THE ROLE-ARGUMENT UNIQUENESS PRINCIPLE IN HPSG

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Abstract. This paper addresses the problem of the Role-Argument Uniqueness. More specifically, it is concerned with the way this constraint (hereafter RAUP) might be expressed within HPSG. Its starting point represents Davis' pioneering work. In section 2, I describe Davis' solution to the problem of the Role-Argument Uniqueness and I show that his proposal has a certain empirical drawback: the filter devised to do the job of the RAUP is not able to rule out some classes of ill-formed constructions which appear to be RAUP violations. I put forward the hypothesis that this happens because the real locus of the RAUP violations is elsewhere, presumably at the level of the representation of semantic roles. In order to check out this hypothesis, I examine two classes of lexical semantic representations which might be held responsible for RAUP violations. One of these classes involves certain cases of concatenations, while the other exhibits instances of failed unifications. I conclude that the latter one may be invoked to explain ill-formed constructions considered RAUP violations. This leads to the last (and the central) claim of the paper: unlike the GB theory, no specific principle ruling the role-argument uniqueness is needed in HPSG.

1. INTRODUCTION

The Θ-criterion as formulated for the GB Theory (Chomsky 1981, Speas 1990) consists in two stipulations:

(i) Every argument position P must be Θ-marked.

(ii) If a Θ-role Θ_i marks an argument position P, there must be only one realization of Θ_i.

These two constraints are not specific only to the GB Theory. Versions of them are incorporated into every grammatical theory which recognizes the import of the relationship between grammatical arguments and semantic roles. For instance, in the HPSG Linking Theory proposed in Davis (2001), stipulation (ii) appears as "the Problem of the Role-Argument Uniqueness", and is defined as follows:

"…the constraint on predicators that no more than one syntactic argument may realize a given semantic role" (Davis 2001: 262).

In the same framework, clause (i) of the Θ-criterion takes the shape of "the Full Interpretation of Arguments". Its expression is given below:

"Every referential synsem object on an ARG-ST list must structure-share its CONTENT with (a subpart of) the predicator's CONTENT" (Davis 2001: 278).

RRL, **LII**, *1–2*, p. 211–222, Bucureşti, 2007

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This paper approaches the problem of the role-argument uniqueness in HPSG. It discusses Davis' solution to this problem and proposes a simplification. The central claim is that no specific principle ruling the role-argument uniqueness is needed in HPSG, unlike the GB theory.

2. THE HPSG LINKING THEORY AND THE ROLE-ARGUMENT UNIQUENESS PRINCIPLE

With respect to the Linking Theory he proposes, Davis makes two comments:
(i) HPSG does not actually incorporate any formal expression of the role-argument uniqueness principle.
(ii) The typed feature formalisms for HPSG (Carpenter 1992, Keller 1993) make difficult the expression of RAUP as a constraint on feature structures.

The consequence of these situations is that two classes of constructions (which are violations of RAUP) are not ruled out in spite of their obvious ill-formedness:

(1) (a) * Pate ate dinner a large steak.
(b) * Kelly splattered some friends with mud on some friends/themselves.
(c) * Chris rented the gazebo to yuppies to libertarians[1].

(2) * The snake ate itself itself[2].

In (1a) there are two direct objects for the same semantic role. In (c), the TO complement of **rented** has also double expression. Finally, in (1b) the NP **some friends** doubles the semantic role of **splattered**, while in (2) the reflexive **itself** repeats the incremental theme of the verb **ate**. Comparable facts are displayed in examples under (3), where each verb has two syntactic means of expressing the same meaning (Davis 2001: 234, example 14):

(3) (a) * Terry aspired to fame for fame.
(b) Pat talked to the president of the USA in 2005 with George W. Bush.
(c) ?? Tim $_i$ hid the paper under himself $_i$ beneath him $_i$.

In order to avoid the licensing of such constructions, Davis appeals to two constraints: the Principle C of the (HPSG) Binding Theory and a new constraint designed to cope with the problematic examples of type (2).

According to the Principle C, a non-pronoun has to be o-free, that is, non-coindexed with another element o-commanding it. This requirement is not

[1] Examples (56 a-c) in Davis (2001: 262)
[2] Example (58) in Davis (2001: 264)

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observed by the non-subject argument realizations in (1). Let us examine closer example (1a). The NPs **dinner** and **a large steak** express the same semantic role of **ate** (that is, THE EATEN THING), and this amounts to assign each of their CONTENT value the same tag:

(AVM1) $$\begin{bmatrix} ARG-ST : \langle NP : |1|, |2|NP : |3|, |4|NP : |3| \rangle \\ CONT : eat-rel \begin{bmatrix} EATER : |1| \\ EATEN : |3| \end{bmatrix} \end{bmatrix}$$

As a consequence of their identical relationship with the value of the semantic role attribute EATEN, the NPs **dinner** and **a large steak** are compelled to share the value of their referential indexes. Thus, they become coindexed, which means that the NP **a large steak** is locally o-bound by the NP **dinner**, in spite of its being a non-pronoun.

Principle C, however, is not able to rule out examples of type (2). Indeed, the reflexive **itself** is an anaphor and it has to be locally o-bound. This is what actually happens. So Binding Theory is not able to sanction ill-formed constructions like (2).
For this kind of examples Davis proposes a second constraint, which he calls "The Distinct Content Condition" (DCC - Davis 2001: 266). DCC states the following:

DDC. Let A and B be *synsem* objects on an ARG-ST list, with CONTENT values X and Y respectively. Then X and Y are distinct (i.e, not taken identical).

The consequence of DCC is that examples of type (2) are now declared ill-formed. For instance, in the ARG-ST list of **eat** in sentence (2), the second and the third synsem are identical, fact which violates DCC:

(AVM2) $$\left[ARG-ST : \langle ss, |1|ss, |1| \rangle \right]$$

Also, on the same ground, DCC is able to rule out ill-formed structures of type (3), like the following:

(4) * Jesse believed them $_i$ to be honest that they $_i$ were honest.

In the ARG-ST list of **believed** in (4) there are three synsems which are related to the (two) semantic roles distributed by the verb content[3]. The last two synsems (namely, the one of the VP **to be honest** and the one of the clause **they were honest**) share their CONTENT value and thus violate DCC.

[3] The pronoun **them** is the raised argument of the raising verb **believe** and because of this it has nothing to do with the semantic roles belonging to **believe**.

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Both the Principle C of Binding Theory and DCC therefore fulfill the task of RAUP.

3. A PROBLEM OF EMPIRICAL COVERAGE WITH DAVIS' APPROACH

This approach, though, has a certain empirical drawback. Namely, there are constructions which by their very ill-formedness are also RAUP violations, and which, in spite of this, escape the filter represented by the conjunction of Principle C and DCC. Consider the structures below:

(5) * The snake ate a frog itself.
(6) * The snake ate itself a frog.

In (5), **itself** is an anaphor and is locally o-bound (as the Principle A requires), and **a frog** is a nonpronominal expression and is o-free (as the Principle C stipulates). On the other hand, NPs **a frog** and **itself** do not have the same content and hence they comply with DCC. In spite of this, the structure is ill-formed, and what is of interest here is that this is an obvious instance of the RAUP violation, because there are two direct objects for the same (Incremental Theme) semantic role.

The situation does not improve if one changes the order of complements, as in (6). Again, the NP **itself** obeys the Binding Principle A, which says that an anaphor has to be locally o-bound, whereas the NP **a frog** obeys the Principle C, by its being o-free. As in the previous case, either NP has its own content, thus observing the DCC. Yet the RAUP is also violated. The general conclusion therefore is that the conjunction between the Principle C and DCC does not have the expected empirical coverage. A normal question is why it is so.

4. REPRESENTATIONS OF THE RAUP VIOLATIONS IN DAVIS' APPROACH

A possible answer might be found by inspecting the nature of the representations considered by Davis to explain violations of RAUP. In this respect, one has to notice that a characteristics of Davis' account is its exclusive concentration upon the ARG-ST level. Thus, according to his approach, a banned representation is the one which displays either a repetition of the same CONT value in the synsems belonging to the ARG-ST list, or a repetition of the synsem itself. Both instances are pointed out below by means of identical tags assigned either to the synsems CONT values or to the synsems themselves. RAUP violations therefore look as in AVM3 or as in AVM4 below:

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(AVM3) $\left[ARG-ST:\left\langle ss\left[CONT:\boxed{1}\right], ss\left[CONT:\boxed{1}\right]\right\rangle\right]$

(AVM4) $\left[ARG-ST:\left\langle \boxed{1}ss, \boxed{1}\right\rangle\right]$

What AVMs3 and 4 are intended to describe is *a competition* of the same synsem (or of different synsems with identical content) *in expressing the same argument*. Since these representations do not suffice to rule out classes of examples represented by (5) and (6) above, in what follows I will adopt a different strategy in approaching the issue. I will make the hypothesis that the locus involved in RAUP violations is the other part of the Linking Theory, namely the representation of the word content, which deals with semantic roles and their values.

The strategy may be summarized as follows: if we find lexical semantic representations which could be related to ill-formed constructions illustrating RAUP violations, then we could declare those semantic representations banned representations.

5. ALTERNATIVE HYPOTHESES TO RAUP VIOLATIONS

In principle what might be wrong with a lexical semantic representation might be either a problem of concatenation or a problem of unification. It follows then that in principle we could have either a Concatenation-based explanation of RAUP violations or a Unification-based explanation of this phenomenon.

5.1. The concatenation-based explanation

Concatenation is a relationship of succession between two arbitrary linguistic objects. It is also a relationship which observes a certain given order defined within a domain – if any. For example, the succession of synsems in the ARG-ST list observes the obliqueness hierarchy, while the succession of the items in the value of the PHON attribute respects the presumed acoustic order of the phonemes themselves in pronunciation.

One of the properties of concatenation is the possibility of using the same item several times in a given succession. Due to this property, it is possible for instance to concatenate **p** and **p** (in the written word **appendix**) and to thus avoid to write ***apendix**. One may call this property "self-concatenation", and describe it as follows:

D(self-concatenation)

For an arbitrary linguistic item **i**, **i** ⊕ **i**

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What might now be the relationship between semantic representations using concatenations and constructions declared violations of RAUP? A possible answer would be the following: certain semantic representations which use concatenations of their values might plausibly be considered to model (and thus explain) RAUP violations. Consider for instance the representations below, where Θ and Ω are arbitrary semantic role labels, and tags $|1|$ and $|2|$ .are arbitrary content objects:

(AVM5) $\left[\mathrm{CONT}: \mathrm{x}-\mathrm{rel}\left[\mathrm{SEM}-\mathrm{ROLE}\theta:|1|,|2|\right]\right]$

(AVM6) $\left[\mathrm{CONT}: \mathrm{y}-\mathrm{rel}\left[\mathrm{SEM}-\mathrm{ROLE}\Omega:|1|,|1|\right]\right]$

AVM5 describes a relation (*x-rel*) characterized by a semantic role which has as value a concatenation of distinct content objects. AVM6 on the other hand describes a relation which features the semantic role Ω. The value of Ω is a self-concatenation of a content object.

Let us notice now that there is a striking correspondence between representations such as AVMs 5 and 6 and instances of RAUP violations. Let us start with AVM6.

Suppose that AVM6 characterizes in fact the semantics of the verb **believe** in English. Otherwise said, suppose that *y-rel* is actually *believe-rel,* and $\mathrm{SEMROLE}\,\Omega$ is identical to WHAT_IS_BELIEVED. Under this hypothesis, what is got as a semantic representation for **believe** is described in the following AVM[4]:

(AVM7) $\left[\mathrm{CONT}: \mathrm{believe}-\mathrm{rel}\left[\begin{array}{l}\mathrm{BELIEVER}:\ldots \\ \mathrm{WHAT}-\mathrm{IS}-\mathrm{BELIEVED}:|1|,|1|\end{array}\right]\right]$

This content assigned to **believe** fits well with the following construction (projected and headed by **believe**):

(7) Jesse believed them $_{i}$ to be honest that they $_{i}$ were honest.

Indeed, AVM7 displays the self-concatenation of the value 1 for the second semantic role, whereas (7) has two arguments expressing this semantic role. Both arguments have the same content, the content indicated by the tag 1. Notice that (7) is in fact (4) above, that is, one of the RAUP violations, which in Davis' approach is ruled out by DCC.

[4] We leave aside the problem of the value for the first semantic role attribute. It does not influence in any way the analysis.

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Suppose now that AVM6 is realized as a characterization of the meaning of **eat**. This time, the following identities hold: *y-rel=eat-rel*. SEMROLE Ω = WHAT_IS_EATEN

With these identities, the meaning of **eat** looks as follows:

$$\text{(AVM8)}\ \left[\text{CONT}:\text{eat}-\text{rel}\left[\begin{array}{l}\text{EATER}:\ldots\\ \text{WHAT}-\text{IS}-\text{EATEN}:|1|,|1|\end{array}\right]\right]$$

The correspondence between this representation and the construction ***The snake ate itself itself** (projected and headed by **eat**) is even more impressive: this time what appears as a self-concatenation in the domain of the semantic representation is syntactically realized as a self-concatenation in the domain of the direct object argument.

The same interesting correspondences may be noticed with respect to AVM5. If AVM5 is realized as *eat-rel*, the meaning of **eat** appears to be the following:

$$\text{(AVM9)}\ \left[\text{CONT}:\text{eat}-\text{rel}\left[\begin{array}{l}\text{EATER}:\ldots\\ \text{WHAT}-\text{IS}-\text{EATEN}:|1|,|2|\end{array}\right]\right]$$

This representation may be related to an **eat**-projection like ***** **Pate ate dinner a large steak**. In Davis' analysis, this **eat**-projection is ruled out by Principle C. However, the advantage of considering AVM5 an explanation of the ill-formed construction ***** **Pate ate dinner a large steak** is obvious: AVM5 may be also used to explain ill-formedness of constructions of type (5)-(6), that is, structures left unexplained under Davis' account.

It seems then that a Concatenation-based explanation of RAUP violations is appealing, thanks to its superior empirical coverage. What seems to be still done is just to build a constraint according to which representations of type AVM5-6 have to be ruled out. This constraint will represent the concatenation version of RAUP.

A problem of empirical coverage with the concatenation-based hypothesis

Unfortunately, the concatenation-based hypothesis has a problem of empirical coverage, too. It is not able to distinguish between a construction like (9) which is a coordination (and is not a violation of RAUP) – and a construction like (8) which is not a coordination and is a RAUP violation:

(8) * The snake ate itself itself.
(9) The snake ate a frog and a rabbit.

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Indeed, according to the concatenation version of RAUP, both constructions display concatenations of their semantic role values. Consequently, they must be both ruled out.

The costs of the attempt to make the concatenation version of RAUP a correct constraint are high. The constraint should be modified such that it allows certain concatenations, while ruling out certain others. The distinction in this case might be between self-concatenation and concatenation of synsems (with distinct content). But even on this strategy, one reaches impasse, because with this new distinction, RAUP is no longer able to rule out examples of type (10):

(10) * Pate ate dinner a large steak.

An extreme solution to all these puzzles would be to declare coordination a case of *non*-concatenation. But obviously, this is an *ad-hoc* strategy, with no independent evidence in its support. So, in spite of its seemingly advantages, the concatenation-based explanation of RAUP has to be abandoned.

5.2. The unification-based explanation

In this section I will investigate some general conditions upon lexical semantic representations. These conditions regard unification. The approach will be developed as follows:

- I will identify some of the most general conditions a lexical semantic representation has to meet with respect to unification.
- I will pursue what happens as a consequence of the fact that these general conditions are not met.

To anticipate the result, these two steps suggest the following conclusion: the violation of certain very general constraints on feature structures unification yields (when it manifests into the domain of semantic representations of words) effects which are identical to the RAUP violations pointed out both in constructions of type (1)-(3) and of type (5)-(6).

Let us consider two arbitrary lexical items li_x and li_y. Suppose they have the following (partial) content representations (where Θ and Ω are again arbitrary semantic role labels, and $\perp$ means failed unification).

(AVM10) Partial semantic representation of $li_x : \perp$ *x-rel* $\begin{bmatrix} \text{SEMROLE}\Theta : |1| \\ \text{SEMROLE}\Theta : |2| \end{bmatrix}$

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(AVM11) Partial semantic representation of $li_y : \perp$ *y-rel* $\begin{bmatrix} \text{SEMROLE}\Omega : |1| \\ \text{SEMROLE}\Omega : |1| \end{bmatrix}$

Of course, lexical items with a semantic structure like the ones above cannot exist in any language in the world. The explanation is that either of them violates a certain property of unification, fact which leads to failed unifications. Thus in AVM10 unification fails because what is not observed is the property of consistency. That is, inconsistent pieces of information are subject to unification and this is not allowed.

In AVM11 it is more difficult to show the source of the failure. AVM11 looks like a unification of the feature structure [SEMROLE Ω :| 1|] with itself. When a feature structure unifies with itself, it has to observe the property of idempotency. In our case the result has to be a feature structure like the one in AVM12 (see, for instance, Shieber1986: 18):

(AVM12) $\begin{bmatrix} \text{SEMROLE}\Omega : |1| \end{bmatrix}$

AVM12, though is distinct from AVM11.

In general, the presentations of properties of unification do not describe the consequences of the fact that a certain property is not observed. The propensity is rather to say that if a certain representation fails to obey a certain property of the unification, then that representation cannot be used to model any phenomenon in natural language. And indeed, sometimes it is really difficult to indicate actual consequences of the violations of properties of unification. For instance, it is not easy to describe, with respect to a given natural language, the result of the fact that a certain noun is (inconsistently) assigned two cases at the same time, say nominative and genitive.

These difficulties, though, are not principled arguments against the attempt to show what the empirical effects of such violations are. On the contrary, it is quite normal to try to correlate banned representations with empirical data. This is the way chosen in the following lines.

Suppose then that we assign the partial semantic representation described in AVM10 to the verb **eat**. If we do that, this is only in order to see what consequences one gets. Suppose further that AVM10, if applied to the case of the verb **eat** realizes the Incremental Theme. In other words, the following identity holds: SEMROLEΘ =EATEN THING. Under this hypothesis, the content of the verb receives the following (partial) representation:

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$$\text{(AVM13)}\ \bot\ \textit{eat-rel}\begin{bmatrix}\text{EATER}:\ldots\\ \text{EATEN_THING}:\boxed{1}\\ \text{EATEN_THING}:\boxed{2}\end{bmatrix}$$

In this representation, the Incremental Theme is expressed by two different content values, fact which, as expected, leads to a failed unification.

If one wonders now what is the linguistic expression of this failed unification, the answer is pretty obvious. There are different values for the same semantic role attribute project constructions headed by the verb **eat** like the following:

(11) * Pate ate dinner a large steak.
(12) * The snake ate a frog itself.

Notice that both in (11) and (12) the direct object argument is expressed twice. (11) repeats here (1a) above, that is, a type of construction ruled out in Davis' approach by Principle C. On the other hand, (12) repeats (5) above, which has been shown to be a critical example for Davis' account. Nothing changes if one replaces (12) with (6).

Let us now apply the same test to the failed unification in AVM11. As noticed above, in this latter situation the violated property of unification is idempotency.

The verb involved in the experiment is again **eat**. Let us suppose that the following identity holds: SEMROLE Ω = EATEN THING. As a consequence, one obtains the following partial semantic representation for the verb **eat**:

$$\text{(AVM14)}\ \bot\ \textit{eat-rel}\begin{bmatrix}\text{EATER}:\ldots\\ \text{EATEN_THING}:\boxed{1}\\ \text{EATEN_THING}:\boxed{1}\end{bmatrix}$$

One may now wonder again what kind of ill-formed construction headed by the verb **eat** may occur as a consequence of this forbidden semantic representation. The intuitive answer is that such a construction is for instance *** The snake ate itself itself**. Indeed, if idempotency is not observed, there is no way to block the repetition of the same piece of linguistic information (the same feature structure). In our case, the repeated information concerns the semantic role attribute EATEN THING along with its value.

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To draw a conclusion of these experiments, if what has been shown above is right, then one can explain ill-formed examples of type (1a) through the violation of a certain property of unification, namely, consistency. Likewise, one can consider that ill-formed examples of type (2) and (3a) occur as a consequence of the fact that idempotency – another property of the unification – is not observed. Both these violations yield such ungrammatical constructions whenever they manifest in the domain of attributes for semantic roles. The advantage of this explanatory hypothesis is that it covers all the cases discussed in Davis' analysis, and, in addition, accounts for cases like (5) and (6), which remain outside the explanatory range of Davis' approach.

6. CONCLUSIONS

As noticed in the introduction, RAUP is the HPSG counterpart of one of the two clauses designed to express in the GB theory the Θ-criterion. To recall, the GB clause in question says the following:

If a Θ-role Θ_i marks an argument position P, there must be only one realization of Θ_i.

To the best of my knowledge, the reasons for proposing such a clause within the GB theory have been never made explicit. An ill-formed sentence such as ***The snake ate itself itself**, for instance, is possible as long as for an arbitrary lexical item, one writes in the lexicon "more arguments than semantic roles". But, of course, *one does not write* a lexical entry with such a strange structure. Under these conditions, it seems that the import of the above mentioned stipulation is to show that if we do not write such bizarre lexical entries this is not an accident. It is rather a necessity, the expression of which is the stipulation itself. In other words, the stipulation seems to be designed to express a very general constraint over lexical entries.

In a linguistic theory like GB, where the language in which the theory is expressed is not clearly determined, such a constraint is perhaps necessary. However, in a theory like HPSG, in which the formalism of the theory is reasonably known, things are different. The HPSG formalism – the one of the feature structures – is subject to certain constraints. Feature structures themselves have to have certain properties. Consistency and idempotency are two of them. As I attempted to prove here, to the extent that consistency and idempotency are responsible for what is called RAUP violations, in HPSG no *ad-hoc* principle like RAUP is actually needed: constraints which rule out ill–formed examples discussed in this paper follow without stipulations from very general properties of feature structures, when these properties are instantiated by lexical semantic representations.

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