

Incorporating Selectional Restrictions into HPSG

Abstract

This article is concerned with integrating the phenomenon of selectional restrictions in a formal grammar theory. Firstly, the question of treating selectional restrictions purely in the semantic module is discussed, as there are some contextual (or pragmatic) influences, which can repair the ill-formedness of violated selectional restrictions. Secondly, we shed light on the structure of pragmatics in general and then see how pragmatics is dealt with in Head-Driven Phrase Structure Grammar, a formal framework we take as a concrete example for implementation. Then we present existing approaches to selectional restrictions within this framework and, lastly, make our own proposal which describes the subject as part of the semantics-pragmatics interface. In particular, we show how a semantic ontology can be integrated.

1 Introduction

The phenomenon of selectional restrictions, first described by Chomsky (1965, pp. 114ff), is part of almost every introduction to linguistics. Androutsopoulos and Dale define such restrictions as follows:

Selectional restrictions are semantic sortal constraints imposed on the participants of linguistic constructions to capture contextually-dependent constraints of interpretation. (Androutsopoulos and Dale, 2000, p. 1)

This is the intuitive explanation for the oddity of the following examples:¹

(1) ¹*Kim ate a motorbike.*

(2) ¹*There is an apple bathing in the water.*

The verb *eat* requires an edible object and the action of *bathing* can be fulfilled only by an animate actor. Consider further examples showing that the choice of possible arguments can vary with different verbs.

(3) *The dog is drowning.; The philodendron is drowning.; ¹The bacon dumpling is drowning.*

(4) *The dog barks.; ¹The philodendron barks.; ¹The bacon dumpling barks.*

¹A superscript exclamation mark indicates a violation of selectional restrictions.

Even though there are rather diverse views about the role of selectional restrictions, there is general agreement about the central point of compatibility between verbs and their arguments.²

Selectional restrictions help with parsing the utterance, word-sense disambiguation and the resolving of anaphora, which are also relevant for natural language processing systems.

(5) *The astrologer married a star.*

The word *star* being ambiguous between “famous person” and “celestial body”, example (5) can be disambiguated because we know that the object of *marry* must be human. In the opposite way, the exact meaning of the polysemous verb *shoot* can be disambiguated by the object it takes:

(6) *He shot the rabbit.* vs. *He shot the picture.*

Selectional restrictions also are responsible for zeugmatic effects:

(7) *Are you getting fit or having one?* (from the television program M*A*S*H)

However, in metonymic, metaphoric or idiomatic utterances, selectional restrictions are often violated. A metonymy can be found in example (8), for the object of *put* is the container (e. g. a bottle), rather than the substance.

(8) *She puts the wine back on the shelf.*

²Selectional restrictions play a role with adjectives and nouns, too, but we will confine ourselves to the discussion of verbs.

As a *book* is not edible, violating the selectional restriction of *devour*, we understand (10) as being metaphoric:³

(10) *He devoured the book in one single night.*

Within idioms we can find violations of selectional restrictions, too. As was pointed out by Soehn and Römer (2004), this could be counted as a marker for a non-free reading. Take for example:

(11) *to pour out one's grief to someone*

(12) *juicy/spicy bits of gossip*

Firstly, in (11), the object of the verb *to pour out* must be a container, which doesn't hold for *grief*. Secondly, *bits of gossip* cannot be *juicy* or *spicy* in the literal sense, for *gossip* is abstract. Thus, the violations of selectional restrictions allow us to recognize a nonliteral meaning and imply an exclusively idiomatic reading.

At this point, it has to be emphasized that selectional restrictions and metaphor are two different phenomena and that selectional restrictions have to be treated as a language-specific aspect on their own. If a violation of selectional restrictions occurs, the meaning of the sentence is somehow ill-formed

³A violation of selectional restrictions may occur in metaphoric utterances but this need not be the case. Consider

(9) *He is not fit to hold a candle to her.*

(as Chomsky’s famous “Colorless green ideas sleep furiously”⁴). The strategies a language-user may apply to overcome this problem and to assign a consistent meaning to the sentence (namely a metonymic, metaphoric or idiomatic meaning, that is: assuming a figurative reading) are downstream the language understanding process.

The remainder of this article is organized as follows: after this introduction we tackle the question of whether to treat selectional restrictions as an intra- or extragrammatical phenomenon and, more exactly, whether to regard selectional restrictions as part of semantics or as part of pragmatics. Subsequently, we examine how pragmatics can be structured and how it interacts with other domains of language. Then we describe how pragmatics is integrated into HPSG (Head-Driven Phrase Structure Grammar, cf. Pollard and Sag, 1994), which we take as an example for a formal grammatical framework. We discuss existing approaches for handling selectional restrictions in HPSG and, lastly, propose our own analysis.

⁴However, there seems to be a possible interpretation, cf. <http://home.tiac.net/~cri/1997/chomsky.html>

2 Selectional Restrictions as Part of Grammar?

There is a debate whether one should view selectional restrictions as part of grammar or treat them as a grammar-independent phenomenon. Lang (1994) distinguishes, according to Dölling (1992, 1994), selectional restrictions from sortal restrictions. Whereas the former are said to be part of language-specific knowledge and thus part of the lexical information, the latter are universal and belong to the conceptual structure. Examples for sorts are **object** (“The coin melted.”) versus **kind** (“Coins are minted.”), moreover **configuration** (“The heap is being sorted.”), **substance** (“There is some beer in the fridge.”), **group** (“Our team gains the lead.”) and **institution** (“The university fired two professors.”)

Selectional restrictions, in contrast, are language-specific and thus have to be specified in lexical entries. An example Lang uses (op. cit., p. 30) for selectional restrictions is the verb *drink* which bears a selectional feature [+animate] __ [-abstract]]⁵. The idea is that verbs select and thereby restrict the range of possible arguments. That selectional restrictions may vary from language to language can be illustrated by the verbs *drive* and *ride* and their German counterparts *fahren* and *reiten*. Consider the following data:

a1) *Kim drives a truck/car/¹motorbike/¹bike/¹horse*

⁵*Peter drinks some water.* vs. **Peter drinks an idea.*

a2) *Kim rides a [!]truck/[!]car/motorbike/bike/horse*

b1) *Ute fährt ein(en) Lastwagen/Auto/Motorrad/Fahrrad/[!]Pferd*

b2) *Ute reitet ein(en) [!]Lastwagen/[!]Auto/[!]Motorrad/[!]Fahrrad/Pferd*

Whereas in English *drive* means locomotion by means of operating a motorized vehicle having more than two (possibly three) wheels, the German *fahren* is not sensitive to the number of wheels of the vehicle. The English word *ride* denotes locomotion while sitting on a saddle or seat, such as on a horse, the German counterpart *reiten* can be said only when the subject sits on the back of an animal. Thus, selectional restrictions are part of language-dependent lexical information. Sortal restrictions are more general. They constitute a proper subset of selectional restrictions (cf. Lang, 1994, p. 38).

Does violation of selectional restrictions necessarily result in an ill-formed semantics? The answer is no. We have already seen cases of metaphoric and idiomatic reading where the violation makes the literal meaning unavailable and hints at a figurative meaning. Information from selectional restrictions marks sentences as odd only if one has in mind the lexical meaning of the words and a “normal” context of utterance. This means that there is nothing inherently wrong with a sentence such as (1), the reader only has to imagine a suitable context (e. g. eating chocolate motorbikes). In addition, there are certain contextual features that render expressions like *ate a motorbike* perfectly grammatical. These “repairing contexts” (cf. Chomsky, 1965, p. 158

and Androutsopoulos and Dale, 2000, p. 1) neutralize violations of selectional restrictions and the sentence is fully interpretable:

- (13) a) ¹*Kim ate a motorbike.*
- b) *Kim did not eat a motorbike.*
- c) *One cannot eat motorbikes.*
- d) *Kim tries to eat a motorbike.—Kim believes/dreamed that she can eat motorbikes.*
- e) *I'll eat my hat if Kim ate a motorbike.*
- f) *Did Kim really eat a motorbike?*

The repairing contexts are negation (13 b), modals and negation (c), epistemic verbs as *believe*, *try*, etc. whose arguments introduce a state-of-affairs in a possible – not the actual – world (d), conditionals (e) and questions (f).⁶ Thus, a violation of selectional restrictions is highly context sensitive. Therefore, Androutsopoulos and Dale argue that selectional restrictions are a pragmatic phenomenon.

To sum up, we have so far seen that on the one hand, selectional restrictions are part of the lexical information. On the other hand, a violation of selectional restrictions does not mean that the expression becomes totally uninterpretable,

⁶Chomsky (1965, p. 158) also mentions meta-linguistic expressions like *It is not a good idea to eat motorbikes.*

but some context features may repair the violation, or a suitable context-of-utterance may even render the expression perfectly acceptable. In our view, one can account for these facts best when regarding the phenomenon of selectional restrictions as part of the semantics-pragmatics-interface.

In HPSG, there is much literature currently available on semantics, but pragmatics has been widely regarded as marginal to grammar theory. As there is an HPSG approach that treats selectional restrictions together with pragmatic phenomena (cf. Androutsopoulos and Dale, 2000), we will now discuss pragmatics in general and then how pragmatics is dealt with in HPSG.

3 Pragmatics and Grammar

3.1 General Remarks on Pragmatics

Pragmatics is a discipline of linguistics which deals with the use of language in different contexts. The central questions are: why an utterance is used and what consequences it brings about. The following phenomena fall into the domain of pragmatics: deixis, implicatures, information structure, presuppositions, reference, speech acts and rules of conversation.

The newer linguistic schools with their distinctions *langue/parole* or *competence/performance* tend to see pragmatics and grammar as opposed to each other. However, in his introduction to linguistics, Meibauer (2001) gives some

reasons for regarding certain pragmatic information as a part of grammar. For instance, the knowledge about the typical usage of sentence types can be seen as part of grammar: declarative sentences are used for assertions, imperatives express a request or an order and an interrogative sentence implies a question. Römer (1996) emphasizes the modularity of the whole language system and mentions that syntax, semantics and pragmatics are somewhat intertwined. Moreover, she describes the most important questions to be answered by the three modules. In addition, she argues that the lexicon can be seen as a complex entity which consists of several sublexicons and lexical rules. According to Römer, it would be admissible to enrich the lexicon with pragmatic information.

Harnish and Farmer (1984) divide the language system into syntax, semantics and pragmatics.⁷ The idea of Harnish and Farmer is that pragmatics comprises primarily the phenomena of reference and speech acts. The question of how to handle conversational implicatures is left open.

This entails the general question of whether pragmatics has an internal modular structure. If, according to Harnish and Farmer, only a few phenomena – such as reference and speech acts – have found their way into the language system, there must be another pragmatic module outside the system, dealing with the rest. Meibauer (2001) presents several approaches concerning this

⁷We can find this trichotomy in standard HPSG's feature structure, containing three attributes CATEGORY, CONTENT and CONTEXT.

matter (Chapters 5 and 9). He cites Kasher (1991) who distinguishes between five components⁸ of pragmatic knowledge:

- Core Pragmatics (knowledge about basic speech act types as assertion, order and question)
- Amplified Core Pragmatics (other speech act types such as congratulation)
- Talk-in-Interaction Pragmatics (knowledge about basic aspects of conversation, e. g. turn-taking or repair)
- Central Pragmatics (knowledge about basic principles of speech processing, production and understanding: conversational implicatures, indirect speech acts, politeness, register and style)
- Interface Pragmatics (knowledge about the integration of the linguistic channel with other channels, e. g. deixis)

There is no hypothesis without counter arguments: There definitely are approaches which deny that pragmatics is modular. Meibauer (op. cit.) assumes that headway can be made only by thorough empirical investigation, where the interpretation of the results again would be subject to different theoretical assumptions.

⁸Kasher calls them “modules” but he uses this term in a different way which we leave unexplained here.

A debatable answer to the question of where pragmatics is situated in the brain, is given by Kasher: The first two domains (core and amplified core pragmatics) are linked to grammar and processed within the left hemisphere of the brain (for right-handed persons), whereas the latter domains belong to more general cognitive faculties situated in the right hemisphere.

3.2 The Pragmatic Side of HPSG

How is pragmatic information implemented in (Standard-) HPSG's feature geometry? There is a feature BACKGROUND below SYNSEM LOCAL CONTEXT, reserved for "felicity conditions on the utterance context", "presuppositions or conventional implicatures" and "appropriateness conditions" (Pollard and Sag, 1994, pp. 27 and 332). It seems that selectional restrictions are in good company there.

In Pollard and Sag (1994) there are two features below CONTEXT, depicted in Fig. 1.⁹

Values of C-INDS denote the contextual anchors of an utterance, e. g. a pointer to the speaker, addressee etc. The "background" information in BGR comprises presuppositions and conventional implicatures (see above).¹⁰ These facts are represented as so-called "psoas" (*parameterized-states-of-affairs*),

⁹Henceforth we will use the following abbreviations: CONTEXT (CTXT), BACKGROUND (BGR), CONTEXTUAL-INDICES (C-INDS)

¹⁰Note that such information does not belong to grammar according to Kasher.

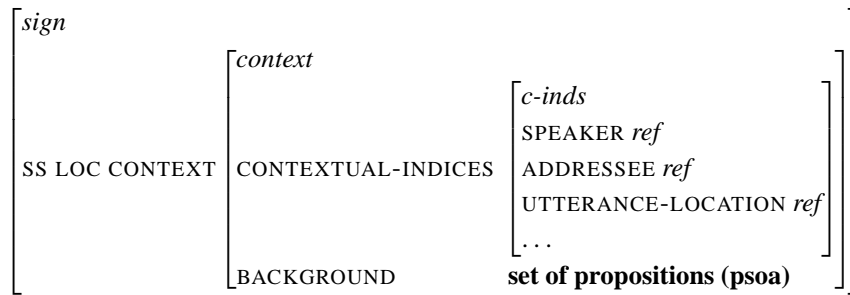


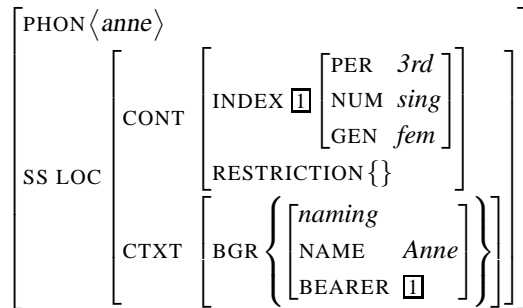
Figure 1: Feature Geometry below CONTEXT

consisting of numerous subsorts with different features. In addition, Pollard and Sag define the PRINCIPLE OF CONTEXTUAL CONSISTENCY, stating that the BGR value of a phrase is the union of all BGR values of its daughters, thus allowing the projection of pragmatic information.¹¹

¹¹Pollard and Sag (1994) admit themselves (p. 333) that this principle is a simplistic generalization of presupposition-inheritance. There are some expressions (e. g. *if... then...*) blocking inheritance systematically. The authors refer to some theories which encompass this kind of inheritance phenomena (cf. I. Heim: *On the Projection Problem for Presuppositions*. In: Barlow et. al. 1983), but they do not attempt to integrate these findings into their HPSG-architecture. They point out that any amendments will have consequences for semantic representations as well. Green (2000) discusses this principle, calling it the CONTEXT-INHERITANCE-PRINCIPLE. As far as “consistency” is concerned, she notes:

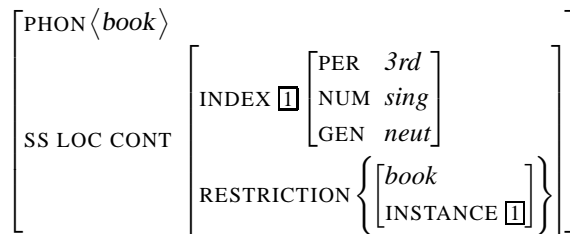
If that value [of the principle] should happen to contain inconsistent situations, or situations that are inconsistent with situations that are asserted to hold, that does not pose a logical problem, or a problem for the formal theory. Indeed, it is not a linguistic problem at all. It is a problem for a human being who wants to construe the speakers’ behavior in uttering the sentence as rational. (Green, 2000, p. 13, emphasizing by Green)

To illustrate the use of BACKGROUND, we sketch the lexical entry of a proper name such as *Anne* (cf. Pollard and Sag, 1994, p. 27):



This entry contains the restriction that the proper name can only be used if the referent with an INDEX value “third person singular feminine” is called *Anne*.

Green (1996) looks closely at the representation of pragmatic restrictions. She points out that although reference like naming is done via CONTEXT, it is the feature CONTENT that is needed for instantiating an object (after Pollard and Sag, 1994, p. 26):



Green notices that *index* is an abstract linguistic object (with the features PERSON, NUMBER and GENDER) and that, concerning the relation *book*, one does not want to restrict the *index* object, but the entity it refers to. Pollard and Sag (1994) are unclear about how this might work. Green develops a more adequate description of reference, handling it entirely via the CONTEXT feature. Although this might hold for some kinds of pragmatic information, there should be – and are – approaches to constrain the possible elements of the BGR set.

Intuitively, during a conversation, it becomes clear by the context which object a speaker refers to. Green introduces new psoas for what is generally assumed to be true (*normally-believe*) and for what interlocutors mutually believe to be true (*mutually-believe*). In her approach she leaves the feature geometry below CONTEXT unchanged.

Murphy (1995) develops a discourse theory for HPSG, which includes phenomena such as focus and the theme-rheme distinction. He needs to introduce new features below CONTEXT for old and new information. At the same time, he retains the dichotomy INDICES and BACKGROUND. His proposal is a promising basis for the further development of a discourse theory within the HPSG framework.

Further phenomena handled via CONTEXT are the “honorific plural” (e. g. third person plural in German or second person plural in French) and honorification in Japanese and Korean (Pollard and Sag, 1994, S. 91-97). For Japanese, Siegel (2000) gives an enhanced and more detailed analysis. She also introduces new psoas (among other things), contained in the BGR set.

4 Selectional Restrictions in HPSG

4.1 Previous Approaches

There are not many publications about selectional restrictions in HPSG that we know about, only those of Nerbonne (1996), and Androutsopoulos and Dale (2000).

In his article, Nerbonne focuses on topics which are related to the processing of semantic information. In order to disambiguate the sense of *chair* in the example “*The chair decided on Mary.*” he introduces a new feature M-AGT for “mental agent” within the semantics module. Thus, one can distinguish between the two meanings “piece of furniture” and “head of organization”. However, the author does not make clear what other features would be necessary and a detailed concept of selectional or sortal constraints is beyond the focus of Nerbonne’s contribution.

A more concrete proposal for handling selectional restrictions is described by Androutsopoulos and Dale (2000). More precisely, the authors describe two alternative approaches. In their first proposal, Androutsopoulos and Dale adopt a pragmatic point of view, putting all relevant information about a verb’s selectional restrictions on the BACKGROUND set of the verb. They argue that selectional restrictions belong to the non-literal information, which is always situated in BACKGROUND, in contrast to literal information, which is to be

handled in CONTENT. For this approach the authors need an inferencing component which compares the relevant psos and rules out signs corresponding to readings that violate a selectional restriction. This “constraint-satisfaction reasoning” would have to be pipe-lined after the parser of a natural language processor, because the information comes from a semantic hierarchy and has to be compared with the arguments present.

In their alternative approach, Androutsopoulos and Dale treat selectional restrictions exclusively within CONTENT. They introduce a sortal hierarchy below *index*. The INDEX value of the object of *eat* can thus be constrained to be of sort *edible*. This approach is more efficient for NLP applications. However, it yields an immediate failure of analysis when there is a violation of selectional restrictions and so does Nerbonne’s proposal. Neither approach takes into account the effect of a repairing context. Only the first alternative by Androutsopoulos and Dale seems to be capable of being sensitive to contextual effects but, regrettably, the authors do not explain how this might work.¹²

4.2 Our Proposal

As we have argued above, the phenomenon of selectional restrictions can be best accounted for by regarding it as part of the semantics-pragmatics-interface.

¹²In a similar vein, Ben-Avi and Francez (2004) propose to combine information from a semantic ontology with a type-logical grammar. Unfortunately, their approach within the framework of Categorical Grammar does not take into account repairing contexts either.

The idea is to put the relevant information into the BACKGROUND set of the sign and use structure-sharing with respective semantic indexes. Contrary to the first proposal by Androutsopoulos and Dale (2000) we introduce a semantic hierarchy with new sorts and relations as part of every *unembedded-sign*. Thus, we avoid the need for a separate inferencing component.

As a first step, we define two new elements to figure on the BGR set. These are, following standard assumptions, subsorts of *psoa*.

$$\left[\begin{array}{l} \textit{sel-restr-imp} \\ \text{ARG} \quad \textit{index} \\ \text{MUST-SATISFY} \quad \textit{selection-sort} \end{array} \right] \qquad \left[\begin{array}{l} \textit{sel-restr-stf} \\ \text{ARG} \quad \textit{index} \\ \text{SATISFIES} \quad \textit{selection-sort} \end{array} \right]$$

The first *psoa* can be introduced to BGR by signs which impose a selectional restriction.¹³ A verb can subcategorize for a noun with a certain restriction, as illustrated in Fig. 2: *eat* selects an optional object, which must be edible (see below for the nature of the values of MUST-SATISFY and SATISFIES).

$$\left[\begin{array}{l} \text{PHON} \langle \textit{eat} \rangle \\ \text{SS LOC} \left[\begin{array}{l} \text{CAT} \left[\begin{array}{l} \text{HEAD} \quad \textit{verb} \\ \text{SUBCAT} \langle \textit{NP}, \left(\left[\text{LOC} \left[\begin{array}{l} \text{CAT} \quad \text{HEAD} \left[\begin{array}{l} \textit{noun} \\ \text{CASE} \textit{acc} \end{array} \right] \right] \right] \right] \right] \rangle \rangle \end{array} \right] \\ \text{CTXT} \left[\text{BGR} \left\{ \dots, \left[\begin{array}{l} \textit{sel-restr-imp} \\ \text{ARG} \quad \mathbb{1} \\ \text{MUST-SATISFY} \quad \textit{edible} \end{array} \right] \dots \right\} \right] \end{array} \right] \end{array} \right]$$

Figure 2: Lexical entry (abbr.) for *eat* imposing a selectional restriction

¹³*sel-restr-imp* for *imposed*

Nouns such as *apple* satisfy this restriction.¹⁴ They have also included this information in their BGR set, see Fig. 3.¹⁵

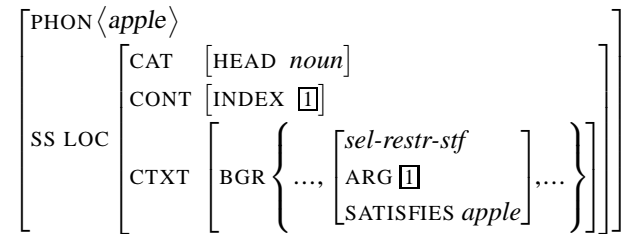


Figure 3: Lexical entry (abbr.) for *apple* including a SATISFIES value

The phrase “...eats apples” is sketched in Fig. 4. The collection of all elements in all BGR sets is guaranteed by the CONTEXTUAL-CONSISTENCY-PRINCIPLE, which exists independently of our proposal.

As a second step we introduce a principle which guarantees that the values of MUST-SATISFY (M-STF) and SATISFIES (STF) in the CTXT BGR set are compatible. To be compatible means that the STF value of the argument of *eat* is either identical to the M-STF value of the verb itself, or that the STF value is a subelement of the M-STF value in a semantic ontology. In other words, the verb only requires an edible object, whereas the object itself can be more concrete – a pancake or a banana.

¹⁴*sel-restr-stf* for *satisfies*

¹⁵Löbner notes (Löbner, 2002, p. 114) that in cases of pronominal objects (*It (the dog) barks.*), only the referent of the complement must satisfy the selectional restrictions. Our approach can easily account for this, because pronouns and their antecedent share their INDEX value.

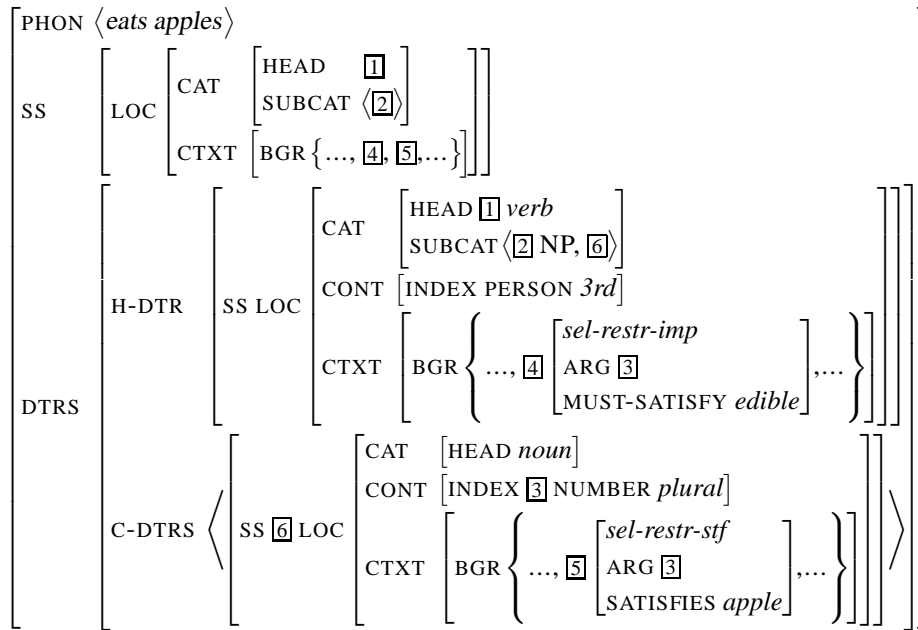


Figure 4: Phrase including selectional restrictions

The principle should license only phrases which have compatible values of M-STF and STF – but only if the argument or the whole proposition is outside the scope of a negational operator, a conditional operator, a question-operator, or an epistemic verb. As stated above, these contexts “repair” the effect of a violation of selectional restrictions.

(14) VALIDITY-PRINCIPLE OF SELECTIONAL RESTRICTIONS

(VPSR, preliminary version):

If in a phrase x there is a sign s , a verb v (s is an argument of v) and a proposition p , which is formed by v and its arguments, and

if neither the meaning associated with s nor the meaning associated with p are within the scope of a negational operator, a conditional operator, a

question-operator or an epistemic verb,

then the STF value of a *sel-rest-stf* element in the CTXT BGR set of x and the M-STF value of a *sel-restr-imp* element that shares the ARG value with *sel-rest-stf* must be compatible.

How can we capture this compatibility formally? We define the possible values of M-STF and STF as subsorts of the newly-introduced *selection-sort*, cf. Fig. 5.

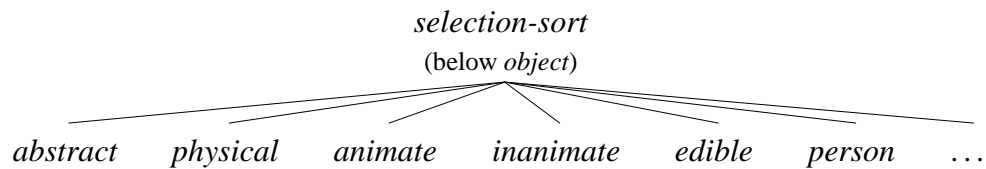


Figure 5: The sort *selection-sort*

This sort has a finite number of subsorts such as *abstract*, *physical*, *artifact*, *animate*, *edible*,... which correspond to elements of a semantic ontology as in WordNet¹⁶ or GermaNet¹⁷. In Fig. 6 we roughly sketch such a semantic ontology, including multiple inheritance (subelements inherit from more than one superunit).

In such an ontology the elements are related to each other, indicated by the tree-structure. We want to establish such relations between the subsorts of

¹⁶cf. Christiane Fellbaum, ed. (1998): *Wordnet: An Electronic Lexical Database*. Bradford Books, The MIT Press.

¹⁷cf. <http://www.sfs.nphil.uni-tuebingen.de/lcd/>

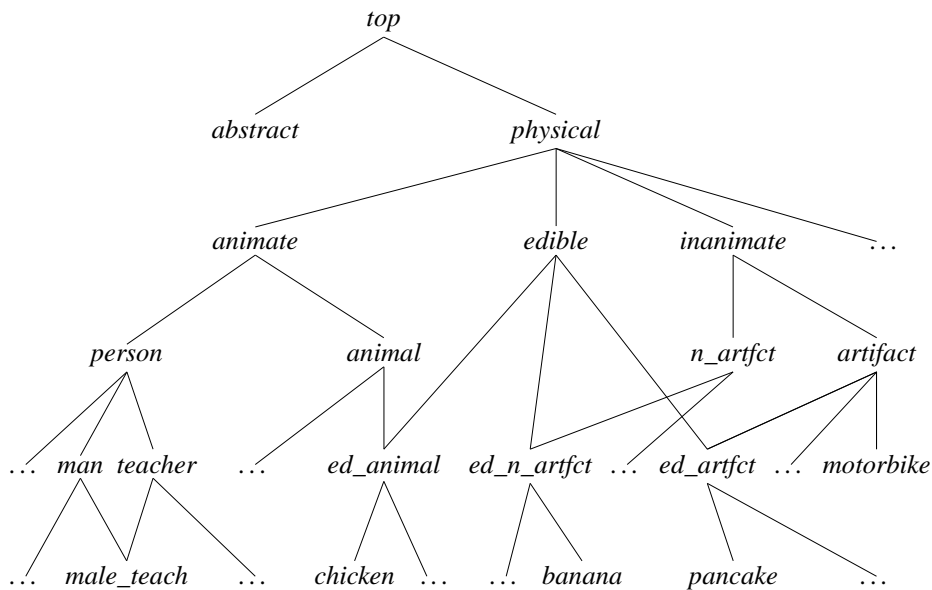


Figure 6: A semantic ontology

selection-sort, too. However, a sort hierarchy, as used for the normal HPSG sort inventory, cannot be adopted here. An HPSG formalism for Pollard/Sag-style grammars (as RSRL e.g. Richter et al., 1999) requires that objects be sort-resolved. This allows us to talk about objects having maximally specific sorts on the one hand and about underspecified descriptions (among them lexical entries) on the other. If we had a sort hierarchy for *selection-sort* analogous to the one in Fig. 6, we could not capture generalizations such as, e. g., that *eat* takes something *edible* as its object, for *edible* is not maximally specific. To clarify this point, we stick to our example of *eat* with the lexical constraint imposing an edible object. Consider the concrete utterance “*She eats pancakes.*” where there is a noun-object with $\left[\text{STF } \textit{pancake} \right]$, which is the argument of a ver-

bal object *eat* with an arbitrary, maximally specific value $\left[\text{M-STF } banana \right]$. Even though *banana* is a subsort of *edible* (the constraint in the lexical entry of the verb thus is fulfilled), the two sorts *banana* and *pancake* are still incompatible and the selectional restriction seems to be violated. This shows that we need sorts such as *edible*, which are somewhere in the middle of the hierarchy, as values in sort-resolved objects.

Thus we insert the subsorts of *selection-sort* into the signature as depicted in Fig. 5. The relations have to be defined separately and can be compiled in a list. This list is the value of a new attribute HIERARCHY, which we define for all unembedded signs. It contains pairs of subsorts of *selection-sort* being in an “is a”-relation. Formally, this is a partial order of the elements below *selection-sort*. The following principle describes the list and defines it as the value of HIERARCHY for every unembedded sign.

(15) SELECTION-HIERARCHY-PRINCIPLE (outlined):

$$unembedded\text{-}sign \rightarrow \left[\text{HIERARCHY} \left\langle \dots, \begin{bmatrix} is_a \\ ARG1 \ animate \\ ARG2 \ animate \end{bmatrix}, \begin{bmatrix} is_a \\ ARG1 \ animate \\ ARG2 \ person \end{bmatrix}, \begin{bmatrix} is_a \\ ARG1 \ animate \\ ARG2 \ animal \end{bmatrix}, \dots \right\rangle \right]$$

Excursus: Unembedded signs Unembedded signs are stand-alone utterances. According to Richter (2004, Ch. 2.1.2), they are empirical objects and central to linguistic research.

I will suggest that the empirical entities of linguistics are unembedded signs or utterances. Fragments of linguistic expressions which are smaller than utterances do not have a phonology or a semantics in the same way as utterances do. They typically lack pragmatics. Smaller units are insufficiently equipped to adequately express syntactic generalizations which belong to the standard inventory of the principles of syntax. Embedded sentences, fragments of constituents, or words which cannot occur as independent utterances on their own can only be meaningfully studied as parts of unembedded utterances. (Richter, 2004, p. 75)

Richter argues already in (1997, Ch. 5.2) that a more fine-grained distinction of *signs* is necessary. In the signature which he develops, every subsort of *sign* can occur both as an embedded and as an unembedded version. Major differences between embedded and unembedded signs are that the latter do not contain any unbound traces (if one assumes that traces exist) and that they have illocutionary force. Richter (op. cit.) defines a new feature, ILLOCUTION, for unembedded signs which can have the values *question*, *assertion*, *exclamation*, and others.

Returning to our selectional restriction approach, we recapitulate: Compatibility of *selection-sorts* means that there is an “is-a” relation between the val-

ues of MUST-SATISFY and SATISFIES. We do not mean that the HIERARCHY, which can easily become quite large, is a genuine part of every unembedded sign. We only want to express the fact that every speaker has access to this kind of knowledge when formulating or listening to an utterance. Defining HIERARCHY as a feature of *unembedded-sign* allows us to determine the grammaticality of each unembedded sign without any further context. This seems to conform to our intuitions concerning unembedded signs. Thus we do not have to postpone the treatment of selectional restrictions to a separate inferencing component but we can recognize the semantical ill-formedness immediately for each unembedded sign.

The is-a relation can contain one or more intermediate sorts; it is transitive.

(16) *She drank a sip of the Cabernet Sauvignon 2001.*

This example is about a special kind of wine. *Cabernet Sauvignon* **is** wine, which **is** an alcoholic beverage, which **is** a beverage, which **is** drinkable. This example shows that such an ontology becomes remarkably complex. At this point we have to admit that it is very easy to postulate and roughly outline such ontologies. However, an exact implementation requires a lot of work, particularly when accounting for all the theoretical and empirical problems such a project raises (for a successful project cf. the one mentioned in footnote 16).

To sum up: we propose a way to integrate selectional restrictions into HPSG which includes the effects of repairing contexts. Restrictions are im-

posed by the verbs in their lexical entries and have to be satisfied by the verbs' arguments. If the argument is within the scope of a repairing operator, the whole sign is not ungrammatical – it is licensed by the VPSR.¹⁸

4.3 Metonymy – A Further Issue

In our introduction, we mentioned the phenomenon of metonymy. The given example (8) is repeated as (18):

(18) *She puts the wine back on the shelf.*

The resolution of metonymies requires the speaker to have a certain amount of world knowledge, e. g. that a given object has certain parts – a chair has legs or a personal computer “has” a monitor. In addition, the speaker disposes of a huge amount of other known relationships between objects and entities in the

¹⁸One argument we have disregarded is that a violation of selectional restrictions gets repaired by certain kinds of contexts such as fairy tales or science fiction stories. The following example is perfectly acceptable in a setting where there are various kinds of chocolate figures:

(17) *Peter ate a football and a motorbike.*

So there are contexts which override given facts systematically and where edible footballs or spaceships with a “Warp Drive” are perfectly normal. To account for this kind of contextual shift one would have to assume a more fine-grained structure in the CONTEXT and distinguish between a standard context and an active context. Moreover, one would need relations which can take over standard assumptions (footballs are not edible) to the actual context or which can introduce new scenarios (starships can travel faster than light).

language. In example (18) one needs the information (and has it) that drinkable liquids are usually stored in bottles, which can be placed on a shelf.

For the handling of selectional restrictions, we have introduced a semantic hierarchy in form of the HIERARCHY list, which contains a kind of relation between entities, the is-a relation: a word **is** a sign, a banana **is** edible etc. We can now go on and define other relations such as “has part” or “consists of”. Such relations (*has_part(x, y)*, *consists_of(x, y)*) have, as well as *is_a*, two arguments which point to a certain element in the hierarchy.

For implementation there are two possibilities. On the one hand, we could define more lists such as HIERARCHY, a new one for each relation that is to be implemented. These lists contain all valid tuples of the sorts below *selection-sort* being in that given relation (as sketched above for HIERARCHY). On the other hand, relations could be defined directly over the elements on HIERARCHY, one for each desired relationship between the elements. This second possibility has the advantage that generalizations can be captured elegantly. For example, all kinds of persons have a mother. This fact does not have to be made explicit for all subelements of *person*, as the is-a relation on HIERARCHY guarantees the inheritance. These generalizations follow only implicitly when one chooses to define multiple lists. Thus, it seems that a solution with relations over elements on HIERARCHY is to be preferred.

We adapt the VPSR and formulate the final version:

(19) VALIDITY-PRINCIPLE OF SELECTIONAL RESTRICTIONS

(VPSR, final version):

If in an unembedded sign x there is a sign s , a verb v (s is an argument of v) and a proposition p , which is formed by v and its arguments, and if neither the meaning associated with s nor the meaning associated with p are within the scope of a negational operator, a conditional operator, a question-operator, or an epistemic verb, then the STF value of a *sel-rest-stf* element in the CTXT BGR set of x and the M-STF value of a *sel-restr-imp* element that shares the ARG value with *sel-rest-stf* must be in the *is-a* relation on the HIERARCHY list of x or in another relation.

Now all cases where a violation of selectional restrictions is grammatical are licensed.¹⁹

5 Conclusion

We have investigated the phenomenon of selectional restrictions and characterized it as being situated on the semantics-pragmatics-interface. On the one hand, there are clearly language-specific constraints on a verb's arguments, for

¹⁹It is evident that the vast field of semantic ontologies, the representation of world knowledge, and the differences between world knowledge and linguistic knowledge has been disregarded in this discussion. However, these topics are a desideratum of further research.

which compliance contributes to the felicity of a given sentence. On the other hand, there are both linguistic and situational contexts which can “repair” a violation of selectional restrictions.

After discussing pragmatics in general and the handling of pragmatic information in HPSG, we have outlined previous approaches to selectional restrictions within that theoretical framework. Subsequently, we have proposed our own analysis comprising three elements. Firstly, we defined two psos for imposing and satisfying selectional restrictions. Secondly, we introduced a principle (the `VALIDITY-PRINCIPLE OF SELECTIONAL RESTRICTIONS`) which licenses all and only those unembedded-signs for which selectional restriction information is compatible. Thirdly, we implemented a great portion of world knowledge – a semantic ontology – in the theory, which models relationships between entities a speaker talks about. With the help of this knowledge (in `HIERARCHY` and the relation inventory), not only selectional restrictions can be analysed but also some cases of metonymy and, perhaps, other phenomena involving both linguistic and world knowledge. The crucial point of our approach is that it allows unembedded signs to be interpreted without any further context. It still remains to be seen how this analysis can be carried forward to other formal grammar frameworks.

Up to this point we have – more or less implicitly – presumed that an utterance yielding a violation of selectional restrictions is to be counted as un-

grammatical. This view is probably too extreme. As for language in use, one might say that an addressee tries to interpret all of the information he has, even a sentence with violated selectional restrictions. This addressee relies on the Cooperative Principle of Grice (Grice, 1975, p. 45), in particular that the speaker says something relevant and avoids obscurity of expression. Thus the addressee tries to find a context in which all selectional restrictions are satisfied. Such contexts may include fictitious contexts of utterance or metaphors. If this is correct, we could modify our grammar in such a way that the VPSR does not rule out anything but that it passes questionable utterances to a metaphor resolution component²⁰ downstream the language understanding process.

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²⁰See Barnden (1999) or Lee and Barnden (2001) for some work in this area.

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