
Lexicalization of Context

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1.1 Introduction

This paper proposes the lexicalization of context in HPSG. Instead of *phrasal* amalgamation of contextual information from a phrase's daughters, which is specified by the Principle of Contextual Consistency of Pollard and Sag 1994, we propose *lexical* amalgamation of context from a word's arguments by means of lexical constraints. The Principle of Contextual Consistency is replaced by a Contextual Head Inheritance Principle, in which a phrase's CONTEXT feature is token-identical to that of its contextual head daughter. We offer motivations for the proposal on theoretical, computational¹ and linguistic levels.

The paper has three main parts. Section 1.2 shows that the proposal naturally follows other recent revisions in HPSG theory concerned with set-valued features, and brings the handling of context features into line on a theoretical level with the lexicalization of nonlocal features and of quantifier storage. Section 1.3 argues that the lexicalization of context, combined with the lexicalization of quantifier scoping, allows the idea of semantic heads to regain its original significance, which otherwise is lost when quantifier retrieval and background conditions are involved. Section 1.4 briefly sketches a linguistic analysis which combines the lexicalization of context with the lexicalization of nonlocal features, in an approach to register variation within Sag's analysis of English relative clauses.

¹A version of this paper was presented at the 4th International Conference on HPSG at Ithaca, NY in July 1997. The material included there on head-driven generation, which forms the main motivation on a computational level, has been transferred to another paper (Wilcock and Matsumoto to appear) which describes a computational implementation of the ideas presented here.

1.2 Set-valued features

We start by comparing two alternative approaches to the amalgamation of set-valued features: the phrasal approach of Pollard and Sag 1994 and the lexical approach of more recent proposals.

1.2.1 Phrasal amalgamation

Three principles - the Nonlocal Feature Principle, the Quantifier Inheritance Principle, and the Principle of Contextual Consistency - specify constraints on certain set-valued features of a phrase and the equivalent set-valued features of the daughters. In Pollard and Sag 1994, these constraints are specified on *phrases*, that is, the values of the relevant features of all the daughters of a phrase are amalgamated by set union (possibly with subtraction of certain elements) to give the value of the relevant feature of the phrase. We therefore refer to this phrase-based amalgamation of set-valued features as *phrasal amalgamation*.

The Nonlocal Feature Principle requires each of the INHERITED features QUE, REL and SLASH of a phrase to be the set union of the equivalent feature of all the daughters, minus any elements of the equivalent TO-BIND sets of the head daughter. The Quantifier Inheritance Principle requires the QSTORE feature of a phrase to be the set union of the QSTOREs of all the daughters, minus any quantifiers in the phrase's RETRIEVED list. The Principle of Contextual Consistency simply requires the BACKGROUND feature of a phrase to be the set union of the BACKGROUND sets of all the daughters.

In recent revisions of HPSG theory, phrasal amalgamation has been divided into two distinct parts: the amalgamation part and the inheritance part. While the inheritance part is still specified by constraints on phrases, the set-valued feature amalgamation part is now specified by constraints on words.

1.2.2 Lexical amalgamation

Following the proposals of Manning and Sag 1995, a word's arguments are lexically specified in its ARGUMENT-STRUCTURE (ARG-ST) list. A word's set-valued features can now be defined in terms of the amalgamation of the equivalent set-valued features of its arguments. This form of amalgamation, specified by lexical constraints, is referred to as *lexical amalgamation*.

Advantages of lexical amalgamation over phrasal amalgamation have already been proposed for nonlocal features and for quantifier storage. The lexicalization of nonlocal features is described by Sag 1997, who specifies lexical amalgamation of SLASH as in (1), where \uplus designates disjoint set union and $'-$ ' designates contained set difference. (In these

representations, the constraints specified on the right apply to the *type* specified on the left).

(1) SLASH Amalgamation Constraint:

$$word \Rightarrow \left[\begin{array}{l} \text{BIND} \quad \boxed{0} \\ \text{ARG-ST} \quad \left\langle [\text{SLASH } \boxed{1}], \dots, [\text{SLASH } \boxed{n}] \right\rangle \\ \text{SLASH} \quad (\boxed{1} \uplus \dots \uplus \boxed{n}) - \boxed{0} \end{array} \right]$$

This allows a simplification of the mechanism for inheriting SLASH values. Sag states a new SLASH Inheritance Principle (SLIP) as phrasal constraint (2), where *hd-nexus-ph* is the head-nexus-phrase type from Sag’s phrase type hierarchy and ‘/’ indicates a default value. The combination of (1) and (2) means that a phrase inherits the SLASH values of its daughters indirectly, via the head daughter.

(2) SLASH Inheritance Principle (SLIP):

$$hd-nexus-ph \Rightarrow \left[\begin{array}{l} \text{SLASH} \quad / \quad \boxed{1} \\ \text{HD-DTR} \quad [\text{SLASH } \boxed{1}] \end{array} \right]$$

Sag also introduces lexical amalgamation of QUE and REL, and a *Wh*-Inheritance Principle (WHIP) in which QUE and REL are inherited via a phrase’s head daughter. The combination of SLIP and WHIP replaces the Nonlocal Feature Principle of Pollard and Sag 1994.

The lexicalization of quantifier scoping is very similar. Following the proposals of Pollard and Yoo 1995, QSTORE is a local feature which can be included in the features subcategorized for by a lexical head, and can therefore be lexically amalgamated in that head. These proposals have been extended to include lexicalization of quantifier retrieval by Manning et al. in press, who specify a Quantifier Amalgamation Constraint (actually a constraint on word stems) as in (3), where \boxed{Q} is the set of retrieved quantifiers.

(3) Quantifier Amalgamation Constraint:

$$stem \Rightarrow \left[\begin{array}{l} \text{ARG-ST} \quad \left\langle [\text{QSTORE } \boxed{1}], \dots, [\text{QSTORE } \boxed{n}] \right\rangle \\ \text{QSTORE} \quad (\boxed{1} \uplus \dots \uplus \boxed{n}) - \boxed{Q} \\ \text{CONT} \quad [\text{QUANTS} \quad \text{order}(\boxed{Q})] \end{array} \right]$$

Given the Quantifier Amalgamation Constraint, unscoped quantifiers are no longer inherited from all daughters but only from the semantic

head daughter. This is stated in (4) as a revised Quantifier Inheritance Principle (QUIP).

(4) Quantifier Inheritance Principle (QUIP):

$$\begin{aligned}
 hd-nexus-ph &\Rightarrow \left[\begin{array}{l} \text{QSTORE} / \boxed{1} \\ \text{HD-DTR} \left[\text{QSTORE} \boxed{1} \right] \end{array} \right] \\
 hd-adjunct-ph &\Rightarrow \left[\begin{array}{l} \text{QSTORE} / \boxed{1} \\ \text{ADJ-DTR} \left[\text{QSTORE} \boxed{1} \right] \end{array} \right]
 \end{aligned}$$

1.2.3 Lexicalization of CONTEXT

We now propose the lexicalization of contextual features, following the same approach as the lexicalization of nonlocal features and the lexicalization of quantifier scoping. For the set-valued feature BACKGROUND (BACKGR), we introduce the Background Amalgamation Constraint (5), in which a word’s BACKGR set is the set union² of the BACKGR sets of its arguments.

(5) Background Amalgamation Constraint:

$$\left[\begin{array}{l} \text{ARG-ST} \left\langle \left[\text{BACKGR} \boxed{1} \right], \dots, \left[\text{BACKGR} \boxed{n} \right] \right\rangle \\ \text{BACKGR} \quad \boxed{1} \cup \dots \cup \boxed{n} \end{array} \right]$$

Amalgamation of CONTEXTUAL-INDICES (C-INDICES) depends on how they are defined. As Pollard and Sag 1994 say, “each part of an utterance (at least each lexeme) has its own C-INDICES value.” This suggests set-valued C-INDICES, amalgamated in phrases by set union. However, as Pollard and Sag also say, it is typical of discourse situations that the contextual indices are uniform throughout an utterance. In a coarse-grained analysis, a phrase’s C-INDICES can be simply the *unification* of the C-INDICES of its daughters. The same simplification could be specified by the lexical constraint (6), in which a word’s C-INDICES feature is the unification of the C-INDICES of its arguments.

(6) Lexical Amalgamation of C-INDICES (simplified version):

$$word \Rightarrow \left[\begin{array}{l} \text{ARG-ST} \left\langle \left[\text{C-INDS} \boxed{1} \right], \dots, \left[\text{C-INDS} \boxed{1} \right] \right\rangle \\ \text{C-INDS} \quad \boxed{1} \end{array} \right]$$

²Here, set union should not be disjoint. There may be duplicate conditions with the same index in examples such as *She saw herself*.

If a more fine-grained analysis is required, the C-INDICES should be set-valued. For a single word the indices will usually be singleton sets, but for phrases these sets need to be amalgamated by set union. The three standard indices of Pollard and Sag 1994 then need to be specified by separate constraints, as in (7)

(7) Lexical Amalgamation of C-INDICES (set-valued version):

$$\begin{aligned}
 \text{word} &\Rightarrow \left[\begin{array}{l} \text{ARG-ST} \left\langle [\text{SPEAKER } \boxed{1}], \dots, [\text{SPEAKER } \boxed{n}] \right\rangle \\ \text{SPEAKER} \quad \boxed{1} \cup \dots \cup \boxed{n} \end{array} \right] \\
 \text{word} &\Rightarrow \left[\begin{array}{l} \text{ARG-ST} \left\langle [\text{ADDRESSEE } \boxed{1}], \dots, [\text{ADDRESSEE } \boxed{n}] \right\rangle \\ \text{ADDRESSEE} \quad \boxed{1} \cup \dots \cup \boxed{n} \end{array} \right] \\
 \text{word} &\Rightarrow \left[\begin{array}{l} \text{ARG-ST} \left\langle [\text{U-LOC } \boxed{1}], \dots, [\text{U-LOC } \boxed{n}] \right\rangle \\ \text{U-LOC} \quad \boxed{1} \cup \dots \cup \boxed{n} \end{array} \right]
 \end{aligned}$$

Given the lexical amalgamation of BACKGR and C-INDICES, their values can be passed up to higher levels by a new Contextual Head Inheritance Principle (CHIP), in which a phrase's CONTEXT is by default token-identical to that of its *contextual head* daughter. We will assume that contextual heads are defined in the same way as semantic heads: in a head-adjunct-phrase the adjunct daughter is the contextual head, and in a head-nexus-phrase the syntactic head is the contextual head. The principle is stated in (8).

(8) Contextual Head Inheritance Principle (CHIP):

$$\begin{aligned}
 \text{hd-nexus-ph} &\Rightarrow \left[\begin{array}{l} \text{CONTEXT} \quad / \quad \boxed{1} \\ \text{HD-DTR} \left[\text{CONTEXT } \boxed{1} \right] \end{array} \right] \\
 \text{hd-adjunct-ph} &\Rightarrow \left[\begin{array}{l} \text{CONTEXT} \quad / \quad \boxed{1} \\ \text{ADJ-DTR} \left[\text{CONTEXT } \boxed{1} \right] \end{array} \right]
 \end{aligned}$$

The combination of (5) and (8) ensures that a phrase inherits the BACKGR values of its daughters, not directly but via the contextual head daughter. This combination replaces the Principle of Contextual Consistency of Pollard and Sag 1994.

1.3 Semantic Heads

We now link the lexicalization of context to the role of semantic heads in head-driven grammar. Though HPSG is fundamentally head-driven by *syntactic* heads, it is also to a secondary degree head-driven by *semantic* heads. The definition of semantic head in Pollard and Sag 1994 is clear: in head-adjunct phrases the adjunct is the semantic head, and in other headed phrases the syntactic head is the semantic head. The definition is intended to work together with the Semantics Principle, so that the major semantic features of a phrase are inherited from the semantic head, while the major syntactic features are inherited from the syntactic head by the Head Feature Principle.

In Pollard and Sag 1994, when an NP is assigned as an argument of a verb, only the NP's index is directly assigned to the verb's content. Other semantic features from the NP are distributed to other features of the VP by phrasal amalgamation. If the NP is a quantificational NP, its unscoped quantifiers are added to the VP's QSTORE. If the NP is non-quantificational (a pronoun or proper noun), its background conditions are added to the VP's BACKGR. In both cases, which we will look at in turn, the VP includes major semantic features which it does *not* inherit from the verb which is its semantic head according to the definition. In effect, phrasal amalgamation "by-passes" the semantic head, which loses its intended significance.

1.3.1 Quantificational-Semantic Heads

The original form of the Semantics Principle in Pollard and Sag 1994, Chapter 1, equates semantic content with the CONTENT feature and simply says that a phrase has the same CONTENT as its semantic head. However, the principle is reformulated in Chapter 8 to cater for quantifier storage and retrieval, because only scoped quantifiers are included in the QUANTS list within CONTENT, while unscoped quantifiers are stored in the QSTORE set which is not part of CONTENT. In this approach to quantifier scoping, a quantifier may be retrieved from storage at any suitable syntactic node. A quantifier retrieved at a particular node is a member of the QSTORE set, but not the QUANTS list, of a daughter of that node, and due to the retrieval it is a member of the QUANTS list, but not the QSTORE set, of the mother node. As QUANTS is part of CONTENT, the effect of retrieval is that the phrase and the semantic head have different CONTENT values.

The reformulated Semantics Principle therefore makes a distinction between *quantificational* content and *nuclear* content, and requires only nuclear content (the NUCLEUS feature) to be shared between a VP and

its head verb. This clearly reduces the significance of semantic heads. Though the verb is the semantic head according to the definition, it only passes one part of its semantic content up to the phrase.

In the lexicalized approach to quantifier scoping, with the Quantifier Amalgamation Constraint (3), this problem does not arise. Retrieval is located in the lexicon, inside the verb’s lexical entry, and does not cause a difference in either QSTORE or QUANTS between a VP and its head verb. The phrase and the semantic head have identical QSTORE, identical QUANTS and identical NUCLEUS.

The identity of QUANTS and NUCLEUS between a phrase and its semantic head is full identity of CONTENT. We can therefore return to the original form of the Semantics Principle, in which a phrase inherits the full CONTENT of the semantic head. We restate this, renamed as the Semantic Head Inheritance Principle (SHIP) in the style of QUIP and CHIP in (9).

(9) Semantic Head Inheritance Principle (SHIP):

$$\begin{aligned}
 hd\text{-}nexus\text{-}ph &\Rightarrow \left[\begin{array}{l} \text{CONTENT} / \boxed{1} \\ \text{HD-DTR} [\text{CONTENT} \boxed{1}] \end{array} \right] \\
 hd\text{-}adjunct\text{-}ph &\Rightarrow \left[\begin{array}{l} \text{CONTENT} / \boxed{1} \\ \text{ADJ-DTR} [\text{CONTENT} \boxed{1}] \end{array} \right]
 \end{aligned}$$

The identity of QSTORE between a phrase and its semantic head was stated earlier as a revised Quantifier Inheritance Principle (QUIP) in Section 1.2.2. The combination of SHIP and QUIP means that a phrase inherits all of its nuclear and quantificational content from the semantic head.

1.3.2 Contextual-Semantic Heads

Non-quantificational NPs such as pronouns or proper nouns generally have contextual background conditions. The way these are handled parallels the way a quantificational NP’s unscoped quantifiers are handled. In both cases, only the NP’s index is assigned to the verb’s NUCLEUS. With phrasal amalgamation, a phrase inherits background conditions as well as unscoped quantifiers from all daughters. In general therefore, a phrase and its semantic head will have the same NUCLEUS feature but will have different BACKGR and QSTORE features.

Figure 1 shows the standard analysis of *She saw Kim* with phrasal amalgamation. *She* has a non-empty contextual BACKGR set (shown by tag $\boxed{1}$), stating a pragmatic requirement that the referent is female. This background condition is passed up from NP to S by the Principle

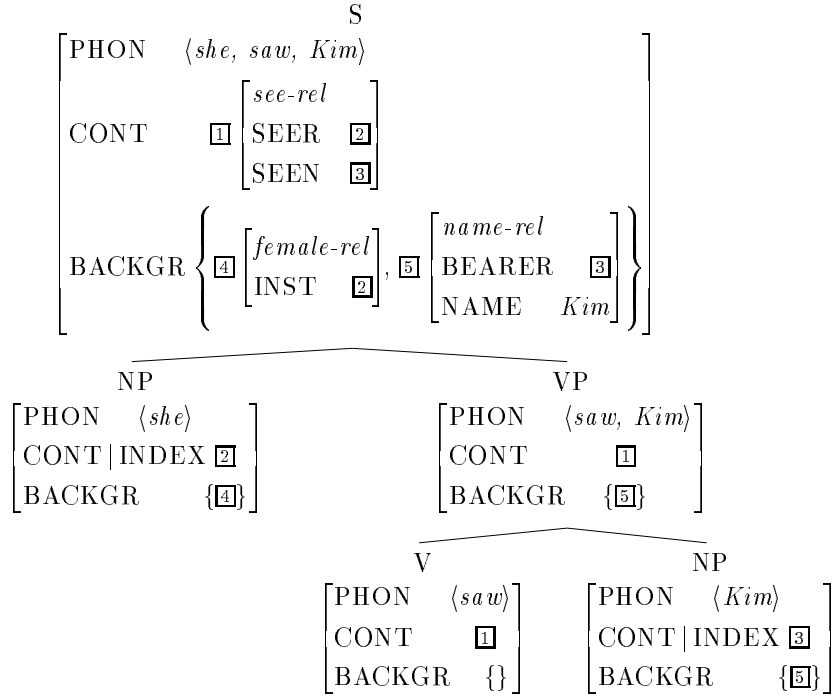


FIGURE 1 Contextual Background (Phrasal Amalgamation)

of Contextual Consistency. Similarly, *Kim* has a background condition (shown by tag $\boxed{5}$) that the referent bears this name. This condition is also passed from NP to VP, and from VP to S.

As there are no quantifiers, V is the semantic head of VP and VP is the semantic head of S not merely by definition but also in the sense of the original Semantics Principle, since S, VP and V all share the same CONTENT (shown by tag $\boxed{1}$). However, VP includes the BACKGR condition shown by tag $\boxed{5}$ which it does not inherit from V, and S includes the BACKGR condition shown by tag $\boxed{4}$ which it does not inherit from VP. If semantic features are understood in a wider sense, not restricted to the CONTENT feature, then in both cases the phrase includes a major semantic feature which is not inherited from its semantic head.

With lexical amalgamation, by contrast, the BACKGR sets of *she* and *Kim* are amalgamated in the verb's lexical entry by the Background Amalgamation Constraint (5). So the empty BACKGR set of *saw* in Figure 1 is changed from BACKGR $\{ \}$ to BACKGR $\{ \boxed{4}, \boxed{5} \}$. This set is inherited by VP from V and by S from VP by the Contextual Head

Inheritance Principle (8). Since the contextual heads and the semantic heads are the same, all major semantic features (nuclear, quantificational and contextual) are inherited via the semantic heads. In this way, semantic heads play a full role in the organization of the grammar.

1.3.3 Semantic Head-driven Generation

The role of semantic heads is clear in semantic head-driven generation, which requires the identity of logical forms between phrases and their semantic heads. Though logical form is not a separate level in HPSG, we could use a logical form consisting of CONTENT, QSTORE and CONTEXT. These features are all needed to include sufficient information for generation. In order to achieve the required identity of logical forms between phrases and semantic heads, we need to combine lexicalization of quantifier scoping and lexicalization of context, so that SHIP ensures identity of CONTENT, QUIP ensures identity of QSTORE, and CHIP ensures identity of CONTEXT, as shown in (10).

(10) SHIP + QUIP + CHIP:

$$\begin{array}{l}
 hd-nexus-ph \Rightarrow \left[\begin{array}{l}
 \text{CONTENT} \quad / \quad \boxed{1} \\
 \text{CONTEXT} \quad / \quad \boxed{2} \\
 \text{QSTORE} \quad / \quad \boxed{3} \\
 \text{HD-DTR} \left[\begin{array}{l}
 \text{CONTENT} \quad \boxed{1} \\
 \text{CONTEXT} \quad \boxed{2} \\
 \text{QSTORE} \quad \boxed{3}
 \end{array} \right]
 \end{array} \right] \\
 \\
 hd-adjunct-ph \Rightarrow \left[\begin{array}{l}
 \text{CONTENT} \quad / \quad \boxed{1} \\
 \text{CONTEXT} \quad / \quad \boxed{2} \\
 \text{QSTORE} \quad / \quad \boxed{3} \\
 \text{ADJ-DTR} \left[\begin{array}{l}
 \text{CONTENT} \quad \boxed{1} \\
 \text{CONTEXT} \quad \boxed{2} \\
 \text{QSTORE} \quad \boxed{3}
 \end{array} \right]
 \end{array} \right]
 \end{array}$$

An alternative logical form with unscoped quantifiers and contextual factors is Minimal Recursion Semantics (MRS, Copestake et al. 1997). However, the reformulation of the Semantics Principle proposed by Copestake et al. greatly reduces the significance of semantic heads. MRS is therefore more suitable for non-head-driven generation. Head-driven generation would require lexical amalgamation of LISZT.³

³Different approaches to generation with HPSG are discussed by Wilcock to appear. The need for lexicalization of context in semantic head-driven generation is described by Wilcock and Matsumoto to appear.

1.4 Register Variation

To introduce the lexicalization of context in linguistic analysis, we now briefly sketch a simple approach to register variation. We combine the lexicalization of context with the lexicalization of nonlocal features.

To keep a representation for register variation as simple as possible, we assume that CONTEXT has an additional attribute REGISTER (REGSTR), with value of sort *register*, which has only two subsorts, *formal* and *informal*. To maintain the lexical amalgamation of context, we introduce a Register Amalgamation Constraint (11).

(11) Register Amalgamation Constraint:

$$word \Rightarrow \left[\begin{array}{l} \text{ARG-ST} \left\langle \left[\text{REGSTR } \boxed{\square} \right], \dots, \left[\text{REGSTR } \boxed{\square} \right] \right\rangle \\ \text{REGSTR } \boxed{\square} \end{array} \right]$$

The combination of the Register Amalgamation Constraint and the Contextual Head Inheritance Principle (8) ensures that a phrase inherits the REGSTR values of its daughters via the contextual head daughter. In the same style as (6) for C-INDICES, this representation does not cater for register-switching, but assumes that register will typically be uniform throughout an utterance.

1.4.1 Relative pronouns

In his revised analysis of English relative clauses (1997), Sag argues for treating relative *that* as a pronominal, rather than a complementizer, as the only real obstacle is that it disallows pied piping (12a), and this property is shared with relative *who* (12b) in many varieties of English.

- (12) a. *The person [with that we were talking] ...
 b. *The person [with who we were talking] ...
 c. The person [with whom we were talking] ...

Observing that in such varieties the only pied-piped relative pronouns are *whose*, *which* and *whom* (12c), Sag comments that “the constraints on this variation have to do with case assignment, register restrictions, or both”. We will look at two ways of specifying such constraints, first as clausal constraints, and then as lexical constraints.

We begin by noting that, while *whom* (13) is always accusative and formal, there appears to be systematic covariation of case assignment and register restrictions in *who* and *that*. Relative *who* is either nominative and unrestricted (REGSTR value *register*) as in (14) or accusative and informal as in (15). The same covariation seems to occur in relative *that*, and also in interrogative *who*.

$$(13) \quad \text{whom (accusative):} \quad \left[\begin{array}{ll} \text{PHON} & \langle \textit{whom} \rangle \\ \text{CAT} & \text{NP}[\textit{acc}] \\ \text{REGSTR} & \textit{formal} \end{array} \right]$$

$$(14) \quad \text{who (nominative):} \quad \left[\begin{array}{ll} \text{PHON} & \langle \textit{who} \rangle \\ \text{CAT} & \text{NP}[\textit{nom}] \\ \text{REGSTR} & \textit{register} \end{array} \right]$$

$$(15) \quad \text{who (accusative):} \quad \left[\begin{array}{ll} \text{PHON} & \langle \textit{who} \rangle \\ \text{CAT} & \text{NP}[\textit{acc}] \\ \text{REGSTR} & \textit{informal} \end{array} \right]$$

1.4.2 Clausal Constraints

Nonsubject relative clauses such as *whose bagels I like* and *from whom I bought these bagels* are treated by Sag in terms of a single construction type *fn-wh-fill-rel-cl*. He hints that the constraints on this type have more work to do than the simplified formulation shown in (16), which states only that the filler daughter must be an NP or a PP.

$$(16) \quad \textit{fn-wh-fill-rel-cl} \Rightarrow \left[\text{FILLER-DTR} \quad \left[\text{HEAD } \textit{noun} \vee \textit{prep} \right] \right]$$

We can associate register restrictions with construction types. For example, a relative clause with a PP filler such as (12c) is formal. We could specify this by splitting the construction type (16) into two distinct subtypes *fn-wh-np-fill-rel-cl* (17) and *fn-wh-pp-fill-rel-cl* (18).

$$(17) \quad \textit{fn-wh-np-fill-rel-cl} \Rightarrow \left[\text{FILLER-DTR} \quad \left[\text{HEAD } \textit{noun} \right] \right]$$

$$(18) \quad \textit{fn-wh-pp-fill-rel-cl} \Rightarrow \left[\text{FILLER-DTR} \quad \left[\begin{array}{l} \text{HEAD } \textit{prep} \\ \text{REGSTR } \textit{formal} \end{array} \right] \right]$$

Now we can describe the constraints in (12). In (12a) and (12b), *with* assigns accusative case to its arguments *who* and *that*. Given that accusative *who* is informal register in (15), the Register Amalgamation Constraint unifies its informal register with that of *with*. The value *informal* is then passed up to the PP by CHIP (8). The *formal* register restriction in (18) would then prevent the *informal* PP from being the filler of a relative clause. The clausal constraint would in this way block examples (12a) and (12b) but allow (12c) as required.

1.4.3 Lexical Constraints

It could be argued that the PP *with who* in (12b) is both formal and informal. That is, it violates some constraints on case and register consistency. These constraints should apply at the level of the PP, not only at the higher level of the relative clause in (18).

This could be done by specifying PP construction subtypes, putting the register restrictions on them instead of on relative clause subtypes. However, we will explore the lexicalization of context and the lexicalization of nonlocal features to show that the same result can be produced by lexical constraints. We specify systematic covariation between register and nonlocal features of prepositions. These covariations are stated in (19) – (21) as constraints on lexical subtypes.

$$(19) \quad \begin{array}{l} \text{rel-} \\ \text{prep} \end{array} \Rightarrow \left[\begin{array}{ll} \text{HEAD} & \textit{prep} \\ \text{QUE} & \{\} \\ \text{REL} & \{\boxed{\square}\} \\ \text{SLASH} & \{\} \\ \text{REGSTR} & \textit{formal} \end{array} \right]$$

$$(20) \quad \begin{array}{l} \text{que-} \\ \text{prep} \end{array} \Rightarrow \left[\begin{array}{ll} \text{HEAD} & \textit{prep} \\ \text{QUE} & \{\boxed{\square}\} \\ \text{REL} & \{\} \\ \text{SLASH} & \{\} \\ \text{REGSTR} & \textit{formal} \end{array} \right]$$

$$(21) \quad \begin{array}{l} \text{slash-} \\ \text{prep} \end{array} \Rightarrow \left[\begin{array}{ll} \text{HEAD} & \textit{prep} \\ \text{QUE} & \{\} \\ \text{REL} & \{\} \\ \text{SLASH} & \{\boxed{\square}\} \\ \text{REGSTR} & \textit{informal} \end{array} \right]$$

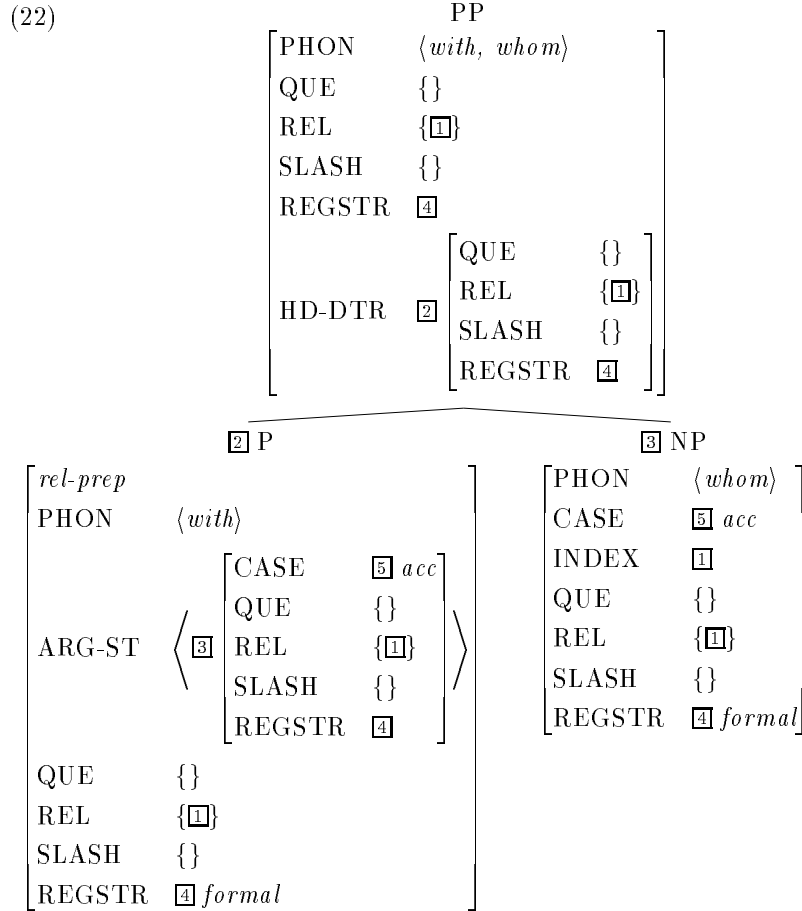
Lexical constraint (19) requires prepositions with non-empty REL to have formal register. Similarly, (20) requires prepositions with non-empty QUE to have formal register. By contrast, (21) requires prepositions with non-empty SLASH to have informal register. Prepositions whose nonlocal features are all empty have no register restriction.

The point of (19) is that it requires a *rel-prep* preposition to take as argument a relative pronoun which is formal. The non-empty REL requires the argument to be a relative pronoun, as its REL value is acquired by lexical amalgamation of nonlocal features. The *formal* reg-

ister requires the argument also to be formal, as its REGSTR value is acquired by lexical amalgamation of context.

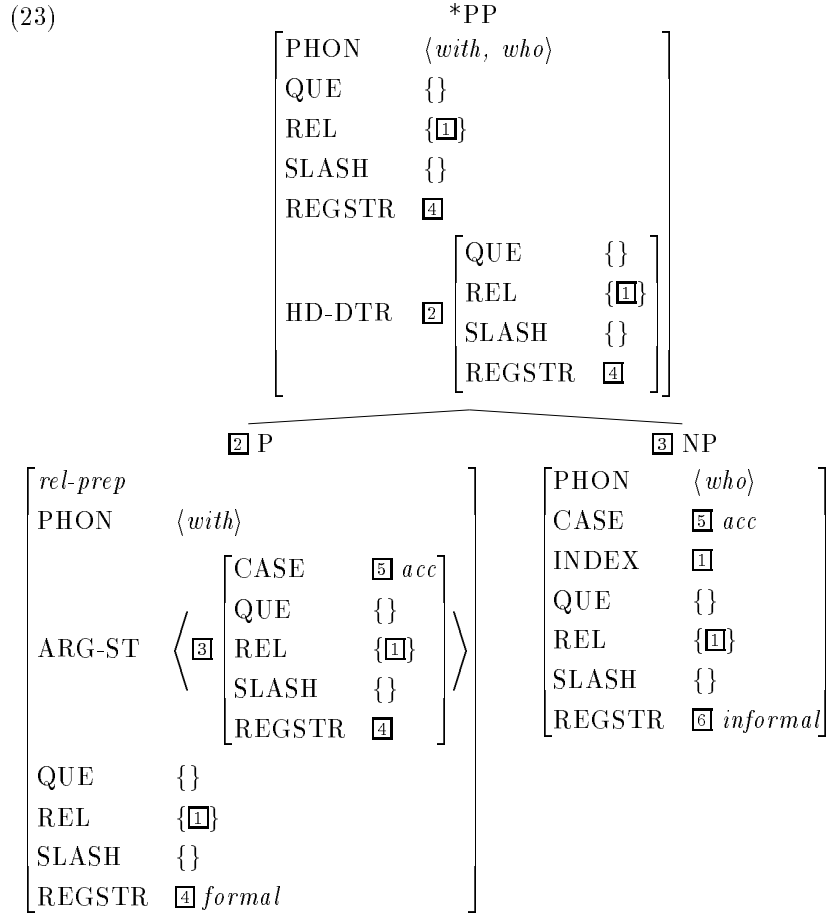
1.4.4 Interaction of Constraints

We can see in (22) and (23) how the lexical constraints, interacting with the lexicalization of nonlocal features and the lexicalization of context, provide an alternative way to block *with who* at PP level, while allowing *with whom*, as required.



In (22), *with* assigns accusative case to its argument *whom*, which is lexically specified as accusative in (13) anyway. The SLASH Amalgamation Constraint requires *with* to amalgamate the non-empty REL of *whom* in its own REL. As the preposition has thereby a non-empty

REL, constraint (19) requires it to have formal register. As *whom* is lexically specified as formal register in (13), the Register Amalgamation Constraint simply requires the two formal registers to be unified.



In (23), *with* also assigns accusative case to its argument *who*. Lexical constraint (15) thereby requires accusative *who* to have [6] *informal* register. As in (22), the SLASH Amalgamation Constraint requires *with* to amalgamate the non-empty REL of *who* in its own REL, and as the preposition has thereby a non-empty REL, constraint (19) requires it to have [4] formal register. The Register Amalgamation Constraint is therefore violated, as the informal register of accusative *who* cannot be unified with the formal register of *rel-prep with*.

1.5 Conclusion

We have proposed the lexicalization of context in HPSG, giving three motivations. On a theoretical level, it naturally follows other recent revisions in HPSG theory concerned with set-valued features, bringing contextual features into line with the lexicalization of nonlocal features and the lexicalization of quantifier scoping. Combining lexicalization of context and lexicalization of quantifier scoping restores and enhances the role of semantic heads in head-driven grammar (which is significant on a computational level for semantic head-driven generation). Finally, the lexicalization of context may be exploited in the development of constraint-based lexicalist approaches in linguistic analysis, as suggested in a brief sketch of lexical constraints on case assignment and register variation in English relative clauses.

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