boxed{e2}
\end{bmatrix} \\[3em]
\text{AGEN} & \begin{bmatrix}
\text{RELN} & underline \\
\text{AGENT} & \boxed{i1} \\
\text{THEME} & \boxed{i2} \\
\text{EVE} & \boxed{e1}
\end{bmatrix}
\end{matrix}
\end{bmatrix} \right\}
\end{bmatrix}
\end{bmatrix}
$$

Fig. 15.6 subratllar ('underline')

$$
\begin{bmatrix}
\text{CAT} & \begin{bmatrix}
\text{HEAD} & noun \\
\text{VALENCE} & \begin{bmatrix}
\text{COMPS} & \left\langle \left(\text{NP}_{\mathbf{S}\boxed{i2}} \right) \right\rangle
\end{bmatrix}
\end{bmatrix} \\[2em]
\text{CONT} & \begin{bmatrix}
\text{INDEX} & \boxed{i1} \\
\text{ARGSTR} & \begin{bmatrix} \text{D-ARG1} & \boxed{i2}\ animate\text{-}ind \end{bmatrix} \\[2em]
\text{RESTR} & \left\{ \begin{bmatrix} \text{QUALIA} \mid \text{FORM} & \begin{bmatrix}
\text{RELN} & mother\text{-}of \\
\text{ARG1} & \boxed{i1} \\
\text{ARG2} & \boxed{i2}
\end{bmatrix} \end{bmatrix} \right\}
\end{bmatrix}
\end{bmatrix}
$$

Fig. 15.7 mare ('mother')

In order for the representation of S-Args to be appropriate, a constraint has to be formulated upon the semantics of the optional complement: namely, that it be more specific than the semantic implication.

$$
\begin{bmatrix}
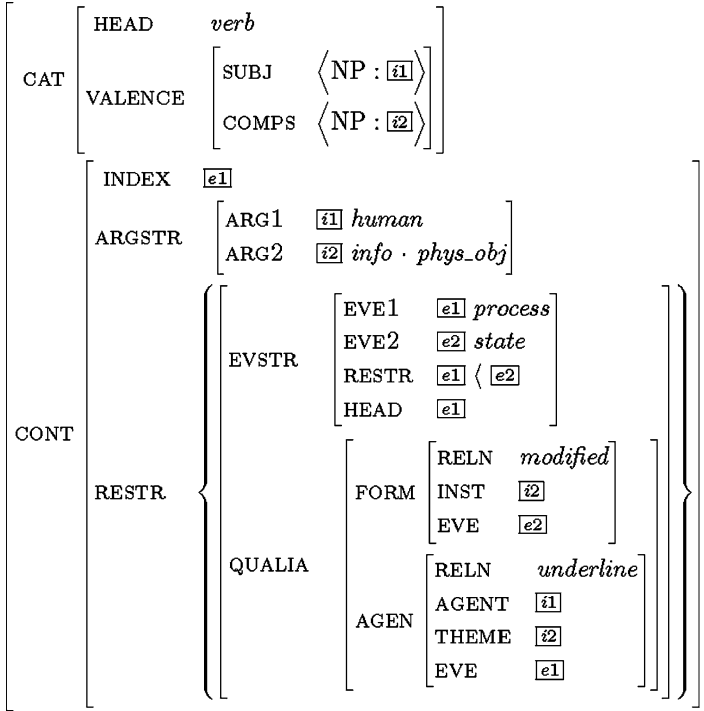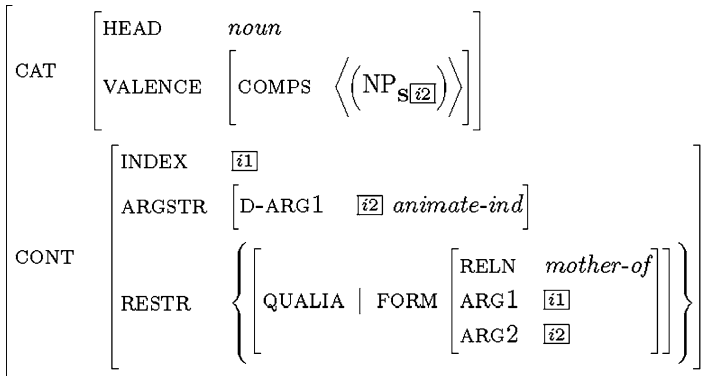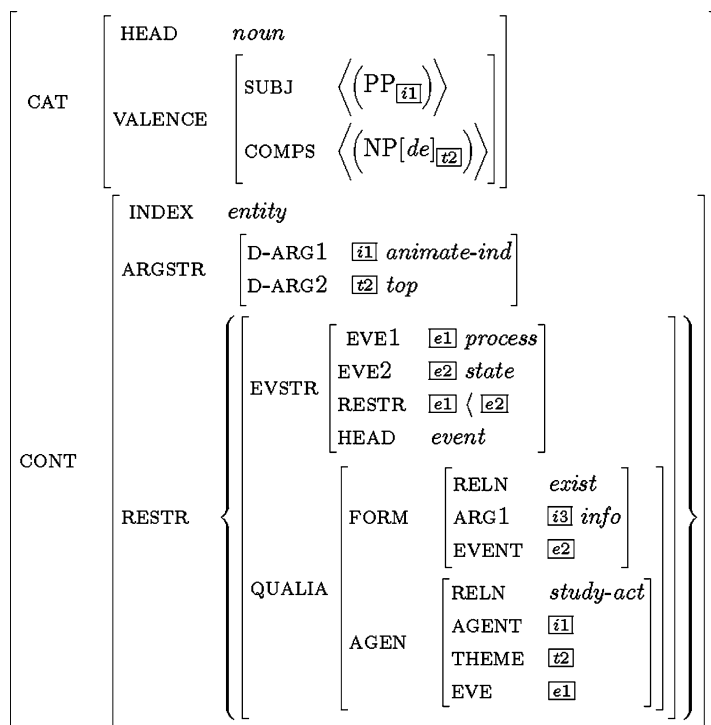\text{CAT} & \begin{bmatrix}
\text{HEAD} & noun \\
\text{VALENCE} & \begin{bmatrix}
\text{SUBJ} & \left\langle \left(\text{PP}_{\boxed{i1}} \right) \right\rangle \\
\text{COMPS} & \left\langle \left(\text{NP}[de]_{\boxed{t2}} \right) \right\rangle
\end{bmatrix}
\end{bmatrix} \\
\text{CONT} & \begin{bmatrix}
\text{INDEX} & entity \\
\text{ARGSTR} & \begin{bmatrix}
\text{D-ARG1} & \boxed{i1}\ animate\text{-}ind \\
\text{D-ARG2} & \boxed{t2}\ top
\end{bmatrix} \\
\text{RESTR} & \left\{ \begin{bmatrix}
\text{EVSTR} & \begin{bmatrix}
\text{EVE1} & \boxed{e1}\ process \\
\text{EVE2} & \boxed{e2}\ state \\
\text{RESTR} & \boxed{e1} \langle \boxed{e2} \\
\text{HEAD} & event
\end{bmatrix} \\
\text{QUALIA} & \begin{bmatrix}
\text{FORM} & \begin{bmatrix}
\text{RELN} & exist \\
\text{ARG1} & \boxed{i3}\ info \\
\text{EVENT} & \boxed{e2}
\end{bmatrix} \\
\text{AGEN} & \begin{bmatrix}
\text{RELN} & study\text{-}act \\
\text{AGENT} & \boxed{i1} \\
\text{THEME} & \boxed{t2} \\
\text{EVE} & \boxed{e1}
\end{bmatrix}
\end{bmatrix}
\end{bmatrix} \right\}
\end{bmatrix}
\end{bmatrix}
$$

Fig. 15.8 estudi ('study')

In addition to the benefits seen above, the rich semantic information we use also allows for coping with the distinction between subjective and objective complements shown in (7–8). The representation structure in Fig. 15.8 adequately blocks the false ambiguity of example (7) by avoiding an entity like *plantes* ('plants') be the agent of *estudi* ('study') –it has to be an animate individual. Furthermore, the underspecification of the *index* value allows for having just one lexical entry for the two interpretations of *estudi*: as the process, with an index value of type *eventuality*, or as the resulting object, thus bearing an *individual* index.

15.4.3 Hidden Arguments

In order to see that other types of verbal and nominal predicates can also be treated in this way, consider for instance redescription predicates such as *traduir* ('translate') and *copiar* ('copy'). As seen above, they involve at least three different entities: the agent (realised by the subject), the entity that undergoes the process denoted by the verb (expressed by the object), and the entity resulting from the process (which cannot be expressed as a syntactic complement of the predicate). When
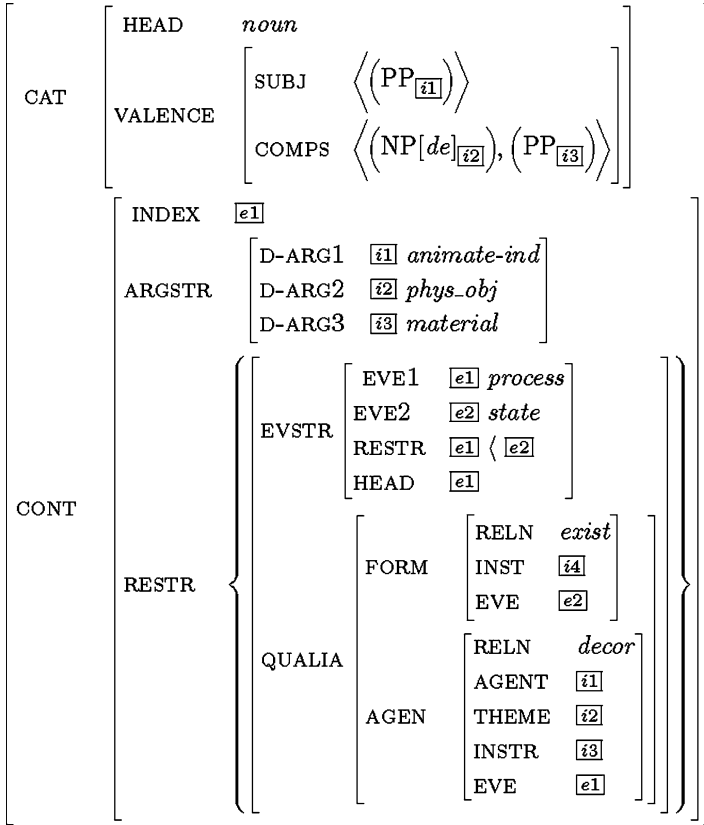
$$
\begin{bmatrix}
\text{CAT} & \begin{bmatrix}
\text{HEAD} & noun \\
\text{VALENCE} & \begin{bmatrix}
\text{SUBJ} & \left\langle \left(\text{PP}_{\boxed{i1}} \right) \right\rangle \\
\text{COMPS} & \left\langle \left(\text{NP}[de]_{\boxed{i2}} \right), \left(\text{PP}_{\boxed{i3}} \right) \right\rangle
\end{bmatrix}
\end{bmatrix} \\[2em]
\text{CONT} & \begin{bmatrix}
\text{INDEX} & \boxed{e1} \\
\text{ARGSTR} & \begin{bmatrix}
\text{D-ARG1} & \boxed{i1}\ animate\text{-}ind \\
\text{D-ARG2} & \boxed{i2}\ phys\_obj \\
\text{D-ARG3} & \boxed{i3}\ material
\end{bmatrix} \\[3em]
\text{RESTR} & \left\{ \begin{bmatrix}
\text{EVSTR} & \begin{bmatrix}
\text{EVE1} & \boxed{e1}\ process \\
\text{EVE2} & \boxed{e2}\ state \\
\text{RESTR} & \boxed{e1} \langle\ \boxed{e2} \\
\text{HEAD} & \boxed{e1}
\end{bmatrix} \\[4em]
\text{QUALIA} & \begin{bmatrix}
\text{FORM} & \begin{bmatrix}
\text{RELN} & exist \\
\text{INST} & \boxed{i4} \\
\text{EVE} & \boxed{e2}
\end{bmatrix} \\[2em]
\text{AGEN} & \begin{bmatrix}
\text{RELN} & decor \\
\text{AGENT} & \boxed{i1} \\
\text{THEME} & \boxed{i2} \\
\text{INSTR} & \boxed{i3} \\
\text{EVE} & \boxed{e1}
\end{bmatrix}
\end{bmatrix}
\end{bmatrix} \right\}
\end{bmatrix}
\end{bmatrix}
$$

Fig. 15.9 decoració (process reading)

viewed in this way, redescription predicates share some characteristics with both transformation and creation predicates. The object of transformation predicates like *subratllar*, ('underline', in Fig. 15.6) denotes the entity that undergoes the transformation –as with redescription predicates. And creation predicates (like *construir*,'build', in Fig. 15.4) imply the appearance of a new entity (as with redescription predicates), the difference being that with the former the resulting entity is expressed by the object, whereas with the latter it cannot appear in the surface as a complement. Similarly, the process reading of the nominalisations of these verbs cannot syntactically express the argument denoted by the result nominalisation, in contrast with the process reading of creation nominalisations.

However, as seen in examples (12–13) above, there are discourse factors that ask for the possibility of referring to the result arguments of this and similar predicates, even if it cannot be syntactically realised. We therefore assume that redescription predicates introduce the relation of existing a new object in the FORMAL quale, the level that represents the state resulting from the decoration process, in the same way creation predicates do. As shown in Fig. 15.9, the reference to the result is allowed

by the argument of the formal role. This participant is not bound by any element in the ARGSTR just because it can never be syntactically realised as an argument: it is treated as a hidden argument.

Thus the argument structure acts as interface between the rich semantic representation (i.e., the set of qualia structures in the value of RESTR) and the surface mechanism that licenses predicate complements (VALENCE list): only semantic arguments that may be syntactically realised are present in the argument structure, either as obligatory complements (T-Args) or as optional complements (D- and S-Args). In addition, the rich semantic structure of the sign allows us to express semantically implied arguments, and thus provides a treatment for semantically motivated discourse factors like the ones shown in (12–13) above.

This take is comparable to other work on implicit arguments (Koenig and Mauner 1999) developed within the Discourse Representation Theory framework (DRT, Kamp and Reyle 1993). Koenig and Mauner defend that there is a particular type of arguments which satisfy a predicate's argument position but cannot be used as discourse referents. They are therefore represented only at the level of the predicative conditions of the predicate, but not at the level of discourse referents. The fact that in some cases they can be referred to anaphorically is explained by means of lexically-based devices or a process of accommodation, in an analogous way to the treatment we propose here.

15.4.4   Ambiguities in Participles Modification

Redescription verbs present yet another feature that begs for an accurate treatment of their semantics. As seen in examples (15–16), repeated here as (25–26), when they appear in the passive participle form and thus behave as modifiers, the entity they modify can be interpreted as either one of the two entities involved in the process denoted by the verb: the theme or the created object. The meaning related to the created object is the preferred one (25a, 26a), unless there is a contextual specification that triggers the one related with the theme (25b, 26c).

(25)   a.   És una aquarel·la copiada (*It's a copied watercolour*)
         b.   És una aquarel·la molt copiada (*It's a very copied watercolour*)

(26)   a.   És una novel·la traduïda (*It's a translated novel*)
         b.   És una novel·la traduïda del basc
                                   (*It's a novel translated from Basque*)
         c.   És una novel·la traduïda al basc
                                   (*It's a novel translated into Basque*)

Particular specifications that promote sense alternations are: modifying the participle by some quantification adverb, such as *molt* ('very') (25b), or the presence of the predicate goal complement (26c). Both elements force the participle form

to relate to the predicate theme (i.e., the object undergoing the process) instead of relating to the resulting object, as is the case in (25a) and (26a-b). Compare now those examples with the sentences in (27a) and (28a), in which *molt* appears modifying a transformation and creation predicate, respectively.

(27) a. En Joan subratlla molt el llibre   (*Joan underlines the book a lot*)
      b. És un text subratllat   (*It's an underlined text*)
      c. És un text molt subratllat   (*It's a very underlined text*)

As a transformation predicate, *subratllar* can be quantified by an adverb such as *molt* ('very') in example (27a). Transformation predicates can be quantified, and there is a correlation between the quantification of the process they denote and the degree of the transformation of the entity denoted by the object (Dowty's 1991 incremental theme). (27b-c) show how passive participles can be used to express that the entity denoted by the head noun has been transformed, and that this transformation can be measured. As is the case with passive participle forms, the verb here denotes the resulting state.

(28) a. *En Joan construeix molt la casa   (*Joan builds the house a lot*)
      b. ??És una casa construïda   (*It's a built house*)
      c. *És una casa molt construïda   (*It's a very built house*)

By contrast, creation predicates (and their corresponding resulting states) cannot be quantified (28), and this is certainly related to the fact that there is no degree applicable to the extent to which the object has been created (that is, a house has to be completely built in order to exist; otherwise it is not a house).[10] As said redescription predicates share with creation verbs the obtention of a new entity as a result of the denoted process. When both kinds of predicates are used in their active form, this new entity realises as the object only in the case of creation verbs (29), but when creation and redescription predicates are used as passive participles, the resulting entity realises as the nominal that both of them modify (30).

(29) a. Maria copia l'aquarel·la.   (*Maria copies the watercolour*).
      b. Maria construeix una casa.   (*Maria builds a house*).

(30) a. una aquarel·la copiada   (*a copied watercolour*)
      b. una casa construïda amb totxana vermella
          (*a house built out of red bricks*)

Creation and redescription predicates however mainly differ in that, whereas the former class does not accept quantification, the latter do, given that their

---

[10]The ?? in (28b) show that a creation participle can only be used to modify a head noun under certain circumstances. Here its use is somewhat awkward because it is not informative enough: all houses are objects that have been built. A default argument such as *amb totxana vermella* ('with red bricks') appears here obligatory in order to make the sentence pragmatically acceptable. See Goldberg and Ackerman (2001) for a detailed analysis of similar data.
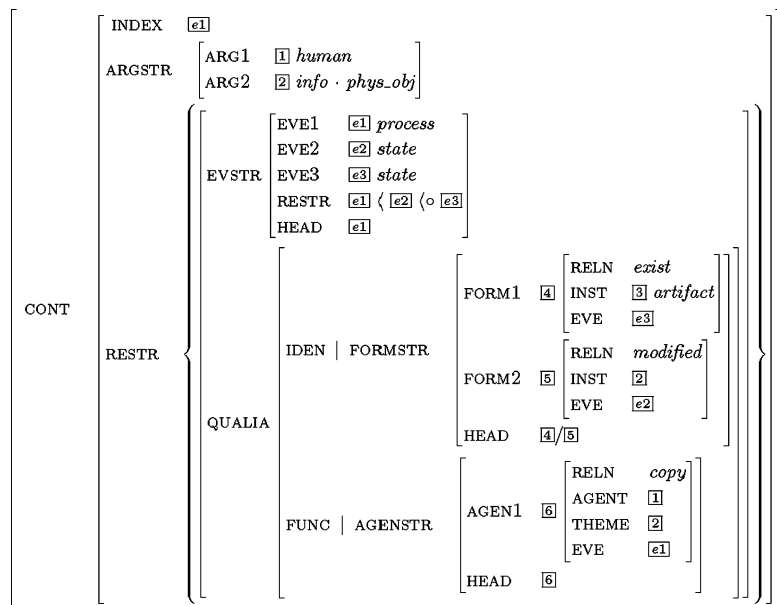
Fig. 15.10 copiar ('copy')

elements express not only a creation process but also a transformation one, and thus quantification can apply to this last process. Quantification of redescription predicates active forms is straightforward because the object refers to the entity being transformed by the process (31a). It is not the case, however, with their passive participle forms since, as creation predicates, they express the process of creating a new object (30a). Thus in this case the introduction of a quantifier such as *molt* ('very') triggers a sense alternation; that is, instead of denoting the default reading for redescription participle forms (the creation process), they denote the transformation process (31b).

(31) a. Maria copia molt l'aquarel·la   (*Maria copies the watercolour a lot*)
      b. una aquarel·la molt copiada   (*a very copied watercolour*)

We therefore put forward the introduction of an additional relation in the FORMAL role: one expressing a relation of transformation over the theme of the process. From now on, redescription predicates will be characterised by presenting a complex formal structure (FORMSTR), constitued of two FORMAL relations: a first one, stating the existence of a new entity, and a second one, denoting the state of being modified of the original object. Figure 15.10 for the redescription verb *copiar* ('copy') illustrates this modification.

The two states in FORMSTR are related by the restrictions over eventualities expressed at the EVSTR. In addition, the attribute HEAD in the *formstr* type expresses which one of them corresponds to the head of the structure. This is necessary for

representating redescription predicates when denoting the resulting state, as happens when the verb is used in its passive participle form (25–26). Since participles of redescription verbs relate to either the theme (25b) or the resulting object (25a) of the process described, depending on the contextual information, the head of FORMSTR in the representation for *copiar* in (25a) corresponds to the *exist* relation (index 5). By contrast it corresponds to the *modified* relation (index 4) when the participle relates to the theme (as in 25b). The selection of one value or the other is determined by the restrictions that the adverb *molt* imposes on its head.

Indeed, the introduction of a complex formal structure also applies to predicates with a single formal relation (Figs. 15.4 and 15.6), though they will only instantiate one of the possible *formal* types. Similarly, the complexity of the formal structure will be also reproduced in the other qualia roles, for cases where it may be necessary more than one agentive or telic relations.

15.4.5 A General Treatment for Modifiers

The modification of the HPSG content structure also has positive effects on the treatment of modifiers. We start by considering pure intersective adjectives like *inacabat* ('unfinished') and *eficaç* ('effective') in examples (32) and (33):

(32) a. un poema inacabat   (*an unfinished poem*)
      b. *un roc inacabat   (*an unfinished stone*)

(33) a. un ganivet molt eficaç   (*a very effective knife*)
      b. una postura eficaç contra la ciàtica
                         (*a position effective against sciatica*)

The enlargement of the semantic structure benefits the treatment of adjuncts. They now can precisely select for their head, thus accounting for differences of acceptance such as the one in (32). As can be seen in Fig. 15.11, *inacabat* ('unfinished') is an adjective modifying the process in the agentive quale of its nominal head, which in turn must express some kind of creation process in its agentive structure (that is, it must be an artifact). This is the case of *poema* ('poem') in (32a), in contrast to *roc* ('stone') in (32b), which is a natural object.

Conversely, the adjective *eficaç* ('effective') asks for a telic event. Note that it is naturally interpreted when combining with an instrumental noun such as *knife* (33a). But when it modifies a noun with an empty telic structure (as is the case with *position*, in (33b), mainly featured by its formal and agentive role), or a noun in which the information it contains does not unify with the requirements of the adjective, an explicit complement has to be added to the resulting NP (or an appropriate context has to be given) in order to know the event that the adjective is modifying (33b). Thus, an effective knife is commonly understood as a 'knife that cuts well', but an effective position or an effective sneeze can be useful
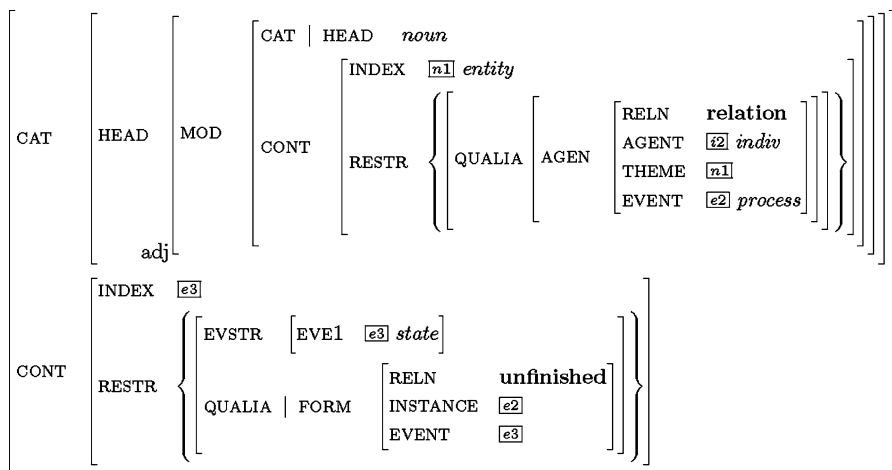
Fig. 15.11 inacabat ('unfinished')

for different purposes not inherent to the noun denotation. In example (33b), for instance, position is effective against sciatica, whereas in appropriate contexts a sneeze can be effective to frighten an annoying fly away.

The rich semantic structure proposed for the treatment of all major categories contributes further benefits to adjuncts. As with nouns and verbs, it enables to deal with their potential argument structure and their capability of being modified. The use of *eficaç* ('effective') in (33) is an example of an adjective presenting argument structure. Other adjectives behaving in a similar way are: *aliè (a)* ('foreign (to)'), *assequible (a/per)* ('attainable (to)'), *apte (per)* ('suitable (for)'), *coetani (de)* ('contemporary (with)'), *conseqüent (amb)* ('consistent (with)'), *ample (de)* ('wide/broad'), etc. With the introduction of ARGSTR as an essential level in the semantic structure of all major categories, the use of *eficaç* ('effective') in (33) is represented as follows (Fig. 15.12)[11]:

The information concerning the argument structure of *eficaç* is displayed at the ARGSTR attribute. It introduces the two arguments of the adjectival predicate: the indexes *i1* and *e2*, respectively referring to the entity denoted by the modified noun, and the state introduced by the complement PP. In addition, VALENCE introduces the information relative to the subcategorised PP complement. Since this PP can be headed by the prepositions *for* and *against*, the qualia role adequate to represent the denoted state is TELIC, which is shared with the TELIC role of the adjective.

Of course, this structure represents a subsidiary use of *eficaç*. Namely, the one that is triggered when the nominal head lacks the telic information that is

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[11]The same consideration is applicable to adverbs introducing complements, as *independentment (de)*, ('independently (of)'), *paral·lelament (a)* ('in a parallel way (to)'), and similar deadjectival adverbs.
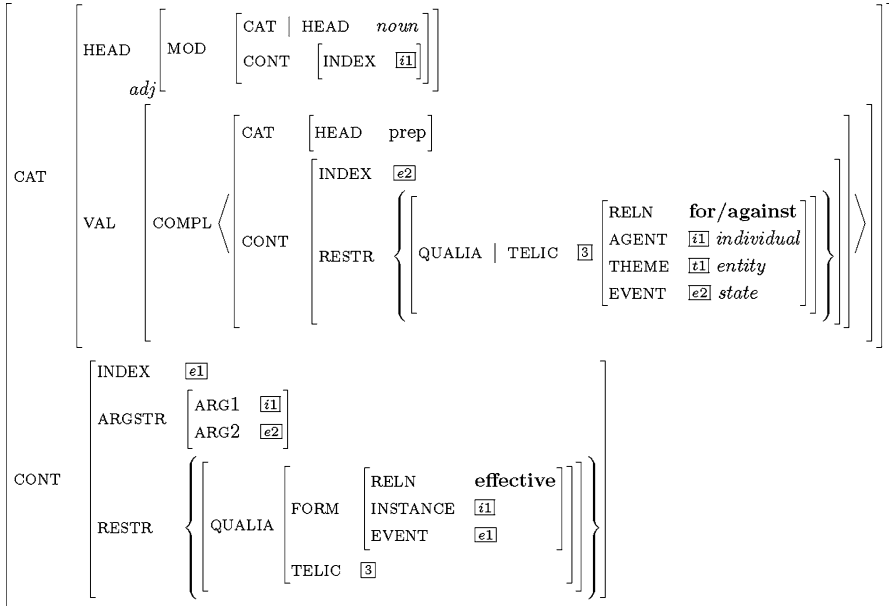
```
        ┌ HEAD ┌ MOD ┌ CAT | HEAD    noun ┐ ┐                    ┐
        │      │      │ CONT [ INDEX  i1 ] │ │                    │
        │  adj └      └                    ┘ ┘                    │
        │                                                         │
        │            ┌ CAT [ HEAD    prep ]                    ┐  │
        │            │                                         │  │
CAT     │            │ CONT ┌ INDEX   e2                    ┐  │  │
        │ VAL ┌ COMPL⟨      │       ┌ ┌ RELN    for/against ┐┐ │⟩ │
        │     │            │ RESTR {│ QUALIA|TELIC  3│ AGENT i1 individual││ │  │
        │     │            │      │       │ THEME  t1 entity ││ │  │
        │     │            └       └ └ EVENT  e2 state    ┘┘ │  │
        │                                                         │
        ┌ INDEX   e1                                           ┐
        │ ARGSTR ┌ ARG1   i1 ┐                                 │
        │        └ ARG2   e2 ┘                                 │
CONT    │                                                      │
        │         ┌ ┌ QUALIA ┌ FORM ┌ RELN      effective ┐ ┐ ┐ │
        │ RESTR  {│ │        │      │ INSTANCE  i1        │ │ }│
        │         └ │        │      └ EVENT     e1        ┘ │ ┘ │
        └           └        └ TELIC  3                    ┘     ┘
```

Fig. 15.12 eficaç ('effective')

required by the adjective. There are other possible uses of *eficaç*: combining with a pure instrumental-denoting noun with the information in telic compatible with the adjective requirements (as in (33a)); similarly, modifying an instrumental noun but in a context where additional telic information is required, as in *a knife effective for slicing cured ham*.[12] The treatment for *eficaç* in all these uses, in addition to the relation it maintains with the use represented above, will be illustrated in Sect. 15.5, when addressing the linguistic mechanisms.

The proposed semantic treatment brings about a final remarkable change in the content structure of modifiers and predicates in general: they now introduce an index attribute, in the same way referential categories such as nouns do. Intersective adjectives already introduced it in the HPSG standard treatment, although in that case the index value was coindexed with the index introduced by its nominal head, and therefore it expressed the referent denoted by the noun instead of the state denoted by the adjective. As already mentioned, that strategy caused undesirable consequences: it forced modifiers of adjectives (as for instance the adverb *molt* ('very') in example (33a)) to also bear a nominal index. In that same treatment, verbs did not bear any index attribute, thus being impossible to relate any adjunct to them. As a consequence, 'polymorphic' adjuncts required different lexical entries in order

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[12]As we will see in Sect. 15.5, this case corresponds to what Pustejovsky (1995) identifies as shadow arguments. See also Sect. 15.2.2 above.

to combine with their possible heads (either nominal or verbal). That inadequacy was already observed in Pollard and Sag (1994:57) with regard to the treatment of phrasal adjuncts such as PPs. We repeat here their set of examples illustrating the multiple sorts of heads the phrase *in Chicago* can modify:

(34) a. A man in Chicago claims that the Axiom of Infinity is inconsistent.
      b. Kim slept in Chicago.
      c. In Chicago (at last), Kim slept soundly.
      d. Kim is in Chicago.

Our proposal allows an appropriate treatment to these data. On the one hand, the introduction of a referential index to the semantic structure of verbs enables them to be modified by *in Chicago* (either at the level of the VP (34b) or the sentence (34c)) in the same way a noun can be (34a). And on the other hand, the *index* hierarchy presented in Sect. 15.1 helps in the establishment of the restrictions that the adjunct imposes over its head. In the current example, the PP states, by means of its head *in*, that the INDEX value of the head it modifies must be of type *entity* (that is, without specifying between an individual or eventuality denotation). Similarly, the introduction of the INDEX attribute to modifiers in general (PPs included) is what allows for the treatment of *in Chicago* in (34d). In this case, it is selected by the copula, which requires as attribute an item presenting an INDEX value of type *state*.

Other'polymorphic' adjuncts that illustrate the phenomena we are dealing with are degree adverbs such as *molt* ('very'). As shown below, they can modify either an adjective, an adverb, or a verb.

(35) És   un llibre molt bonic.
      Is_{3S} a   book very nice.

(36) Miràvem   molt detalladament totes les coses.
      $Looked_{1P}$ very in-detail   all   the things.

(37) En   Bernat corre molt.
      The Bernat runs a-lot.

In the standard treatment molt would require two lexical entries: a first one bearing a nominal index in order to combine with a noun-modifying adjective, and a second one, free of any index attribute and combining (how?) with adverbial and verbal heads.

Nevertheless, thanks to the introduction of an INDEX attribute to predicates and modifiers in general, it is possible to provide a uniform treatment for *molt* and other degree adverbs. Figure 15.13 illustrates the lexical entry for this adverb.

Note that, as a degree modifier, its *index* value is of type *degree*. In addition, it requires a head with an index of type *event*. This allows the filtering of both adjectives, adverbs and verbs, but rejects other linguistic units that can present eventive information, such as predicative nouns. Finally, *molt* also asks for a
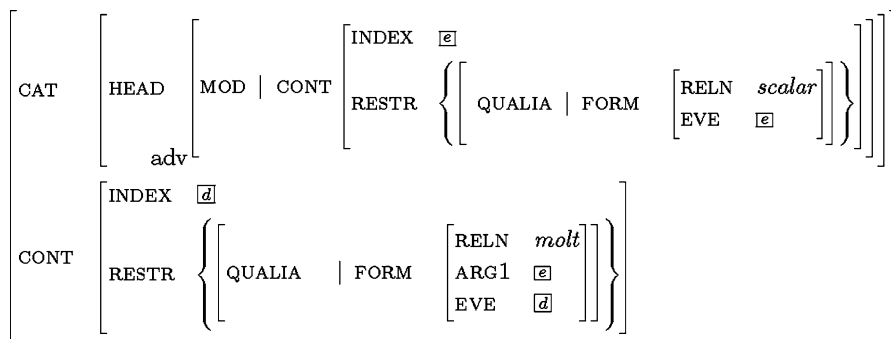
$$
\begin{bmatrix}
\text{CAT} & \begin{bmatrix} \text{HEAD} & \begin{bmatrix} \text{MOD} \mid \text{CONT} & \begin{bmatrix} \text{INDEX} & \boxed{e} \\ \text{RESTR} & \left\{ \begin{bmatrix} \text{QUALIA} \mid \text{FORM} & \begin{bmatrix} \text{RELN} & scalar \\ \text{EVE} & \boxed{e} \end{bmatrix} \end{bmatrix} \right\} \end{bmatrix} \\ \text{adv} \end{bmatrix} \\
\text{CONT} & \begin{bmatrix} \text{INDEX} & \boxed{d} \\ \text{RESTR} & \left\{ \begin{bmatrix} \text{QUALIA} & \mid \text{FORM} & \begin{bmatrix} \text{RELN} & molt \\ \text{ARG1} & \boxed{e} \\ \text{EVE} & \boxed{d} \end{bmatrix} \end{bmatrix} \right\} \end{bmatrix}
\end{bmatrix}
$$

Fig. 15.13 molt ('very')

gradable head, which is precisely what accounts for the sense alternation of redescription participle forms (cf. example (25)). Recall that on a regular basis the nouns modified by those participles are interpreted as the entity being created. However, when *molt* and similar adverbs modify these sort of predicates, they happen to be interpreted as denoting the state of an object of being transformed because, from the two relations in the FORMSTR, only the *modified* one satisfies the requirement of the adverb of being marked as a gradable event.[13] In this case, then, the noun modified by the participle is interpreted as the original entity that has undergone the transformation process.[14]

15.4.6   Non-intersective Modification

We now turn to non-intersective, nominal modifiers, which, as pointed out, also demand a revision of the standard HPSG semantic treatment. The problems illustrated by the adjective *ràpid* ('fast') in (19) above are two. On the one hand, the adjective presents a non-intersective interpretation: it is generally an eventuality predicate but here it modifies individual-denoting nouns. On the other hand, it denotes differently ('who types fast', 'who drives fast', 'that can be driven fast') depending on the noun it combines with, although there is indeed a semantic core that is common to all three instances of *ràpid* –that is, the property of being fast of a given event.

Larson (1998) explains similar non-intersective cases by adapting Davidson's event analysis, originally developed for adverbs, into the semantic structure of the nominal expressions. His proposal, particularly focussed on agentive nouns like

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[13]This can be obtained by having a hierarchy of *scalar* values, where *modified* belongs to.

[14]Such an approach goes pretty much along the lines of McNally and Kennedy (this volume) for the treatment of 'well' and its effects in the interpretation of 'load'-like verbs.

dancer or *typist*, provides good insight into the problem but leaves some aspects unresolved, such as the pervasivity of event modification in nominals. Interestingly, however, Pustejovsky's GL approach offers an adequate and systematic treatment of these facts. If we assume that *ràpid* ('fast') is an event predicate, then we can argue it triggers an event interpretation for the noun it modifies. This can be done by applying the selective-binding mechanism, which forces the adjective to predicate over the qualia level that is adequate to its selectional restrictions (i.e., an event), instead of predicating over the whole entity. Thus, when modifying *mecanògraf* ('typist'), *ràpid* predicates about the process of typing, the event encoded at the telic level of the semantic structure of the noun, whereas with *conductor* ('driver'), *ràpid* predicates about the 'driving' event.

GL therefore provides an elegant treatment of the non-intersective use of adjectives that predicate over events. It is also general enough to explain their apparent sense variation depending on the noun they appear with. These advantages are mainly due to two elements. First, the distinction between individual- or eventuality-modifying adjectives. Second, the introduction of a structured multi-layered semantic level to describe the content of nominals (and other categories). However, there is still one unsolved issue: there are at least two event values in the qualia structure of all nouns (at the agentive and telic level), and it is not clear how event-selecting adjectives manage to choose between them. The adjective *ràpid* ('fast') provides examples of this:

(38) a. un mecanògraf ràpid   (*a fast typist*)
      b. un cotxe ràpid   (*a fast car*)
(39) a. un pastís ràpid   (*a quick cake*)
      b. una construcció ràpida   (*a fast building*)

Ràpid selects the telic quale of the noun when modifying *mecanògraf* ('typist') or *cotxe* ('car') (38); that is, it selects the information about the goal of the denoted entity. But when combining with *pastís* ('cake') or *construcció* ('building'), *ràpid* selects the agentive level (39), which conveys information concerning the genesis of the entity.

It is our intuition that not all nominal entries have their qualia structured in the same way. That is to say, every nominal class has a particular quale role more prominent than the others. For instance, instrumental and agentive nouns (such as *knife* and *typist*, respectively) are characterised by the prominence in their telic quale; whereas in result nominalisations (such as *building*) and nouns like *statue* the most prominent event level is the agentive quale. We will not discuss this issue any further here, but see Badia and Saurí (1999) for detail. What mainly interests us is how to indicate what particular quale role in the qualia structure of nominals is the prominent one in each case. As an example, Fig. 15.14 shows the entry for *ganivet* ('knife'), a noun highlighting the telic role[15]:

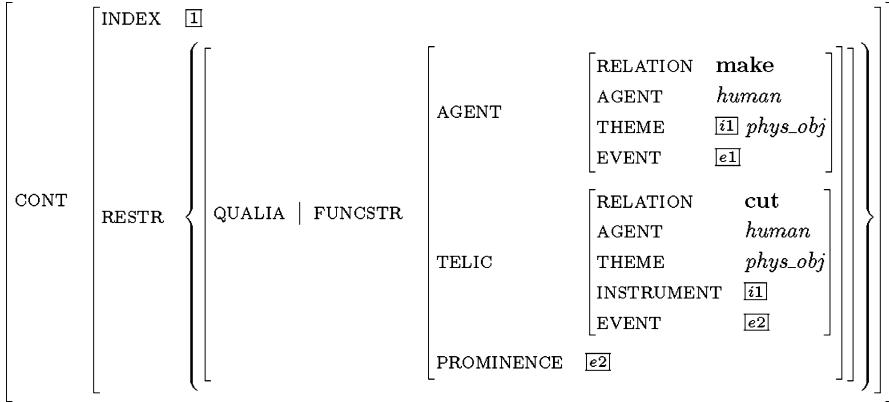[15]For reasons of space, from now on we only show the relevant levels.

$$
\text{CONT} \begin{bmatrix} \text{INDEX} & \boxed{1} \\ \text{RESTR} & \left\{ \text{QUALIA} \mid \text{FUNCSTR} \left[\begin{array}{l} \text{AGENT} \begin{bmatrix} \text{RELATION} & \textbf{make} \\ \text{AGENT} & human \\ \text{THEME} & \boxed{i1}\ phys\_obj \\ \text{EVENT} & \boxed{e1} \end{bmatrix} \\ \text{TELIC} \begin{bmatrix} \text{RELATION} & \textbf{cut} \\ \text{AGENT} & human \\ \text{THEME} & phys\_obj \\ \text{INSTRUMENT} & \boxed{i1} \\ \text{EVENT} & \boxed{e2} \end{bmatrix} \\ \text{PROMINENCE} \quad \boxed{e2} \end{array} \right] \right\} \end{bmatrix}
$$

Fig. 15.14 ganivet ('knife')

Prominence highlights a particular piece of the noun semantic information. The four GL qualia roles are subject to tensions and oppositions among them, which are manifested through analogous pieces of information: between the formal and the constitutive qualia, on the one hand, as the roles that express properties relevant for the identity of entities; and between the agentive and telic information, on the other hand, as eventuality-referring levels. Although for reasons of space this account is very roughly sketched here, this fact is what grounds the division into two pairs of the four classic GL qualia roles: one named *identity structure*, which concerns the identity of the entity referred to by the noun, and a second one which concerns its functionality (*functional structure*). Within this picture, prominence is, then, the feature that expresses the strongest role within each of these two basic relations.

The notion of prominence turns out to be necessary in adjective-noun composition processes; particularly in those cases where the adjective (individual- or eventuality-modifying) is underspecified as to the qualia role that it selects for. The adjective then predicates about the prominent quale in the noun.[16] Take Fig. 15.15 as an example. The requirements imposed by a simple eventuality-modifying adjective like *ràpid* ('fast') on non-predicative nouns (such as *cotxe*'car', and *pastís*'cake') would be expressed basically as shown there.

The adjective content level states that *ràpid* predicates the property of being fast of an eventuality, which in turn corresponds to the prominent eventuality in the FUNCSTR of the modified noun. This structure represents the information that *ràpid* should contain in order to allow for a non-intersective use (as in examples (19)). But *ràpid* is actually a modifier of eventuality-denoting nouns (such as *construcció*

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[16]The fact that nouns present two different prominent qualia (one in IDENSTR and the other in FUNCSTR) is not a problem. The former is established among individual-type indices, whereas the latter is chosen from eventualities.
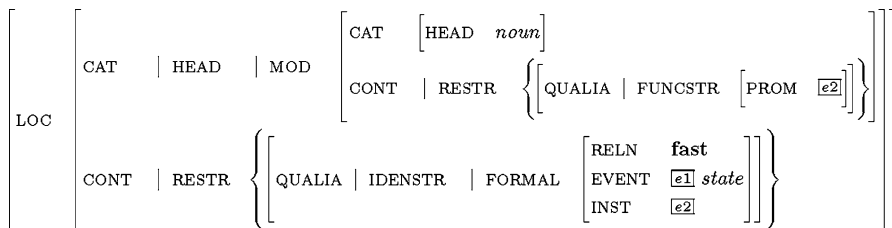
$$\left[\text{LOC} \begin{bmatrix} \text{CAT} \mid \text{HEAD} \mid \text{MOD} \begin{bmatrix} \text{CAT} & \begin{bmatrix} \text{HEAD} & noun \end{bmatrix} \\ \text{CONT} \mid \text{RESTR} & \left\{ \begin{bmatrix} \text{QUALIA} \mid \text{FUNCSTR} \begin{bmatrix} \text{PROM} & \boxed{e2} \end{bmatrix} \end{bmatrix} \right\} \end{bmatrix} \\ \text{CONT} \mid \text{RESTR} \left\{ \begin{bmatrix} \text{QUALIA} \mid \text{IDENSTR} \mid \text{FORMAL} \begin{bmatrix} \text{RELN} & \mathbf{fast} \\ \text{EVENT} & \boxed{e1}\ state \\ \text{INST} & \boxed{e2} \end{bmatrix} \end{bmatrix} \right\} \end{bmatrix} \right]$$

Fig. 15.15 ràpid ('fast')

('building') and *decoració* ('decoration') in their process reading) and therefore it must be able to select for nouns with an index value of type eventuality. It is precisely in cases where the nominal head does not comply with this requirement that a non-intersective interpretation of the adjective is allowed by means of the selective-binding mechanism. The issue arising at this point is how to implement, within a real typed feature system, the selective-binding mechanism used to explain the non-intersective use of certain adjectives. In what follows, we focus on the treatment of this GL mechanism, as well as the other two; namely, co-composition and type coercion.

15.5 Putting the Lexicon at Work

15.5.1 How to Exploit the Semantic Creativity of Words in Context

So far we have extended the semantic information level in HPSG with the representational apparatus of GL, and we have shown how the resulting lexical representation can perfectly undergo the semantic compositional process provided that some changes are introduced in the HPSG grammatical system. The resulting framework has been proved necessary in order to deal with some linguistic data that cannot be accounted for from standard approaches. We have developed the lexical entries for some of those cases by using typed feature structures (in fact, as in HPSG 1994 book), so that they can be effectively implemented in a unification-based system and take advantage of some of the devices provided by such systems to manage linguistic data: underspecification, multiple inheritance, overwriting, etc.

In this section we address how lexical entries like those introduced above can account for polysemy, and thus be sensitive to the context in which they appear. GL deals with lexical creativity by means of three generative mechanisms: *Co-composition*, *Selective Binding* and *Type Coercion* (Pustejovsky 1995:ch.7). They are general devices that cope with polysemy throughout the compositional process,

and an elegant solution for lexical resources given that lexical entries can be maintained simple and, in most cases, monosemous. Let us briefly illustrate this with a couple of cases from Pustejovsky (1995), which have also been introduced in the current article.

A first example is provided by adjectives like *ràpid* ('fast'): although they are event-modifying adjuncts, they can also modify individual-denoting nouns such as'boy','car', or'food'. In addition, they are interpreted differently depending on the noun they modify. In GL, the *Selective Binding* mechanism is the one that allows for maintaining such adjectives monosemous while accounting for their ability to modify both eventualities and individuals.

A second example are transformation verbs (like'bake' and'paint'), which present two possible meanings depending on the noun they subcategorise for. Pustejovsky (1995) deals with their sense alternations by using the *Co-composition* mechanism, a process in which not only the syntactic head semantically specifies its argument, but also the argument has an effect over its head, provided that this argument presents an agentive qualia identical to the one in the head. The operation results in a change of the verbal meaning, and thus allows verbs belonging to that class to have only one lexical entry.

The generative capability of the system is therefore essential in order to reduce the number of lexical entries and, consequently, potential parsing ambiguities. In what follows, we will see how the three generative mechanisms put forward in GL can be implemented in the model introduced so far, in order to provide our lexicon with real contextual-based generativity.

15.5.2   The Framework

The enrichment of the HPSG semantic machinery with the GL treatment of the meaning of linguistic expressions is not new. An integration of GL semantic representation and HPSG syntax was initially proposed in the mid 1990s (Copestake 1993; Copestake and Briscoe 1996; Johnston 1996), and more explicitly in Badia and Saurí (1998, 1999, 2000), so that a reasonably straightforward interaction between syntax and semantics become available. Furthermore, a simplified version of the standard GL representation has been used in two EU-funded projects: Acquilex and SIMPLE.[17] However, common to these approaches is the fact that they do not implement the generative dimension of GL, but merely use its representational structure. In recent years the interest for semantics mechanisms from a lexicalist perspective has increased significantly. See, for instance, the work on MRS and Glue Semantics in the HPSG framework (Copestake et al. 2005; Asudeh and Crouch 2002).

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[17]The Acquilex project references are Esprit-BRA 3030 and Esprit-BRA 7315. SIMPLE is funded by EU's DG-XIII, within the LE programme (LE4-8346).

In GL implementation proposals, the generative mechanisms are generally less used than the representational structure of GL, probably because they are not easy to implement. For example, the LKB used to implement the Acquilex proposals (Copestake 1993) was not powerful enough to introduce the generative mechanisms. We claim, however, that there are currently actual ways of implementing the generative capacity of the lexicon: basically, what is needed is a proper type system with multiple inheritance and enough inference capacity. If these requirements are met, either with subspecification (Markantonatou and Sadler 1998) or default inheritance (Copestake and Briscoe 1992), or with both (Lascarides and Copestake 1999), most of the devices originally contemplated in GL (and a few others) can be implemented.

For our implementation we use the LKB system (Copestake 1998, 2002), a grammar and lexicon development environment which is specifically designed for the use of typed feature structures with underspecification and multiple default inheritance. Such a flexible and robust platform allows us to implement the GL generative mechanisms by simply exploiting the expressiveness of the type system, instead of having to view them as extra processes that apply to the lexicon. In particular, we take benefit of YADU ('Yet Another Default Unification'), the default representation proposal by Lascarides and Copestake (1999) which is effectively integrated in LKB

In YADU, types are represented by means of bipartite structures (typed default feature structures (TDFSs)) of the form *Indefeasibe/Tail*: *Indefeasible* is a simple typed feature structure that expresses what is indefeasible, whereas *Tail*, which specifies the defeasible information, consists of a set of pairs where the first member of the pair is an atomic feature structure (a single path or equivalence) and the second one is a type.

15.5.3 Implementing GL Mechanisms

15.5.3.1 Selective Binding

We will start by looking at the Selective Binding mechanism since it is the generative mechanism we have been considering in more detail so far. In Pustejovsky (1995:129) it is technically defined as follows:

SELECTIVE BINDING:
If α is of type $<\mathtt{a},\mathtt{a}>$, β is of type $\mathtt{b}$, and the qualia structure of β, QS_β has quale, q of type $\mathtt{a}$, then $\alpha\beta$ is of type $\mathtt{b}$, where $||\alpha\beta|| = \beta \cap \alpha(q_\beta)$.

Roughly speaking, the Selective Binding mechanism consists of an operation that allows a predicate to apply to one of the qualia levels of its argument, in case that the semantic type of the argument does not coincide with the one required by the predicate, but the semantic type of the qualia does. The archetypical case here is the eventuality-modifying adjective *fast*. As seen before, when the noun it modifies does not denote an entity of type *event*, it predicates over the eventuality of one of the

noun's functional qualia (telic or agentive). The resulting interpretation corresponds then to the non-intersective use of the adjective.

The lexical entry for *fast* needs then to have available the information concerning both its intersective and non-intersective use. By means of YADU, the implementation of this case of selective binding in our lexicon is as follows: given that non-intersective uses of adjectives are secondary to the common intersective ones, we establish a partial hierarchy for eventuality-modifying adjectives. It consists of a first general type (*event_modifier_adj*), which represents the intersective use of adjectives, and a subtype of it (*subevent_modifier_adj*) representing the non-intersective one. Since part of the information of both types is incompatible (basically, the CONTENT attribute of the modified noun) we need some overwriting mechanism.

The partial YADU hierarchy needed to account for both intersective and non-intersective uses of eventuality-modifying adjectives is as shown in Fig. 15.16.[18] The indefeasible information stated in the general supertype is completely subsumed by the subtype. The difference between both TDFSs is in the Tail, where the supertype asks for an eventuality-denoting noun, whereas its subtype selects for the prominent eventuality in the functional structure of the noun –the other attribute in CONTENT where eventuality-typed indexes are stated. Note that the information in the subtype TDFS basically corresponds to that stated in Fig. 15.15. Lexical entries inherit from the appropriate type in the hierarchy and specify the particular relation introduced by the adjective as the value of RELN in the formal qualia.

Other classes of adjectives require a similar treatment; for instance, concrete entities modifiers. We exemplify it with color-denoting adjectives. They typically modify individuals (40). When the entity denoted by the noun is constituted of several parts, one of which being neatly delimited as the most external or visible one, this is taken to represent the whole entity (thus giving rise to a case of metonimy). The adjective then predicates on the part instead of the whole entity (41).

(40) a. un paper vermell   (*a red piece of paper*)
      b. un pètal vermell   (*a red petal*)

(41) a. una poma vermella   (*a red apple*)
      b. una casa vermella   (*a red house*)

Furthermore, some nouns introduce additional participants in their functional qualia structures, which can be modified by a colour adjective. If this functional qualia is the prominent one, an ambiguous interpretation is triggered. That is the

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[18]Due to space limitations, we will not represent the first members of each pair in the tail set as an atomic feature structure. Instead, we integrate all of them in a unique, non-atomic feature structure – this is why there is just one pair in both tails. In addition, we have abbreviated some of the (already abbreviated) attribute names: C | H | M stands for CAT | HEAD | MOD, whereas R stands for RESTR.
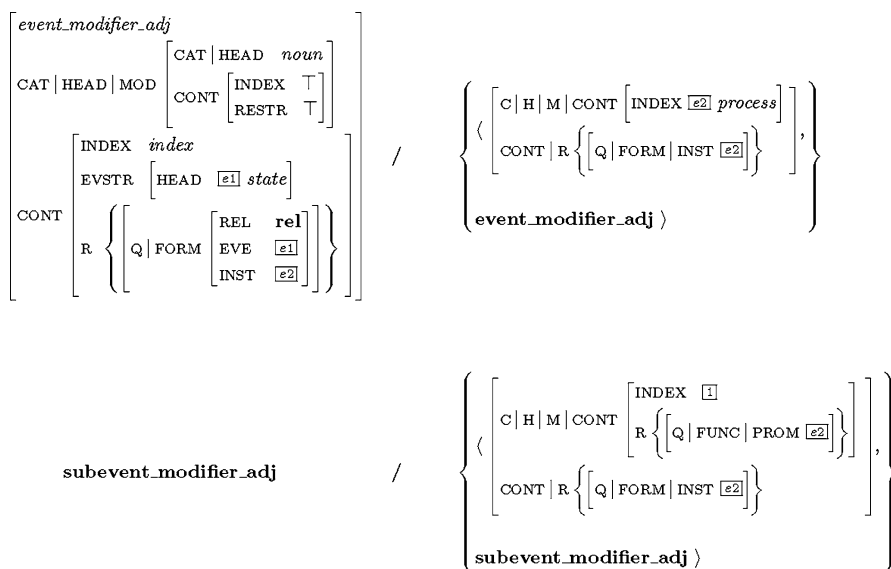
$$
\begin{bmatrix}
event\_modifier\_adj \\
\text{CAT}\,|\,\text{HEAD}\,|\,\text{MOD} \begin{bmatrix} \text{CAT}\,|\,\text{HEAD} & noun \\ \text{CONT} \begin{bmatrix} \text{INDEX} & \top \\ \text{RESTR} & \top \end{bmatrix} \end{bmatrix} \\
\text{CONT} \begin{bmatrix} \text{INDEX} & index \\ \text{EVSTR} \begin{bmatrix} \text{HEAD} & \boxed{e1}\ state \end{bmatrix} \\ \text{R} \left\{ \begin{bmatrix} \text{Q}\,|\,\text{FORM} \begin{bmatrix} \text{REL} & \mathbf{rel} \\ \text{EVE} & \boxed{e1} \\ \text{INST} & \boxed{e2} \end{bmatrix} \end{bmatrix} \right\} \end{bmatrix}
\end{bmatrix}
\quad / \quad
\left\{ \begin{array}{l} \left\langle \begin{bmatrix} \text{C}\,|\,\text{H}\,|\,\text{M}\,|\,\text{CONT} \begin{bmatrix} \text{INDEX}\ \boxed{e2}\ process \end{bmatrix} \\ \text{CONT}\,|\,\text{R} \left\{ \begin{bmatrix} \text{Q}\,|\,\text{FORM}\,|\,\text{INST}\ \boxed{e2} \end{bmatrix} \right\} \end{bmatrix} , \right. \\ \left. event\_modifier\_adj \right\rangle \end{array} \right\}
$$

$$
subevent\_modifier\_adj \quad / \quad
\left\{ \begin{array}{l} \left\langle \begin{bmatrix} \text{C}\,|\,\text{H}\,|\,\text{M}\,|\,\text{CONT} \begin{bmatrix} \text{INDEX}\ \boxed{1} \\ \text{R} \left\{ \begin{bmatrix} \text{Q}\,|\,\text{FUNC}\,|\,\text{PROM}\ \boxed{e2} \end{bmatrix} \right\} \end{bmatrix} \\ \text{CONT}\,|\,\text{R} \left\{ \begin{bmatrix} \text{Q}\,|\,\text{FORM}\,|\,\text{INST}\ \boxed{e2} \end{bmatrix} \right\} \end{bmatrix} , \right. \\ \left. subevent\_modifier\_adj \right\rangle \end{array} \right\}
$$

Fig. 15.16 Partial type hierarchy for fast-like adjectives

reason why the expression in (42a) can be interpreted as a'red-colored pencil' or a'pencil that colours red' and why, similarly, the phrase in (42b) can denote a'red-colored bulb' or a'bulb that emits red light'.

(42) a.   un llapis vermell   (*a red pencil*)
      b.   una bombeta vermella   (*a red bulb*)

The appropriate representation for colour-denoting adjectives would be similar to that for eventuality-modifying adjectives in Fig. 15.16 above. The main difference being that the former would consist of a partial hierarchy of three types (instead of the two types for eventuality-modifying adjectives): a first one for the intersective interpretation (corresponding to the examples in 40), and its two subtypes, one for the non-intersective use that triggers the metonymical interpretation of the noun (41) and the other one, for the use in which the adjective predicates on participants of the prominent functional quale (42).

Other interesting examples of noun-modifier relations show no correspondence between the selectional restrictions imposed by the predicate and the semantic information of its participant which cannot be repaired by selecting a deeper layer in the semantics structure of the participant. Common to these examples is that the argument participating in the predication does not present enough semantic information. An extra argument introduces then the information needed by the predicate.

This behaviour is characteristic of the whole group of instrument-modifying adjectives, such as *eficaç* ('effective'), *adequat* ('adequate','appropriate'), *útil*

('useful'), etc. When they combine with an instrument-denoting noun, they modify the relation stated at the telic quale of that noun. For instance, in example (43a) the adjective modifies the relation of 'cutting' that *ganivet* specifies in its telic role.

(43) a. un ganivet molt eficaç (*a very effective knife*)
      b. un ganivet molt eficaç per tallar carn congelada
                (*a very effective knife to cut frozen meat*)

However, when instrument-modifying adjectives appear with nouns that have no particular telicity, a PP introduced by the prepositions *per* ('for','to') or *contra* ('against') is required in order to supply the telic information missing in the noun (44). Indeed, this complement is also allowed in contexts like (43a) if we want to express a purpose different from the one specified at the telic level of the noun head (43b).

(44) a. ??un esternut eficaç   (*an effective sneeze*)
      b. un esternut eficaç per espantar la mosca que tenies sobre el nas
                (*a snezee effective for causing the fly over your nose to fly away*)

Examples like (44) illustrate that, based on semantic grounds, complements traditionally taken as optional may be obligatory in certain contexts. In (44a), the use of *eficaç* modifying a non-telic noun without a PP conveying purpose, like the one present in (44b), causes a semantic anomaly. Purpose complements appear therefore as obligatory complements of non-telic nouns when modified by adjectives that predicate over the telic role of their head.[19]

To wrap up, instrument modifying adjectives can be realised in three different contexts: a general one in which they attribute a property to the telic event expressed by the noun they modify (43a); a second one in which the property does not apply to the inherent telicity of the instrument but to an additional eventivity introduced by the adjective complement (43b); and a third one, in which the adjective is not modifying an instrument denoting noun and therefore it necessarily relies on the

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[19]This need for additional structure in order to meet predicate restrictions is in fact significantly pervasive. For instance, it seems to regulate the use of shadow arguments – those that are only semantically adequate if specific semantic conditions are given. Example (i) is from Pustejovsky (1995); example (ii) is ours:

(i)   a.   ??Mary buttered the toast with butter.
           b.   Mary buttered the toast with an expensive butter.
(ii)   a.   ??This is an effective knife to cut.
           b.   This is an effective knife to cut frozen meat.

The oddness of both (i.a) and (ii.a) is due to redundancy of the PP complements *with butter* and *to cut*, respectively. In (i.a), the PP is redundant with the semantics of just one lexical item, the verbal predicate *butter*, whereas in (ii.a) it is redundant with the semantics resulting from the composition of a noun and its modifier (*effective knife*). However, both cases are similar in that the acceptance of a presumably optional argument is only possible if this argument is further specified.

existence of an extra argument (44b). Lexical entries for this kind of adjectives can thus be represented as a triplet of types (or partial hierarchy) along the lines we have already introduced for other adjectives.

15.5.3.2 Type Coercion

Type Coercion is generally defined as "a semantic operation that converts an argument to the type which is expected by a funtion, where it would otherwise result in a type error" (Pustejovsky 1995:111). GL considers two main modes of coercion: Subtype Coercion and True Complement Coercion. The first one consists on the semantic shifting of a type *t1* when the predicate that selects it requires an argument of type *t2*, which is a supertype of *t1* in the hierarchy. Thus for the adequate interpretation of sentence (45a) (from Pustejovsky 1995:113) it is necessary to ensure that, although *drive* selects an argument of type *vehicle*, the actual occurrence *Honda* is also acceptable. In fact, such a process is frequent among predicate-argument relations, given that the restrictions imposed by predicates over their arguments are generally less specific than the types of the arguments themselves. In (45b), for instance, *eats* only requires an edible entity as a type of its complement NP.

(45)   a. Mary drives a Honda to work.
        b. Tom always eats a banana for lunch.

The implementation of the Subtype Coercion is fairly simple in a system like LKB, which controls the information by means of a hierarchy of types. In such a framework, all the types inherit the properties defined at their supertypes. It is then just by means of this inheritance relation that a Honda is recognised as the vehicle required by the predicate, in the same way a banana satisfies the requirement of being an edible entity.

Let us now turn to the treatment of True Complement Coercion. One of the paradigmatic examples of this operation are verbs of polymorphic syntactic nature; that is, verbs that can subcategorise for complements of different syntactic category, though there exists a semantic relation between these complements. The following example is extracted from Pustejovsky (1995:115):

(46)   a. Mary enjoyed the movie.
        b. Mary enjoyed watching the movie.

Supposedly, *enjoy* requires a complement of type *eventuality*. The phrase *watching the movie* in (46b) satisfies this requirement, contrary to what happens with *the movie* in (46a), which denotes an individual. And yet example (46a) is acceptable.

GL deals with this systematic subcategorisation alternation by using the true complement type coercion as an alternative to type shifting (Partee and Rooth 1983, Klein and Sag 1985, Pustejovsky 1993; among others) or meaning postulates

(Dowty 1985). The type coercion operation promotes a change of the complement semantic type without modifying its syntactic category, allowing then for the semantic equality between the two sentences in (46) and similar cases. As explained in Pustejovsky (1995:116), the coercion is only successful if the complement has an alternative appropriate type, which in cases like (46a) can be recovered from the qualia of the NP.

From our implementation point of view, however, the operation applied to those verbal complements is of similar nature to the selective binding mechanism. That is, verbs like *enjoy* select for a complement of a specific semantic type, and when it does not correspond to the type of the actual complement, an operation is applied which recovers an entity of the needed type from the appropriate attribute in the complement qualia structure. For example, *enjoy*-like verbs can accept a clausal (46b) or NP (46a) complement provided that it satisfies their semantic requirement, which can be met directly (as in *watching the movie*) or applying a selective binding-like operation (as in *the movie*). Indeed, such an analysis avoids analysing *enjoy*-like verbs as syntactically polymorphic.

The lexical representation for this sort of verbs is pretty similar to the one for *fast*: it is constituted of a first type, which specifies the subcategorisation of a complement denoting an eventuality, and a second one, stating that this eventuality type can be found in the argument's prominent functional quale (Fig. 15.17).[20]

From this perspective, true complement coercion is a relation of the same nature as non-intersective modification. The former is held between predicates and their arguments. The latter, between nominal heads and their modifiers. Both of them however are caused by an initial mismatch between the selectional preferences imposed by the predicate to its argument, and the semantic type of that argument. And also in both cases the selective binding mechanism is the generative device carrying on the compositional interpretation when the default interpretation is not allowed.

15.5.3.3 Co-composition

We finally turn to the Co-composition mechanism. In Pustejovsky (1995:61) it is formally described as an operation "where multiple elements within a phrase behave as functors, generating new non-lexicalised senses for the words in composition." In other words, it is a relation between two predicative elements, one of which happens to undergo a semantic change; specifically, in its eventive properties.

---

[20]Actually, the information required to the noun is more constrained, since *enjoy* does not accept to co-occur with every eventuality-denoting noun (e.g., **John enjoyed the building*). Pustejovsky and Bouillon (1995) analyze these data proposing the existence of aspectual constraints on the type of the coerced complement; i.e., that it must denote a transition. We fully assume this, although for the sake of clarity we do not introduce the information in the figure.
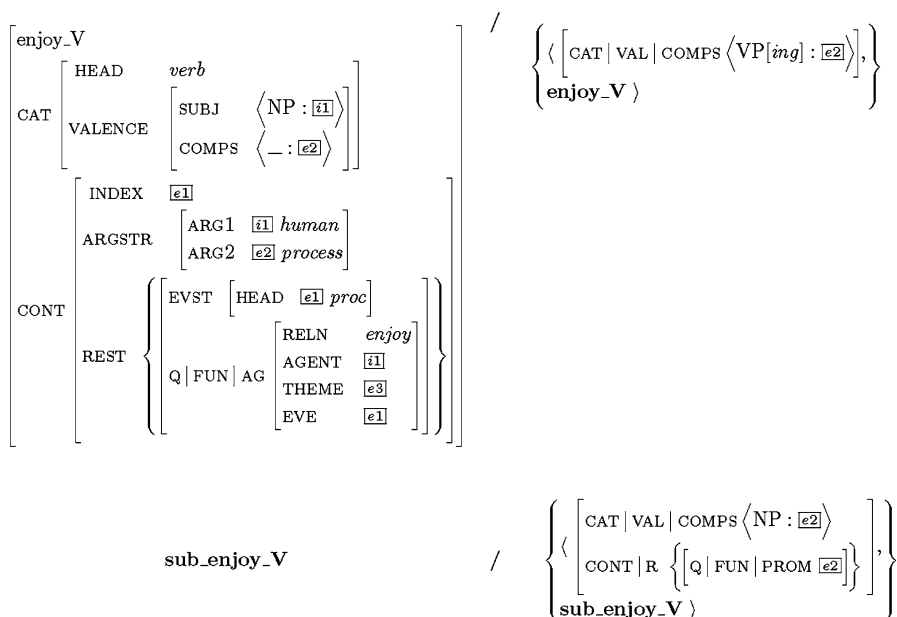
$$
\begin{bmatrix}
\text{enjoy\_V} \\[2pt]
\text{CAT}\begin{bmatrix}
\text{HEAD} & verb \\[4pt]
\text{VALENCE}\begin{bmatrix}
\text{SUBJ} & \langle \text{NP}:\boxed{i1}\rangle \\[4pt]
\text{COMPS} & \langle \_\,:\boxed{e2}\rangle
\end{bmatrix}
\end{bmatrix} \\[10pt]
\text{CONT}\begin{bmatrix}
\text{INDEX} & \boxed{e1} \\[4pt]
\text{ARGSTR}\begin{bmatrix}
\text{ARG1} & \boxed{i1}\ human \\
\text{ARG2} & \boxed{e2}\ process
\end{bmatrix} \\[10pt]
\text{REST}\left\{\begin{bmatrix}
\text{EVST}\begin{bmatrix}\text{HEAD} & \boxed{e1}\ proc\end{bmatrix} \\[6pt]
\text{Q}\,|\,\text{FUN}\,|\,\text{AG}\begin{bmatrix}
\text{RELN} & enjoy \\
\text{AGENT} & \boxed{i1} \\
\text{THEME} & \boxed{e3} \\
\text{EVE} & \boxed{e1}
\end{bmatrix}
\end{bmatrix}\right\}
\end{bmatrix}
\end{bmatrix}
\qquad /\quad
\left\{\begin{matrix}
\langle\begin{bmatrix}\text{CAT}\,|\,\text{VAL}\,|\,\text{COMPS}\,\langle \text{VP}[ing]:\boxed{e2}\rangle\end{bmatrix}, \\[4pt]
\text{enjoy\_V}\,\rangle
\end{matrix}\right\}
$$

$$
\text{sub\_enjoy\_V}\qquad /\quad
\left\{\begin{matrix}
\langle\begin{bmatrix}
\text{CAT}\,|\,\text{VAL}\,|\,\text{COMPS}\,\langle\text{NP}:\boxed{e2}\rangle \\[4pt]
\text{CONT}\,|\,\text{R}\,\left\{\begin{bmatrix}\text{Q}\,|\,\text{FUN}\,|\,\text{PROM}\ \boxed{e2}\end{bmatrix}\right\}
\end{bmatrix}, \\[6pt]
\text{sub\_enjoy\_V}\,\rangle
\end{matrix}\right\}
$$

Fig. 15.17 Partial type hierarchy for *enjoy*-like verbs

Consider first verbs like *float*, which alternate between denoting a manner or a process of movement, depending on the context. So for instance, *floating in the cave* allows only the manner of movement interpretation (which is stative), whereas the PP headed by the preposition *into,* in *floating into the cave,* triggers the process of movement interpretation. Other examples of co-composition are the well-known cases of process-denoting verbs like *wipe* or *hammer*, which can also denote transitions if a resultative adjective is modifying them (*wipe the table clean* or *hammer the metal flat*).

The lexical semantics literature accounts for these alternations by considering the different meanings as separate (though somehow related) lexical entries in the lexicon. However, GL co-composition operation allows to have only one basic sense for *float-* and *wipe*-like verbs: given the semantics of the prepositional or adjectival predicates accompanying them in the examples above, the co-composition operation contextualises the verb basic sense in order to bring about the movement process (in the former cases) or stative interpretation (in the latter).

Co-composition is then an operation that builds up phrasal meaning from the meaning of the phrase's predicative constituents. And such a process can be easily assimilated within our framework since it offers an adequate way of composing the semantics in a parallel way with the syntactic process. In Figs. 15.18, 15.19 and 15.20 we illustrate how the co-composition mechanism for the phrase *float into the cave* works within the framework we have developed. Such a treatment is very close to the one that accounts for the sense alternation in *wipe*-like verbs.
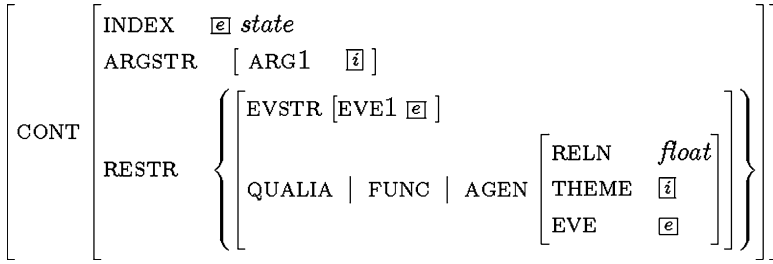
$$
\left[
\text{CONT}
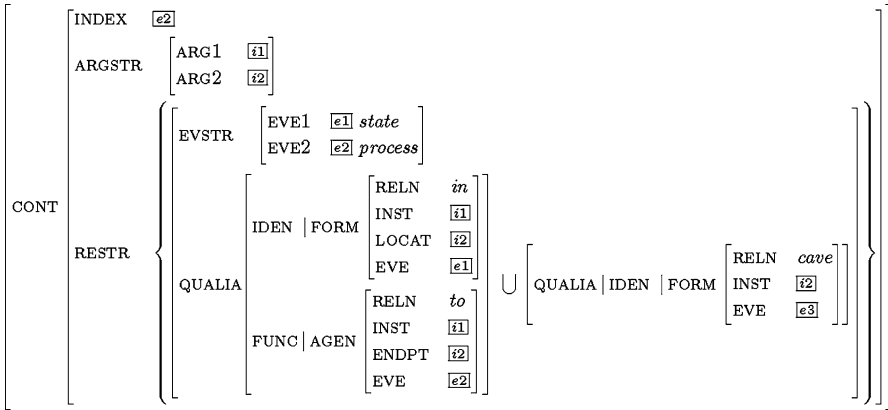\begin{bmatrix}
\text{INDEX} & \boxed{e}\ state \\
\text{ARGSTR} & [\ \text{ARG1} \quad \boxed{i}\ ] \\
\text{RESTR} &
\left\{
\begin{bmatrix}
\text{EVSTR} & [\text{EVE1}\ \boxed{e}\ ] \\[6pt]
\text{QUALIA} \mid \text{FUNC} \mid \text{AGEN} &
\begin{bmatrix}
\text{RELN} & float \\
\text{THEME} & \boxed{i} \\
\text{EVE} & \boxed{e}
\end{bmatrix}
\end{bmatrix}
\right\}
\end{bmatrix}
\right]
$$

Fig. 15.18 float

$$
\left[
\text{CONT}
\begin{bmatrix}
\text{INDEX} & \boxed{e2} \\
\text{ARGSTR} &
\begin{bmatrix}
\text{ARG1} & \boxed{i1} \\
\text{ARG2} & \boxed{i2}
\end{bmatrix} \\
\text{RESTR} &
\left\{
\begin{bmatrix}
\text{EVSTR} &
\begin{bmatrix}
\text{EVE1} & \boxed{e1}\ state \\
\text{EVE2} & \boxed{e2}\ process
\end{bmatrix} \\
\text{QUALIA} &
\begin{bmatrix}
\text{IDEN} \mid \text{FORM} &
\begin{bmatrix}
\text{RELN} & in \\
\text{INST} & \boxed{i1} \\
\text{LOCAT} & \boxed{i2} \\
\text{EVE} & \boxed{e1}
\end{bmatrix} \\
\text{FUNC} \mid \text{AGEN} &
\begin{bmatrix}
\text{RELN} & to \\
\text{INST} & \boxed{i1} \\
\text{ENDPT} & \boxed{i2} \\
\text{EVE} & \boxed{e2}
\end{bmatrix}
\end{bmatrix}
\end{bmatrix}
\ \cup\
\begin{bmatrix}
\text{QUALIA} \mid \text{IDEN} \mid \text{FORM} &
\begin{bmatrix}
\text{RELN} & cave \\
\text{INST} & \boxed{i2} \\
\text{EVE} & \boxed{e3}
\end{bmatrix}
\end{bmatrix}
\right\}
\end{bmatrix}
\right]
$$

Fig. 15.19 into the cave

$$
\left[
\begin{array}{l}
\text{INDEX} \quad \boxed{e1} \\
\text{ARGSTR} \quad [\ \text{ARG1} \quad \boxed{i1}\ ] \\
\text{REST}
\left\{
\begin{bmatrix}
\text{EVSTR} & [\ \text{EVE}\ \boxed{e1}\ state\ ] \\
\text{Q} \mid \text{AG} &
\begin{bmatrix}
\text{RELN} & float \\
\text{AGENT} & \boxed{i1} \\
\text{EVE} & \boxed{e1}
\end{bmatrix}
\end{bmatrix}
\cup
\begin{bmatrix}
\text{EVSTR} &
\begin{bmatrix}
\text{EVE1} & \boxed{e2}\ state \\
\text{EVE2} & \boxed{e3}\ proc
\end{bmatrix} \\
\text{Q} &
\begin{bmatrix}
\text{FRM} &
\begin{bmatrix}
\text{RELN} & in \\
\text{INST} & \boxed{i1} \\
\text{LOCAT} & \boxed{i2} \\
\text{EVE} & \boxed{e2}
\end{bmatrix} \\
\text{AG} &
\begin{bmatrix}
\text{RELN} & move \\
\text{INST} & \boxed{i1} \\
\text{ENDPT} & \boxed{i2} \\
\text{EVE} & \boxed{e3}
\end{bmatrix}
\end{bmatrix}
\end{bmatrix}
\cup
\begin{bmatrix}
\text{Q} \mid \text{FRM} &
\begin{bmatrix}
\text{RELN} & cave \\
\text{INST} & \boxed{i2} \\
\text{EVE} & \boxed{e4}
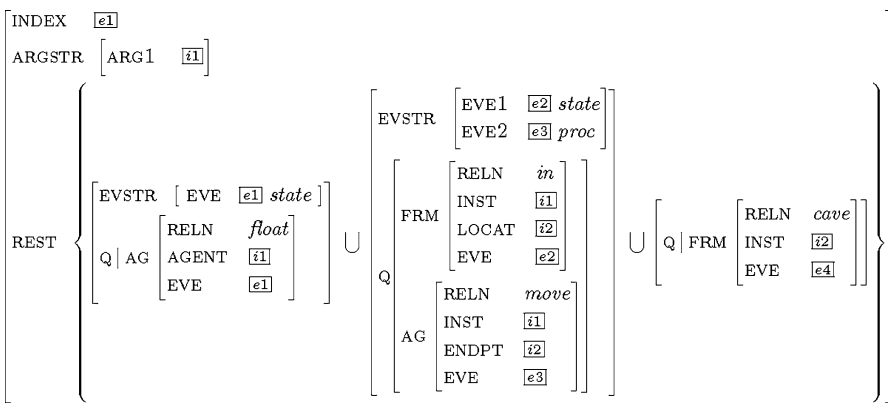\end{bmatrix}
\end{bmatrix}
\right\}
\end{array}
\right]
$$

Fig. 15.20 float into the cave

Figure 15.18 corresponds to the lexical entry for *float* denoting the state of floating in its agentive quale. Figure 15.19 shows the representation of the PP *into the cave*. In an analogous way, the preposition *into* denotes the process of going through a path (at the agentive level, applied to the individual pointed by *i1*) and ending at the state of being in a particular place (*i2*, as shown at the formal level). The partition of the preposition semantics into two different predicates (or functions) goes along the lines of Jackendoff (1990, 2002), and offers a general explanation of the stative component shared by *into the cave* and *in the cave*. In addition, it goes along the lines of Verspoor (1997) in adopting the LOCATION and ENDPOINT attributes to account for paths and places. The piece of information in the agentive quale is important in order to prevent that other verbs of movement (e.g., verbs of change of position such as *stand* or *lie*) combine with path-denoting prepositions. In Fig. 15.20, which represents the semantic structure resulting from the combination of the verbal and prepositional predicates, the same individual *i1* is floating and undergoing a process of moving through a path into a place.

Note that the resulting semantic structure for *float into the cave* in Fig. 15.20 differs to some extend from the one in Pustejovsky (1995:126). He deals with the semantic composition of the different elements in a phrase by means of qualia unification, whereas we use union of qualia structures. The interpretation of both the process of movement and the resultative state of being in the cave is not obtained from the information in the qualia structure of the verbal predicate, but it is recovered from the PP qualia structure, which is unioned to the qualia structure of the verb.

There are however other contexts in which the verbal predicate also undergoes a modulation of its basic sense, but that does not accept the treatment applied so far. They are predicate-argument combinations:

(47)   a.   En Joan va pintar la paret.   (*John painted the wall*)
       b.   En Joan va pintar un quadre força bonic
                                            (*John painted a pretty nice picture*)

(48)   a.   Després de l'acte, va cantar la coral del barri.
                                            (*After the event, the city choir sang*)
       b.   Després de l'acte, la coral va cantar una cançó.
                                            (*After the event, the city choir sang a song*)

In (47a) *pintar* ('paint') is interpreted as a transformation verb, while in (47b) the presence of an argument with an agentive structure identical to the one of its verbal predicate triggers a creation interpretation. Similarly, *cantar* in (48a) denotes a simple process, whereas it is interpreted as a transition when complemented by an argument (48b).

GL accounts for cases similar to those (in particular, to the one in (47), which behaves in the same way as *bake* verbs (Pustejovsky 1995:123ff.)) by means of Co-composition. However, it is not clear how the operation of qualia unification, as put
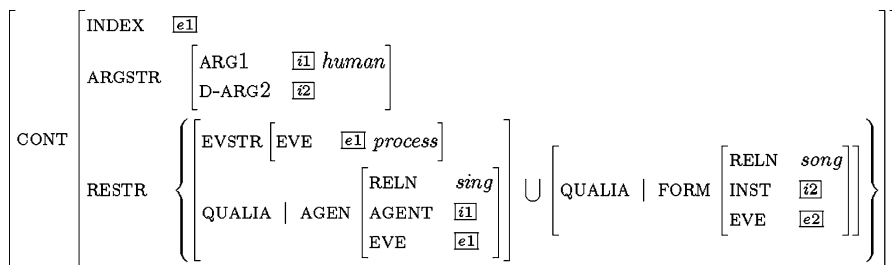
$$
\text{CONT}
\begin{bmatrix}
\text{INDEX} & \boxed{e1} \\[4pt]
\text{ARGSTR} & \begin{bmatrix} \text{ARG1} & \boxed{i1}\ human \\ \text{D-ARG2} & \boxed{i2} \end{bmatrix} \\[14pt]
\text{RESTR} & \left\{ \begin{bmatrix} \text{EVSTR}\ [\text{EVE} \quad \boxed{e1}\ process] \\[6pt] \text{QUALIA} \mid \text{AGEN} \begin{bmatrix} \text{RELN} & sing \\ \text{AGENT} & \boxed{i1} \\ \text{EVE} & \boxed{e1} \end{bmatrix} \end{bmatrix} \cup \begin{bmatrix} \text{QUALIA} \mid \text{FORM} \begin{bmatrix} \text{RELN} & song \\ \text{INST} & \boxed{i2} \\ \text{EVE} & \boxed{e2} \end{bmatrix} \end{bmatrix} \right\}
\end{bmatrix}
$$

Fig. 15.21 cantar una cançó ('to sing a song')

forward in Pustejovsky (1995), works in cases like those, where the information at the formal role of the argument is of different nature from that expressed in the formal role of the verbal predicate.[21] Contrary to previous cases of co-predication, the present examples are constituted of an object of predicative sort and another one, denoted by the argument, which is of referential type and thus cannot change the semantic properties of the predicate. Our treatment based on unioning the qualia of the predicates cannot account either for the sense alternation. Unioning the qualia of the argument and the verbal predicate in *cantar una cançó* ('to sing a song') (48b) would result in the structure of Fig. 15.21, which does not account for the desired transition interpretation because there is no formal structure depicting a resultative state.

These facts beg for a different treatment of verbal semantic alternations induced by the verb's internal arguments. Given that the differences in the interpretation are contextually guided, we will make use of the composition device –as it has been done in all other treatments developed in the current section. In addition, we will rely on the expressivity of the type system and the operations allowed for in LKB. In order to account for the different interpretations of transformation (47) or process-denoting verbs (48), we state the possible senses in the same verbal lexical entry. Once again, we do it by taking advantage of the expressive capability of YADU; in particular, its overwriting mechanisms. Figure 15.22 represents the lexical type for transformation verbs like *pintar* ('paint'). It is a partial hierarchy constituted of a first type, denoting the transformation sense, and a second one, which denotes a creation act for cases when its agentive quale coincides with that of its argument.

In a similar way, *cantar*-like verbs are represented by means of a partial hierarchy constituted of a first type for the intransitive, process-denoting use, and a second one for their transition interpretation.

Note that adapting HPSG in order to allow for an adequate semantics compositionality allows to rethink the co-composition operation. Cases of co-predication can now be easily explained by means of the semantic representational and

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[21]Recall that the formal quale of nominal predicates expresses the kind of the entity pointed at (instrument, mother_of, song, building, etc.). By contrast, the formal quale of verbs conveys the state resulting from the process denoted by the verb.
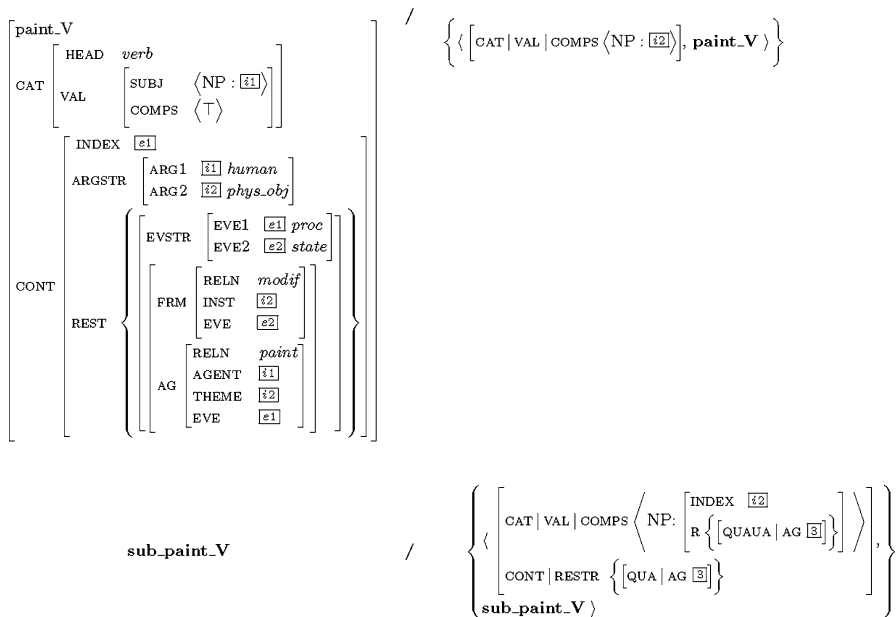
$$
\begin{bmatrix}
\text{paint\_V} \\[2pt]
\text{CAT} \begin{bmatrix} \text{HEAD} & verb \\ \text{VAL} \begin{bmatrix} \text{SUBJ} & \langle \text{NP} : \boxed{\scriptstyle 1} \rangle \\ \text{COMPS} & \langle \top \rangle \end{bmatrix} \end{bmatrix} \\[2pt]
\text{CONT} \begin{bmatrix} \text{INDEX} & \boxed{e1} \\ \text{ARGSTR} \begin{bmatrix} \text{ARG1} & \boxed{\scriptstyle 1}\ human \\ \text{ARG2} & \boxed{\scriptstyle 2}\ phys\_obj \end{bmatrix} \\ \text{REST} \left\{ \begin{bmatrix} \text{EVSTR} \begin{bmatrix} \text{EVE1} & \boxed{e1}\ proc \\ \text{EVE2} & \boxed{e2}\ state \end{bmatrix} \\ \text{FRM} \begin{bmatrix} \text{RELN} & modif \\ \text{INST} & \boxed{\scriptstyle 2} \\ \text{EVE} & \boxed{e2} \end{bmatrix} \\ \text{AG} \begin{bmatrix} \text{RELN} & paint \\ \text{AGENT} & \boxed{\scriptstyle 1} \\ \text{THEME} & \boxed{\scriptstyle 2} \\ \text{EVE} & \boxed{e1} \end{bmatrix} \end{bmatrix} \right\} \end{bmatrix}
\end{bmatrix}
\quad / \quad
\left\{ \left\langle \begin{bmatrix} \text{CAT} \mid \text{VAL} \mid \text{COMPS} \langle \text{NP} : \boxed{\scriptstyle 2} \rangle \end{bmatrix}, \ \mathbf{paint\_V} \right\rangle \right\}
$$

$$
\mathbf{sub\_paint\_V} \quad / \quad \left\{ \left\langle \begin{bmatrix} \text{CAT} \mid \text{VAL} \mid \text{COMPS} \left\langle \text{NP}: \begin{bmatrix} \text{INDEX} & \boxed{\scriptstyle 2} \\ \text{R} \left\{ \begin{bmatrix} \text{QUA} \mid \text{UA} \mid \text{AG} \ \boxed{3} \end{bmatrix} \right\} \end{bmatrix} \right\rangle \\ \text{CONT} \mid \text{RESTR} \ \left\{ \begin{bmatrix} \text{QUA} \mid \text{AG} \ \boxed{3} \end{bmatrix} \right\} \end{bmatrix}, \right. \\ \left. \mathbf{sub\_paint\_V} \right\rangle \right\}
$$

Fig. 15.22 Partial type hierarchy for paint-like verbs

compositional devices provided by our framework. But a particular treatment has to be developed for cases of meaning alternation in predicate-argument combinations, which consists of representing lexical types as conveying different meaning realisations.

15.5.4 Final Remarks

According to what we have introduced so far, the three GL generative devices have been reduced to just one, the Selective Binding mechanism. Co-composition has been integrated within the general process of structure composition. And the cases analysed by standard GL as undergoing either (True Complement) Type Coercion or Selective Binding have been shown to respond to the same linguistic behaviour:

• All of them are relations between a predicative head (be it an adjectival adjunct or a verbal predicate) and its participants (the modified noun or the arguments of the event denoted by the verb),
• They present a general identical problem (the non-satisfaction of the selection restrictions that the predicate imposes onto its participants), which is solved in the very same way: selecting a deeper layer in the semantics structure of the participant.

We consider the Selective Binding mechanism (as understood here) as an abstraction of a general linguistic operation that takes place in the process of meaning composition whenever the selectional restrictions are not satisfied, and that gives rise to the non-intersective interpretation of adjectives or the complement coercion of certain verbs. We have also looked at a completely opposed linguistic operation, consisting on the generation of new structure based also on semantic grounds. Such an operation accounts for the obligatory nature of certain complements traditionally considered as optional. Both the Selective Binding mechanism and this operation of structure generation have been implemented taking benefit of the hierarchic organisation of the lexicon, and the overwriting mechanisms that the last version of LKB provides.

In our implementation, these two wide operations are not general principles applying over the entire lexicon, as it is theoretically proposed in GL regarding the Selective Binding mechanism. Instead, they are expressed as an integral part of lexical types. In spite of their general nature, they adopt specific forms according to the features of the items involved. For instance, the alternative content attribute selected by the Selective Binding operation when an eventuality-modifying adjective is modifying a noun that does not denote an event (as in *fast typist*) is different from the alternative level in the case of colour-denoting adjectives (*red apple*). Hence, in building a real lexicon dealing with contextually-based semantic alternations, the generative mechanisms are implemented tailored to the lexical types.

Of course, it may appear that such an approach does not account for lexical creativity in its purest essence, since all possible word meanings have to be encoded as part of the lexical entries. We are facing here the dichotomy between unrestricted creativity, with its subsequent non-desired overgeneration, and controlled word meaning generation, limited to the regular cases of contextually-induced sense alternation. Our implementation of GL generative mechanisms follows this last direction.

15.6 Conclusions

In this paper we have shown that a syntactically oriented approach is inadequate to deal with both verbal and nominal complement optionality, and modification in general. A basic requirement is having a semantic representation level that, although connected, is independent from the syntactic information. This content level should be based on a rich and robust conception of semantics, allowing to address several issues in a natural way: the implication of participants and events that take part in the denotation of lexical items but are not syntactically expressable, the selection restrictions imposed by predicates to their arguments, and the non-intersective use of adjectives.

Following the latest trends in the HPSG literature, we have introduced several modifications in the standard HPSG content level by adopting a cross-category

approach to semantics. Our basic semantic model has been GL, by means of which we addressed several cases of sense creativity. In particular, we have dealt with the generative capability of the lexicon by means of three different information levels:

1. The semantic structure of words, which accounts for:

   - Lexical semantics information, composed of different layers (i.e., eventive, argument and qualia structures).
   - The multiplicity of lexical senses, conveyed in lexical types (by means of the YADU overwriting mechanisms).

2. The compositional process. Our formulation of HPSG allows for a parallel syntactic and semantic computation. This enables implementing the co-composition mechanism in a straightforward way.
3. Two general generative operations: Selective Binding (which now subsumes the two other GL generative mechanisms: Selective Binding and True Complement Coercion), and an operation of structure generation. We have shown several examples of implementing this mechanisms in a proper type system (the LKB system), with multiple inheritance and default unification.

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