

Information packaging and grammar architecture: A constraint-based approach*

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Abstract

There is increasing awareness of the large degree of crosslinguistic diversity involved in the structural realization of information structure (or information packaging). For instance, while in English the informational focus-ground articulation is realized mostly through prosody, some Romance languages, e.g. Catalan, make predominant use of the word order dimension to achieve the same information-packaging partition. This paper is concerned with how focus-ground should be optimally integrated into grammar. It proposes an analysis with the following characteristics: (1) information structure is an *integral part* of grammar since it interacts in principled ways with both syntax and phonology, (2) the representation of information structure in the grammar is *independent* of its particular structural realisation in different languages, and (3) there is an *analogous implementation* of the relationship between information structure and prosody in English-type languages and between information structure and the word-order dimension in Catalan-type languages. The framework utilised is HPSG. HPSG's multidimensional constraint-based architecture lends itself very well to expressing the mutual constraints on interpretation, syntax, and phonology that so diversely characterise focus-ground in different languages. The study of information structure, we argue, is essential in addressing fundamental questions regarding grammar architecture.

In:

Engdahl, Elisabet (ed.), 1994. *Integrating information structure into constraint-based and categorial approaches* (DYANA-2 Report R.1.3.B), 39-79. ILLC, Amsterdam.

The following must be added by hand to postscript outputs:

- In example (59) label the NP-daughter arc DISLOC.
- In example (60) label the NP[nom]-daughter arc DISLOC-1 and the NP[acc]-daughter arc DISLOC-2.
- Label all other NP-daughter arcs C (in (33), (42), (43), (46), (50), and (63)).
- Label all head-daughter arcs (V[fin], VP[fin], and S[fin]) H (in (33), (42), (43), (46), (50), (59), (60), and (63)).

*We have benefitted from discussions with Steven Bird, Robin Cooper, Jochen Dörre, Claire Grover, Janet Hitzeman, Lex Holt, Jack Hoeksema, Dimitra Kolliakou, Suresh Manandhar, Marc Moens, Mark Steedman, and Maria Vilkuna. This work is carried out within Task 1.3 of ESPRIT project DYANA-2 (Basic Research Project 6852).

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1 Introduction

Work in the DYANA-2 project aims to characterise the process of natural language interpretation in a dynamic way. This means taking into account various contextual factors such as the information state and goals of the participants and how this affects the choice of linguistic realisation. Within this larger aim, Task 1.3 is interested, in particular, in characterising the phenomena that determine INFORMATION PACKAGING and, therefore, the FOCUS-GROUND articulation of utterances. In this paper we propose a way of integrating the focus-ground articulation into a grammatical framework. The framework in question is a *constraint-based* grammar architecture, which, we believe, lends itself very well to expressing the mutual constraints on prosodic and syntactic realisation that reflect the focus-ground articulation of an utterance.

There is a long pragmatic tradition that has looked in detail at how the form of an utterance varies as a function of the contribution the utterance makes to the discourse.¹

¹See, for example, von der Gabelentz 1868, Bolinger 1954, Firbas 1964, Halliday 1967, 1985, Kuno 1972, Gundel 1974, 1988, Clark & Haviland 1977, Sgall & Hajičová 1977-78, Givón 1983, Prince 1986, Ward 1988.

Until not so long ago, it was not uncommon for work in formal semantics to ignore those aspects of an utterance that are peripheral to truth-conditional meaning, whereas work in generative syntax concentrated on deriving possible surface word orders with little regard to their functional import. More recently, however, there has been an upsurge of papers on focus-related notions from the point of view of semantics (e.g. von Stechow 1981, 1991, Rooth 1985, 1992, Kratzer 1991, Partee 1991, Krifka 1991-92, 1992). Some linguists have started to explore the consequences of integrating focus-ground notions with an explicit syntax (e.g. Culicover & Rochemont 1983, Rochemont 1986, Oehrle 1991, Steedman 1991, Erteschik-Shir, to appear) and among phonologists, a number of people have addressed the issue how intonational phrasing signals focus-ground articulation (e.g. Gussenhoven 1983, Ladd 1983, Selkirk 1984, von Stechow & Uhmann 1986, Bird 1991). These works agree that focus-ground articulation is an important aspect of sentence structure and interpretation that needs to be represented in the grammar somehow. However, there is little consensus on how focus-ground information should be represented. Furthermore, few analyses have gone further than proposing some mechanism for ‘marking’ focus without working out the details of how this interacts with other aspects of the grammar.

Our point of departure in this paper is the assumption, as expressed in e.g. Chafe 1976, Prince 1986, that what underlies the focus-ground distinction is a need to ‘package’ the information conveyed by a sentence so that hearers can easily identify which part of the utterance represents an actual contribution to their information state at the time of utterance, and which part represents material that is already subsumed by this information state. In particular, we adopt Vallduví’s (1992) proposal that these ‘ways of packaging’ can be viewed as instructions. Sentences fall, qua information structure, into four basic instruction-types, depending on how (the speaker assumes) they modify the hearer’s information state. This characterisation of instruction-type is independent of how a particular instruction-type is realised in particular languages. Section 2 provides a brief overview of information packaging and surveys a sample of languages which differ in the mechanisms they exploit for realising information packaging. We will focus on two language types: those like English, which, having a malleable prosody, allow for focus-ground distinctions to be marked prosodically, and those like Catalan, in which the prosodic peak is fixed on a particular position and any ground constituents are banished from that position, giving rise to string-order permutations (left- and right-detachments).

Given the view that there is a set of language-independent instruction-types, it is desirable to represent the information packaging of a sentence independently of its particular realisation. Here information structure is treated as an independent dimension of the sentence which may be ‘folded into’ the prosody or the word order in different ways, depending on the language. Section 3, the main body of the paper, outlines a way of representing information structure using the *sign-based* formalism of HPSG and looks at how language-specific generalisations can be expressed in this framework.

Keeping information structure independent of prosody and syntax provides an explanatorily adequate means to capture the interpretative focus-ground identity of structurally dissimilar constructions in different languages, but there are additional advantages of a utilitarian nature. In multi-lingual applications, for instance, it would appear to be useful to be able to use high-level generalisations about instruction-types so that the appropriate correspondences could be established. In addition, given that information packaging is concerned with the process of updating the hearer’s information state by linguistic means, the availability of these high-level generalisations should facilitate the interface between natural language pro-

cessing tools such as a dialogue handler or a database query system and the general reasoning procedures that have to be assumed in order to model an NLP system.

Section 4 considers a number of additional issues that concern the analysis presented in Section 3. We show how our analysis extends naturally to cases of multiple focus and a comparison between the HPSG analysis laid out here and two other recent proposals is sketched out.

Finally, Section 5 touches on the issue of how information packaging should be represented in relation to other aspects of sentence meaning. Unlike recent proposals, in which focus-ground is taken to be part of the context-independent content of sentences, the analysis proposed here assumes that information packaging and the context-independent content of sentences are separate dimensions that nevertheless constrain each other. Section 5 provides some empirical arguments in favour of maintaining such a distinction.

It should be noted that the work reported here is still at an early stage and that feedback, both on the coverage and the implementation, is welcome. We believe, however, that in addressing the issue of integrating focus-ground articulation into a grammar architecture, we are also addressing some fundamental questions regarding the nature of grammar.

2 Information packaging

Section 2.1 is a précis of Vallduví 1994 (this volume). See this paper for a more thorough discussion of the background and issues in information packaging. For more on the empirical issues discussed in Section 2.2 see Vallduví 1993a.

2.1 An instruction-based approach

The sentences in (1) differ not in *what* they say about the world, but in *how* they say it, i.e. they differ in the way their content is packaged:

- (1) a. He hates CHOCOLATE.
- b. He HATES chocolate.
- c. Chocolate he HATES.

These different packagings are viewed in Vallduví 1992, 1994 as different instructions for information update. The sentences in (1) have the same propositional content but encode different instruction-types.

Each instruction-type—there are four of them—corresponds to a different focus-ground partition. The FOCUS is defined as the actual update potential of a sentence S, i.e. the only contribution that (according to the speaker) S makes to the information state of the hearer at the time of utterance. All sentences have a focal segment. The GROUND, in contrast, is already subsumed by the input information state and acts as an usher for the focus: it indicates how the information update is to be carried out. Sentences have a ground only if the context warrants its use, i.e. if the ushering is (thought by the speaker to be) required. The ground is further divided into LINK and TAIL. This yields a more complex articulation with three primitive notions that encompasses the two traditional binomial articulations of focus-ground and topic-comment.

In order to describe how instructions work, information states are viewed as Heimian file-like constructs (Heim 1983). Files are collections of file cards. File cards correspond to what

are called discourse referents, entities, or markers in other frameworks. Each file card has a number of records—analogueous to conditions in Discourse Representation Theory (Kamp & Reyle 1993)—written on it listing descriptions (attributes and relations) that concern the entity it denotes. Given this background, the ushering function of the ground is described as follows. The link, on the one hand, designates a particular file card as the locus of information update (cf. Kuno’s (1972) ‘sort key’, Chafe’s (1976) ‘frame’, and Reinhart’s (1982) ‘address’). If an expression denoting a file card fc is structurally encoded as a link, it is informationally interpreted as $GOTO(fc)$. If the locus of information update for S_n is inherited from S_{n-1} , no link is required for S_n . The tail, on the other hand, points at a particular (possibly underspecified) record on fc and indicates that this record is modified (or further specified) by the focus. In the absence of a tail information update is carried out in a default mode (UPDATE-ADD) consisting of a mere addition of the focus to the input file. The presence of the tail indicates that a nondefault mode of update (UPDATE-REPLACE), involving further ushering, is (in the speaker’s eyes) required.²

The four instruction-types are the result of combining the two modes of update with the designation of a locus of information update or the absence of such designation:

(2)	link-focus	⟶	$GOTO(fc)(UPDATE-ADD(I_s))$
	link-focus-tail	⟶	$GOTO(fc)(UPDATE-REPLACE(I_s, record(fc)))$
	all-focus	⟶	$UPDATE-ADD(I_s)$
	focus-tail	⟶	$UPDATE-REPLACE(I_s, record(fc))$

These four instruction-types encompass systematically all the informational constructions previously described in the literature from the topic-comment, ground-focus, and other perspectives. UPDATE-REPLACE instructions correspond to the so-called narrow-focus sentences or to a typical open-proposition structure in Prince (1986). Link-focus instructions correspond to the typical topic-comment structure or to a standard categorical judgment (Kuroda 1972). Finally, a subset of the all-focus instructions corresponds to the neutral descriptions of Kuno 1972, the news sentences of Schmerling 1976, or to athetic judgment.

It follows from the way the informational primitives are defined that the focus-ground partition of a simplex sentence is composed of discrete units that do not overlap. By this we mean that a given constituent will be interpreted as focus, link or tail, but may not be interpreted as both focus and tail or focus and link. We are not, however, assuming that the linguistic material that make up each one of the informational primitives must form a syntactic or prosodic constituent (see Section 3.2.3). It also follows that every element in a sentence, other than weak pronominal forms (Section 2.2), must contribute to its information structure. In other words, every element must be associated with a focus, link, or ground interpretation. This follows from the assumptions that in every sentence there is a focal segment and that sentences do not have a ground component unless the context requires its use: if a (nonweak) constituent is not ground, it must be focal, and if it is not focal it must be ground.

The structural realisation of these instruction-types differs from language to language. Section 2.2 looks at how English and Catalan realise the three informational primitives (focus, link, and tail) and, for the sake of illustration, compares them to Dutch and Finnish.

²This characterisation of information packaging is presently restricted to declarative sentences. We are currently exploring how coverage can be extended to interrogatives sentences taking Ginzburg’s (1993) approach to questions as a starting point. There seems to be no difference in the way declarative and interrogative sentences express focus-ground.

2.2 Linguistic resources for expressing focus-ground

What are the means available to natural language for expressing information structure? In Section 1 we mentioned prosody and word order. In order to express information structure, some languages manipulate intonational structure, some languages reorder sentential constituents, and some languages do both to some degree. English and Catalan are good candidates to illustrate the first and the second type, respectively. Even though English has a string-permutation operation whose *raison d'être* appears to be exclusively informational, namely topicalisation, the burden of expressing information structure falls on prosody. In contrast, Catalan is unable to use intonational structure to realise information packaging and it must necessarily resort to string permutations to do so. Dutch, which is included in the sample below because it is a truer Germanic representative (as far as strategies for realising information structure is concerned), is closer to the third, mixed type than English is. But a more prototypical example of the mixed behaviour is found in Finnish.³

Here, then, we discuss examples from English, Catalan, Dutch, and Finnish. These languages vary in their structural realisation of information packaging along two important dimensions of variation, namely whether the language has a malleable intonational structure—what Vallduví 1991 calls intonational plasticity—and whether the focus-ground structure affects the constituent order. This pattern of variation is shown in Table 1:

LANGUAGE	INTONATION	STRING ORDER
English	-plastic -A & B accents	links optionally front
Catalan	-nonplastic -A accent	links and tails to detachment slots
Dutch	-plastic -A & B accents	links normally front
Finnish	-some plasticity -A accent	contrastive foci to designated slot

Table 1: Structural resources for realisation of information packaging

English, Dutch, and Finnish have a malleable intonation. This contrasts with the nonplasticity of Catalan. In addition, English and Dutch use a richer repertoire of accents than Catalan and Finnish (the terms A accent and B accent are taken from Jackendoff 1972). As far as string order, English and Dutch may place links in a left-hand position (much more frequently so in Dutch). Catalan is characterised by the need to place nonfocal phrases in right- or left-detachment slots (analysed as S-adjunction slots in Section 3): links are left-detached and tails are right-detached. Finnish performs permutations involving nonfocal elements as well,

³In English, there are other ‘marked’ syntactic constructions, e.g. *it*-clefts, *wh*-clefts, that are also used to express different informational partitions. However, as argued by Delin 1991, 1992, clefting serves other functions as well, such as the marking of presupposition (the kind that displays constancy under negation). Vallduví 1991, 1993a argues that this is the primary function of clefting and that its information-packaging value is secondary.

but its distinctive characteristic is an operation on a subset of the foci. So-called contrastive foci are placed in a designated clause-initial slot.⁴

In all the languages in Table 1, focus is associated with an A accent. In the typology of Pierrehumbert’s (1980) phonology of intonation, Jackendoff’s A accent corresponds to a simplex high pitch accent (H*), generally followed by a falling boundary tone. The difference between English and Catalan, as will be seen below, is in how the association of focus and an A accent is attained. Jackendoff’s B accent corresponds to a complex fall-rise pitch accent (L+H*) in Pierrehumbert’s system. Links in English and Dutch are associated with a B-accent realisation. Finnish and Catalan do not possess a B accent. In Finnish, both foci and links are realised with an A-accent (although they may differ along some other acoustic dimension). In Catalan, in contrast, links display no particular intonational prominence. Instead, what identifies them is that they are obligatorily left-detached. As noted, left-hand placement of the link is also available, albeit optional, in English, Dutch, and Finnish. However, its application does not preempt the corresponding prosodic marking associated with linkhood in each particular language. Tails, finally, display no particular structural marking in English, Dutch, or Finnish, other than being characteristically unaccented, but must necessarily undergo right-detachment in Catalan.⁵

Since the three informational primitives that give rise to the instruction-types discussed in Section 2.1 are associated with different realisation in different languages, it is unavoidable that the instructions themselves are associated with different structures. In order to compare how the four instruction-types are realised in the languages in Table 1, we provide a quartet of propositionally equivalent sentences (cum context) that differ minimally in their information structure. Example (3) is a link-focus instruction: *the president* is the link and the VP is focal. Example (4) is link-focus-tail instruction: *hates* is focus and both *the president* (still a link) and the direct object *the Delft china set* are ground. Example (5) is an all-focus sentence, where the locus of information update is inherited from S_{n-1} , and (6) is a focus-tail instruction (same inheritance of locus of information update):⁶

- (3) a. H₁: I’m arranging things for the president’s dinner. Anything I should know?
 b. S₀: Yes. The **president** [_F hates the Delft CHINA SET]. Don’t use it.
- (4) a. H₂: In the Netherlands I got the president a big Delft china tray that matches the set he has in the living room. Was that a good idea?
 b. S₀: Nope. The **president** [_F HATES] the Delft china set.
- (5) a. H₁: I’m arranging things for the president’s dinner. Anything I should know?
 b. S₀: Yes. The **president** always uses plastic dishes.
 [_F (He) hates the Delft CHINA SET].

⁴Vilkuna 1989 argues that Finnish offers empirical motivation to distinguish between so-called contrastive and plain foci. The view in Vallduví 1991, 1992, adopted here, is that in languages like Catalan and English there is no need for two separate categories. If Vilkuna’s standpoint turns out to be correct, the informational set of primitives discussed in 2.1 will have to be enriched. A necessary contrast between contrastive and plain foci is also argued for in Rochemont 1986.

⁵There is an important language-type which is not represented in table 1 at all: languages that make use of morphemes to realise information packaging. In languages like Navajo (Schauber 1979) and Vute (Thwing and Watters 1987), for instance, foci are associated with a particular morpheme, and Japanese *wa* (Kuno 1972) can be straightforwardly characterised as a marker of linkhood.

⁶Here and in examples below, where judged helpful, the B-accented element within the link is written in boldface. Foci are enclosed in F-labeled brackets and the A-accented item within the focus is written in small caps.

- (6) a. H₂: In the Netherlands I got the president a big Delft china tray that matches the set he has in the living room. Will the president like it?
 b. S₀: Nope. [F (He) HATES] the Delft china set.

It may appear counterintuitive to use (5), which contains a weak pronominal subject, as an example of an all-focus sentence. A little aside on the informational import of weak and strong pronominals is in order. In English, weak and strong pronouns are only distinguished by stress/accent. In many other languages, however, the two classes are not only prosodically but also morphologically distinct. Catalan is one such language. Catalan weak pronouns are either null or clitic, whereas strong pronouns are full-fledged, autonomous words. In Catalan, the subjects in (5) and (6) would be null. We take the presence of the pronouns in these examples to be due to independent requirements of English grammar, which does not allow for null argument slots. Weak pronouns are inert as far as information packaging is concerned (although they are obviously crucial for anaphora resolution and issues of salience/familiarity/novelty) and in (5) and (6) appear vacuously as place-holders. They have been left within the focal bracketing for ease of comparison with the behaviour of Catalan clitics shown below, but they are neither focal nor ground. In fact, weak pronouns cannot display any of the structural properties associated with either foci or links or tails (association with A and B accents or placement in detachment positions). Strong pronouns are full-fledged items and may take part in an instruction as foci, links, or tails (see Vallduví 1992, 1993a for arguments for this view).

Returning to the crosslinguistic facts, let us now compare the English set of sentences to their Catalan, Dutch, and Finnish counterparts. Each sentence is preambled by the instruction-type it instantiates (l-f for link-focus, l-f-t for link-focus-ground, all-f for all-focus, and f-t for focus tail):

(7) **English**

- l-f The **president** [F hates the Delft CHINA SET.]
 l-f-t The **president** [F HATES] the Delft china set.
 all-f [F (He) hates the Delft CHINA SET.]
 f-t [F (He) HATES] the Delft china set.

(8) **Catalan**

- l-f El president₁ [F odia el joc de porcellana de DELFT t₁.]
 l-f-t El president₁ [F l₂'ODIA t₂ t₁,] el joc de porcellana de Delft₂.
 all-f [F Odia el joc de porcellana de DELFT *pro*.]
 f-t [F L₂'ODIA t₂ *pro*,] el joc de porcellana de Delft₂.

(9) **Dutch**

- l-f De **president** [F haat het Delftsblauwe PORCELEINEN SERVIES.]
 l-f-t De **president** [F HAAT] het Delftsblauwe porceleinen servies.
 all-f [F (Hij) haat het Delftsblauwe PORCELEINEN SERVIES.]
 f-t [F (Hij) HAAT] het Delftsblauwe porceleinen servies.

(10) **Finnish**

- l-f **Presidentti** [_F inhoaa (sitä) Delftin POSLIINIASTIASTOA.]
l-f-t **Presidentti** [_F INHOAA (sitä)] Delftin posliiniastiastoa.
all-f [_F (Hän) inhoaa (sitä) Delftin POSLIINIASTIASTOA.]
f-t [_F (Hän) INHOAA (sitä)] Delftin posliiniastiastoa.

In all four languages an item within [_F] is associated with an A accent, although this association, as noted, is brought about through different strategies. In this paradigm, in cases of narrow focus on the verb (l-f-t and f-t), English, Dutch, and Finnish simply change the placement of the A accent from a sentence-final position to a sentence-medial position. The syntactic structure of the l-f and l-f-t sentences, at least in English and Dutch, is exactly the same. They only differ in their intonational structure. In contrast, in Catalan l-f and l-f-t do have different syntactic structures. In the l-f-t example the object *el joc de porcellana de Delft* ‘the Delft china set’ appears in a detachment slot at the sentential periphery. Its peripheral status is evidenced by the presence in the verbal string of a pronominal clitic bound by the detached phrase, since the cocurrence of clitic and argument in situ is illicit. Additional evidence for the peripheral status of the detachment comes from e.g. the position of clause-peripheral vocatives and string order. In effect, then, in both l-f and l-f-t in (8) the A accent is associated with the rightmost accentable item within the sentential core, whatever this item is (object in l-f or verb in l-f-t). This is always the case: in Catalan A accents are necessarily associated with the right-hand boundary of the sentential core. Phrases (arguments or adjuncts) which, due to default string order, would otherwise appear in the rightmost position, must be removed from that position if association with an A accent is inappropriate, namely, if they are nonfocal. In fact, in Catalan the sentential core may contain only focal material (in addition to informationally inert weak proforms).

Let us now look at the realisation of links in (7) to (10). In English, Dutch and Finnish links are associated with a pitch accent as well. It is a B accent in the two Germanic languages and an A accent in Finnish (although it is notated as a B accent in (10) and below for the sake of clarity). The contour formed by a B accent followed by an A accent seen in the l-f sentences in the Germanic languages, typical of many declarative statements, has been called the ‘suspension bridge contour’ by Bolinger 1961 and the ‘hat pattern’ by Cohen & ‘t Hart 1967. This description of the intonational facts is an idealised picture which focuses on those aspects of intonation in English that correlate most directly with the focus-ground articulation. The use of intonation to express other pragmatic or semantic aspects of interpretation may override the default prosodic realisation of foci and links. See, for instance, the L*+H accent associated with speaker uncertainty (Ward & Hirschberg 1985), the uses of intonation to express illocutionary distinctions (Pierrehumbert & Hirschberg 1990), the (de)accenting phenomena that affect the assignment of pitch accent at the phrasal and word-internal level within both focus and link (Ladd 1980, 1983), and the ‘super-utterance prosodic assignments’ due to conversational context or nature of the exchange within which a sentence is uttered (Kowtko, Isard & Doherty 1992, Kowtko 1992). It would clearly be desirable to integrate this, essentially sentence-based, analysis with Isard and Kowtko’s discourse work. Finally, it would perhaps be more appropriate to speak about focus- and link-associated tunes rather than focus- and link-associated pitch accents (Ladd 1991).⁷

⁷ Another use of intonation that we shall leave aside is ‘metalinguistic correction’, as illustrated in examples like *We’ll use ‘EXTension’ in this sentence, not ‘INTension’*. The l-f-t and f-t sentences in (7) may also have

Catalan contrasts with the other three languages in that links are not associated with intonational prominence. Instead, as noted, they appear in a left-detachment slot. The clitic diagnostic mentioned in relation to the position of the right-detached direct object cannot be used for the subject *el president* ‘the president’, since Catalan does not possess subject clitics, but the peripheral status of the subject has been argued for quite convincingly by a number of authors (see Rosselló 1986, Rigau 1988, Bonet 1990, Vallduví 1993b, Solà 1992). Finally, note the lack of any marking for the tail *the Delft china set* in English, Dutch, and Finnish and its placement in a right-detachment slot in Catalan.

The picture presented in (7)-(10) is only partial, because, as noted in Table 1, there are two structural options for links: a purely prosodic option and a syntactic plus prosody option. This contrasts with Catalan, where only a syntactic strategy is available:

(11) **English**

Where can I find the cutlery?

The forks are in the CUPBOARD...

a. ...but **the knives** I left in the DRAWER.

b. ...but I left **the knives** in the DRAWER.

(12) **Catalan**

Les forquilles₁ són a l'ARMARI t₁...

a. ...però els ganivets₁ els₁ vaig deixar t₁ al CALAIX

b. # ...però vaig deixar els ganivets al CALAIX.

(13) **Dutch**

De **vorken** zijn in de KAST...

a. ...maar de **messen** liet ik in de LA.

b. ...maar ik liet de **messen** in de LA.

(14) **Finnish**

Haakurat ovat KAAPISSA...

a. ...mutta **veitset** minä jätin LAATIKKOON.

b. ...mutta minä jätin **veitset** LAATIKKOON.

The context in (11)-(14) forces a link reading for *the knives*: there is a contrast between two loci of information update (these are shifted topics in some topic-comment approaches). Examples (11a) and (11b) are interpretively identical. Both sentences felicitously express the linkhood of *the knives*. In both sentences, *the knives* is associated with a B accent, but, in addition, the phrase is fronted in (11a).

In English, Dutch, and Finnish a constituent in its canonical position has wider interpretation possibilities. The ability to exploit intonational structure for informational purposes makes syntactic marking less crucial. A direct object in situ may be interpreted as a focus or as a link provided it is realised with the appropriate prosodic marking. In Catalan, which has an impoverished prosody, constituents in situ receive a focal interpretation by default. To

somewhat of a correction flavour to them as a consequence of their informational interpretation. However, while a metalinguistic correction is a correction of a (hearer's) *utterance*, an instruction cum tail ‘corrects’, if anything, some aspects of the hearer's *knowledge* or *beliefs*.

avoid focal interpretation, they must undergo a syntactic operation that removes them from their canonical positions. Informational interpretation in Catalan is not recoverable by any means other than syntactic position and, therefore, the wider range of options characteristic of English is not available.

The above array of sentence does not include examples of all-focusthetic sentences. Thetic sentences form an interesting subclass. In the literature they have also been called neutral descriptions and news sentences. They appear, in ‘out-of-the-blue’ contexts, as answers to questions like *What’s new?*, and as answers to *why*-questions, among others. They are a subtype of all-focus instructions and, as such,thetic sentences do not require a GOTO(*fc*). But here the locus of information entry is not a file card specified in a previous sentence S_{n-1} , but rather a default situational file card which can be automatically inherited by S_n .

In English typicalthetic sentences are realized with an A accent on the subject, as in (15). The only difference between the all-focus sentences in (15) and the link-focus sentences in (16) is intonational:

- (15) a. [F WAR broke out.]
 b. [F MICHAEL called.]

- (16) a. **War** [F broke OUT.]
 b. **Michael** [F CALLED.]

Again, we see how English exploits intonational alternatives to realise different information-packaging instructions. Catalan, as expected, fails to do so. Instead, in all-focus sentences the subject appears in postverbal position, within the sentential core, and thus remains within the focus, as in (17). In link-focus instructions the subject must be left-detached (18):

- (17) a. [F Ha esclatat la GUERRA.]
 broke-out the war
 b. [F Ha trucat el MIQUEL.]
 called the Michael

- (18) a. La guerra₁ [F ha ESCLATAT t₁.]
 b. El Miquel₁ [F ha TRUCAT t₁.]

Finnish, in keeping with its mixed nature, allows for both options. However, in this case the alternation is not free. There are independent factors that determine which choice is used. Unaccusative verbs appear to prefer a postverbal placement of the subject (19a), while intransitive verbs stick to the order subject-verb (19b):

- (19) a. [F Syttyi SOTA.]
 broke-out the war
 b. [F MIKKO soitti.]
 Michael called

Notice that the strings in (15) are ambiguous between athetic, wide-focus reading and a reading where there is narrow focus on the subject. In Section 3 it is shown that there are interesting parallelism between this ambiguity and the ambiguity that arises in cases where the focal A accent is associated with a verbal complement, illustrated in (20):

- (20) a. I called [F MICHAEL.]

- (20) b. I [_F called MICHAEL.]

Both ambiguities will be captured using identical structural mechanisms concerning inheritance of focus information (or lack thereof) in the sign.

Let us close this section with a more complete set of focus-ground partitions for Catalan and English. The (English) sentences and contexts are adapted from Steedman 1991. The *What about NP?* question is meant to trigger a link interpretation for NP. The *wh*-element in the subsequent question is meant to trigger a focal interpretation for its instantiation in the answer:

- (21) What about Fred? What did **he** do?
 a. Eng.: **Fred** [_F ate the BEANS.]
 b. Cat.: El Pere₁ [_F es va menjar els FESOLS t₁.]
- (22) What about Fred? What did **he** eat?
 a. Eng.: **Fred** ate [_F the BEANS.]
 b. Cat.: El Pere₁ [_F t_v els FESOLS t₁,] es va menjar_v.
- (23) What about Fred? What did **he** do to the beans?
 a. Eng.: **Fred** [_F ATE] the beans.
 b. Cat.: El Pere₁ [_F se'ls₂ va MENJAR t₂ t₁,] els fesols₂.
- (24) What about the beans? What happened to **them**?
 a. Eng.: [_F FRED ate] **the beans**.
 b. Eng.: **The beans**₁ [_F FRED ate t₁.]
 c. Cat.: Els fesols₁ [_F se'ls₁ va menjar el PERE.]
- (25) What about the beans? What did Fred do to **them**?
 a. Eng.: Fred [_F ATE] **the beans**.
 b. Eng.: **The beans**₁ Fred [_F ATE t₁.]
 c. Cat.: Els fesols₁[_F se'ls₁ va MENJAR t₁ t₂], el Pere₂.
- (26) What about the beans? Who ate **them**?
 a. Eng.: [_F FRED] ate the **beans**.
 b. Eng.: **The beans** [_F FRED] ate.
 c. Cat.: Els fesols₁ [_F t_v t₁ el PERE,] se'ls va menjar_v.

In (21) to (26) we see the main characteristics of the contrast between English and Catalan. The string order of each English sentence, excepting the topicalisations in (24b) and (25b), is exactly the same. What varies from one context to the other is the intonational contour associated with the string: the B and A accents associate with the constituents that are assigned link or focus interpretation, respectively, independent of their position in the string. In Catalan, in contrast, the syntactic makeup of each one of the sentences is different. What remains constant here is the placement of the A accent (there is no B accent): it is always associated with the rightmost element within the sentential core (whose right boundary is indicated in these examples by a period or comma).

Examples (27) and (28) differ from the others in that link marking is associated with the verb. Notice, though, that the contrast between English and Catalan is maintained. While English signals linkhood via a B accent (fronting is not available here), Catalan must resort to a syntactic strategy in which an infinitival form of the verb is left-detached.

- (27) I know what Fred cooked. But then, what did he **eat**?
 a. Eng.: Fred **ate** [_F the BEANS.]
 b. Cat.: De menjar_v [_F es va menjar_v els FESOLS t₁,] el Pere₁.
- (28) I know who cooked the beans. But then, who **ate** them?
 a. Eng.: [_F FRED] **ate** the beans.
 b. Cat.: De menjar_v [_F se'ls₁ va menjar_v t₁ el PERE,] els fesols₁.

The verbal copy left within the sentential core acts like the pronominal clitics that appear in argument left-detachments.

3 An illustration using HPSG

In Section 2.2 we have seen how informational primitives and instruction-types are realised in different ways in different languages. The crosslinguistic study reveals is that this correlation is systematic and rule-governed. In this section we will make explicit the assumption, not universally shared at the outset, that the structural (prosodic or syntactic) realisation of information packaging properly belongs to the grammar of a language (in a wide sense of the term, where grammar is understood to encompass the linguistic knowledge of a language user). In our mind, understanding and being able to use the inventory of pitch accents in English or the two detachment mechanisms in Catalan for informational purposes is an integral part of knowing these languages, and hence something that needs to be accounted for by a complete grammar.

Furthermore, it is important to consider how the realisation of instructions interacts with the other grammatical dimensions exploited for this purpose. We propose to illustrate these issues by looking at a constraint-based grammar such as HPSG. For any particular language, instruction-types and particular structural realisations mutually constrain each other systematically. Since three dimensions of the grammar—phonology, syntax, and information packaging—mutually constrain each other, it seems natural to try to model this in a multi-dimensional constraint-based framework.

3.1 Background notions

3.1.1 The sign in HPSG

HPSG, which has intellectual roots in both categorial grammar and Generalised Phrase Structure Grammar, takes the relevant units of linguistic information to be *signs* which express phonological, syntactic, semantic and pragmatic information in an explicit and structured fashion (cf. Pollard & Sag 1987, 1994). Signs are expressed as typed feature structures. *Lexical signs* contain the basic information about a word: how it is pronounced (in citation form), its inherent and combinatorial syntactic properties, its content (the link to the semantics) and any contextual information that is relevant to its use. An outline of a lexical sign is given in (29):⁸

⁸What follows is both a simplified and eclectic overview of HPSG signs, which, among other things, leaves out the LOCAL/NONLOCAL distinction. The reader is referred to Pollard & Sag 1987, 1994 for details about the structure of signs.

$$(29) \begin{bmatrix} \text{PHONOLOGY:} & [&] \\ \text{CATEGORY} & : & [&] \\ \text{CONTENT} & : & [&] \\ \text{CONTEXT} & : & [&] \end{bmatrix}$$

One core idea in sign-based frameworks is that all relevant linguistic aspects are represented in every linguistic unit, i.e. in words, phrases, clauses and sentences, and may hence interact.⁹ The schematic sign in (29) is actually not used in any of the major HPSG works or implementations (rather, it is more directly reminiscent of Unification Categorical Grammar as described in Zeevat, Klein & Calder 1987 and Bird 1991).

The use of feature structures allows the grammar writer many different ways of organising the linguistic information and the way it interacts. Such interaction is often expressed through structure sharing of relevant parts of a sign. For instance, there is structure sharing between the values in the SUBCAT field in CATEGORY and the arguments of the roles in the CONTENT field as shown in (30):

$$(30) \begin{bmatrix} \text{PHON:} & \langle \text{walks} \rangle \\ \text{CATEGORY:} & \begin{bmatrix} \text{HEAD:} & \text{verb}[\text{fin}] \\ \text{SUBCAT:} & \langle \text{NP}[\text{nom}] \boxed{1} [\text{3rd, sing}] \rangle \end{bmatrix} \\ \text{CONTENT :} & \begin{bmatrix} \text{REL} & : & \text{walk} \\ \text{WALKER:} & & \boxed{1} \end{bmatrix} \end{bmatrix}$$

Pollard & Sag 1994 argue that, for many purposes, it makes sense to refer to the bundle of information represented by the CATEGORY and CONTENT fields, while ignoring the PHONOLOGY field. For instance, they argue that the combinatory potential of a sign, i.e. its SUBCAT feature, should refer to the combined CATEGORY + CONTENT fields of other signs, and introduce a regrouping of the feature structures as in (31), where there is now a convenient way to refer to that bundle of information as the value of SYNSEM:

$$(31) \begin{bmatrix} \text{PHONOLOGY:} & [&] \\ \text{SYNSEM} & : & \begin{bmatrix} \text{CATEGORY:} & [&] \\ \text{CONTENT} & : & [&] \\ \text{CONTEXT} & : & [&] \end{bmatrix} \end{bmatrix}$$

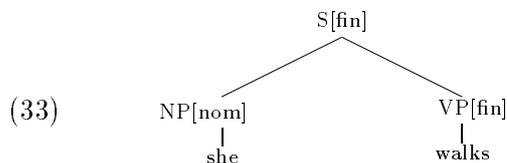
However, we should be clear that this reorganisation of a sign is mainly there for the convenience of a grammar writer. In principle, any feature value can be cross-referenced with any other, given the ability to identify feature-value paths uniquely. In outlining the proposal of this section, we will not be concerned with the detailed architecture of a sign. We will retain a very flat sign structure, without implying thereby that this is the most perspicuous way of representing the informational dependencies in the sign as a whole.

In addition to lexical signs, there are *phrasal signs* which are the result of combining two or more signs according to immediate dominance schemata. Phrasal signs have a *daughters* feature, DTRS, which represents the immediate constituent structure of the phrase:

⁹In this respect, sign-based frameworks differ from most grammatical frameworks that have grown out of the transformational tradition. In these grammars, the different linguistic aspects of a sentence are typically factored out into different levels of representation (such as D-structure, LF, and PF). This makes it difficult to identify the contribution of units smaller than sentences to update potential.

$$(32) \left[\begin{array}{l} \text{PHON} : \langle \text{she, walks} \rangle \\ \text{SYNSEM} : \text{S}[\text{fin}] \\ \text{DTRS} : \left[\begin{array}{l} \text{HEAD-DTRS} : \left[\begin{array}{l} \text{PHON} : \langle \text{walks} \rangle \\ \text{SYNSEM} : \text{VP}[\text{fin}] \end{array} \right] \\ \text{COMP-DTRS} : \langle \left[\begin{array}{l} \text{PHON} : \langle \text{she} \rangle \\ \text{SYNSEM} : \text{NP}[\text{nom}] \end{array} \right] \rangle \end{array} \right] \end{array} \right] \\ \textit{phrase}$$

Looking at the attribute-value matrix notation for phrasal signs, it can be quite hard to trace the way in which information is instantiated, i.e., which part of the information comes from which daughter and so on. In this section, we will frequently follow Pollard & Sag's (1994) practice and notate and abbreviate phrasal signs as trees. The sign in (32) can be abbreviated in tree form as in (33):



This phrasal sign is dominated by a node labelled with an abbreviation of the CATEGORY value of the sign in question (S[fin]). The daughters of the sign appear at the end of labelled arcs. These arcs are labelled H for head daughter and C for complement daughter. The PHON values for each lexical sign are written at the leaf below each daughter node.

3.1.2 The basic fields

The PHONOLOGY field is given a very rudimentary treatment in most of the current HPSG literature. The value of PHON for lexical signs in Pollard & Sag 1994 is simply an orthographic representation of the corresponding lexical item, e.g. *run*. Phrasal signs involve the concatenation of the PHON values of the daughters. However, recent work by Bird 1992 and Bird & Klein 1994, among others, shows how phonological structure may be expressed in typed feature structures. They enrich the PHON field so that it can encode multi-tiered, hierarchical representations. They deal mainly with segmental and liaison phenomena. For our purposes, we need to extend the approach to include pitch accent assignment and intonational phrasing.

The CONTENT field contains information about the word's or phrase's contribution to aspects of semantic interpretation which are assumed to be context-independent. In addition there is an field labelled CONTEXT in which information relating to the pragmatic context of the sign is available. For example, one such type of information is who the speaker and addressees are and what their mutual social relations are, as this may govern the choice of pronominal forms in languages like French and German, or the correct verb form in Japanese or Korean. The way such contextual information is encoded in Pollard & Sag 1994 is in terms of 'parameterised states of affairs', i.e. descriptions of the utterance situation using notions from Situation Semantics.

3.2 Expressing information packaging in HPSG

Where should information structure be located in such multidimensional representations? There are some earlier proposals to integrate some aspects of information structure in the

grammar. Karttunen & Kay 1985, for instance, uses a feature `NEW` in the syntactic category of a phrase. Bird 1991 includes an explicit semantic operator `FOC` in the semantic `CONTENT` field. However, the crosslinguistic facts presented in Section 2.2 and the semantic issues discussed below in Section 5 advise against merging information structure into any other linguistic dimension. Given the view of information packaging summarised in Section 2.1 as having to do with speakers' assumptions about hearers' information states, it would seem most natural to represent the information structure of the sentence as part of the `CONTEXT` field. We propose to enrich the `CONTEXT` field with a feature `INFO-STRUCT` as shown in (34), where the `GROUND` feature will take as values `LINK` and `TAIL`, corresponding directly to the informational primitives introduced in Section 2.1:

$$(34) \left[\text{CONTEXT:} \left[\begin{array}{l} \text{C-INDICES} : [\quad] \\ \text{BACKGROUND:} [\quad] \\ \text{INFO-STRUCT:} \left[\begin{array}{l} \text{FOCUS} : [\quad] \\ \text{GROUND:} [\quad] \end{array} \right] \end{array} \right] \right]$$

The values of `FOCUS` and `GROUND` will be instantiated, through structure sharing, with those constituents that realise the focus and the ground part of the instruction respectively. `FOCUS`, `LINK`, and `TAIL` thus take feature structures of sort *con-struc* as values. The way this instantiation comes about depends on the choice of structural realisation. We will first look at how the assignment of pitch accents in English is correlated with informational status and how this interacts with word order in so-called focus projection. We then turn to the use of detachment in Catalan.

3.2.1 Prosodic marking of focus-ground

We assume that the `PHON` field in lexical signs is specified for all and only the information that is normally found in a citation form in the lexicon (segmental and suprasegmental). Therefore, lexical signs are not specified for what type of informational contribution they make, i.e., they are unmarked for focushood, linkhood or tailhood. It's only when a word is embedded in some phrase, associated with some prosodic contour or a particular syntactic position, that its contribution in terms of focus or ground is determined. We assume that the `PHON` field contains a feature `ACCENT` which may be instantiated through the principles illustrated in (35a) and (35b). We represent the choice of accent using Jackendoff's (1972) A and B accents:

$$(35) \quad (a) \left[\text{PHON|ACCENT: A} \right] \quad (b) \left[\text{PHON|ACCENT: B} \right]$$

$$\left[\text{INFO-STRUCT|FOCUS: } \left[\quad \right] \right] \quad \left[\text{INFO-STRUCT|GROUND|LINK: } \left[\quad \right] \right]$$

word *word*

The structure in (35a) is a skeletal lexical sign which says about itself that it contributes focal information. In a similar way, (35b) introduces a word with accent B that will be interpreted as a link. Note that this approach makes crucial use of circular feature structure which will put certain constraints on the choice of environment for implementation.

The presence of a particular accent is thus sufficient to identify positively the informational contribution of a lexical sign. In an utterance, however, many lexical items are not associated with A or B accent and their informational contribution is determined through intonational phrasing and so-called projection principles for focus. We thus assume a third way of realising a lexical sign as in (36):

$$(36) \quad \left[\begin{array}{l} \text{PHON|ACCENT: } \mathbf{u} \\ \text{INFO-STRUCT: []} \end{array} \right]_{\text{word}}$$

In such a sign, the value of the ACCENT feature is \mathbf{u} , which stands for ‘unmarked’. When an ACCENT feature has this value, the value of the INFO-STRUCT feature is not specified. Consequently, the informational contribution of this item can only be determined as it combines with other signs.¹⁰

We will have nothing to say about how prosodic contours arise from the combination of pitch accents and other tones. Bird 1991 is a first detailed attempt at handling such issues in a sign-based grammar (UCG). He proposes a way of handling intonational phrasing in the phonological field by associating pitch accents with lexical items and building up intonational phrases around them. Here an approach along the lines of Bird’s account is implicitly assumed.¹¹

3.2.2 ID schemata and INFO-STRUCT instantiation

We next consider how INFO-STRUCT specifications are instantiated when signs are combined. We assume that the Immediate Dominance (ID) Schemata that Pollard & Sag 1994 introduce for constituent structure should be further specified to constrain the instantiation of focus-ground information. It turns out that in English, focus instantiation is very regular and can be captured in an elegant way by making reference to the head or complement status of the daughters. In addition to ID schemata we need some way of expressing the constraints on the linear order of constituents. In Pollard & Sag 1987, Linear Precedence statements make reference to the obliqueness hierarchy of complements. Constituent ordering remains an area where considerable research efforts are being made (cf. Reape 1991, 1994, Pollard, Kasper & Levine 1994, and references therein). We have on purpose remained agnostic as to the actual implementation of linearisation constraints. For the purposes of this paper, it would be sufficient to assume that ID schemata impose ordering as well as dominance, but this is clearly not a desirable solution in the long run. The tree structures we give display daughter constituents in the appropriate left-to-right order.

We will make use of two ID schemata. The Head-Complement Schema, given in (37) (Pollard & Sag 1994:402) licences a VP, i.e. a structure with a lexical head and all complement daughters except for the subject. Sentences are licensed by the Head-Subject schema in (38) (from Pollard & Sag 1994:402).

(37) *Head-Complement Schema*

The SYNSEM|LOCAL|CATEGORY|SUBCAT value is a list of length one, and the DTRS value is an object of sort *head-comp-struct* whose HEAD-DTR value is a word.

(38) *Head-Subject Schema:*

The SYNSEM|LOCAL|CATEGORY|SUBCAT value is $\langle \rangle$, and the DTRS value is an object of sort *head-comp-struct* whose HEAD-DTR value is a phrase . . . , and whose COMP-DTRS value is a list of length one.

¹⁰The precise way in which unspecified information is represented is left aside here. An option is to use disjunctive values. See Manandhar 1994b (this volume) for a proposal along these lines.

¹¹Bird 1991, however, does not have a separate representation for information structure in the sign. He assumes that focal and nonfocal lexical items belong to different syntactic categories, but this is an unnecessary assumption in our account.

In addition to satisfying the ID schemata, the phrasal signs must satisfy INFO-STRUCT instantiations constraints given in (39). The way this is done will be illustrated below.

- (39) INFO-STRUCT *instantiation principles for English:*
Either (i) if a DAUGHTER's INFO-STRUCT is instantiated, then the mother inherits this instantiation (*for narrow foci, links and tails*),
or (ii) if the most oblique DAUGHTER's FOCUS is instantiated, then the FOCUS of the mother is the sign itself (*wide focus*).

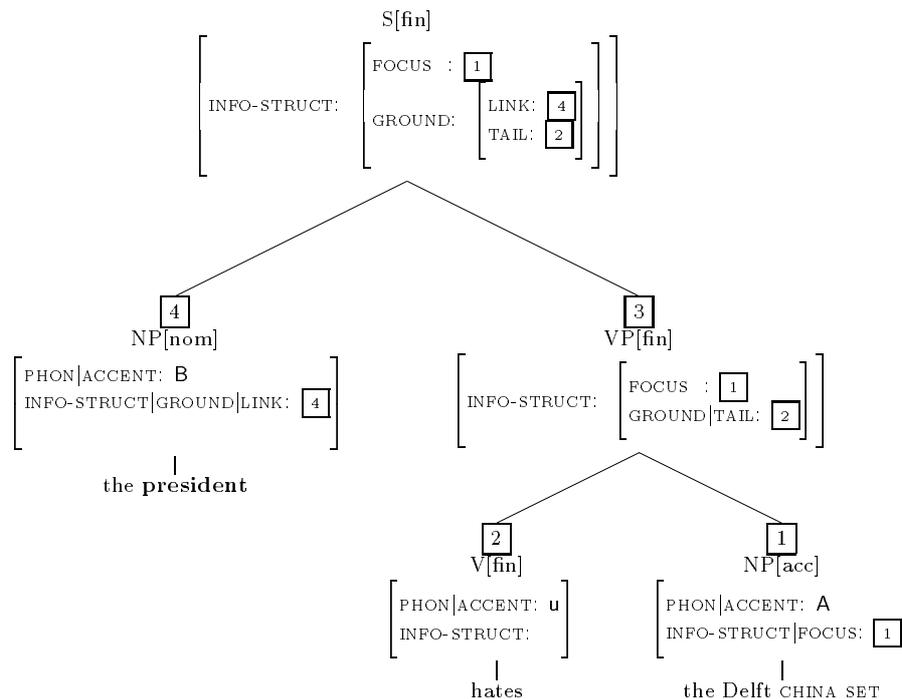
In order to see how INFO-STRUCT gets the appropriate instantiation, let us begin by considering the two ways in which an utterance like *The president hates the Delft CHINA SET* can be interpreted. It can be interpreted either with narrow focus on the object NP, as in (40), or with wide focus on the whole VP as in (41).

(40) The **president** hates [F the Delft CHINA SET.]

(41) The **president** [F hates the Delft CHINA SET.]

In both these examples *the president* is interpreted as a link. The sign for (40) is given in (42). We are here concentrating on the way INFO-STRUCT is instantiated and are omitting other aspects of the sign.

(42) *Object NP focus:*



The B accent on the subject NP *the president* and the A accent on the object NP *the Delft china set* uniquely determine their informational status. Consequently, these constituents are structure sharing with the LINK and FOCUS fields, respectively, through the application of (35a) and (35b), whereas the unaccented verb *hates* does not by itself restrict its potential contribution (cf. (36)). In the abbreviatory tree notation, the value of e.g. LINK in (42) is token-identical to the value of COMP-DTR, which appears at the end of the arc labelled C.

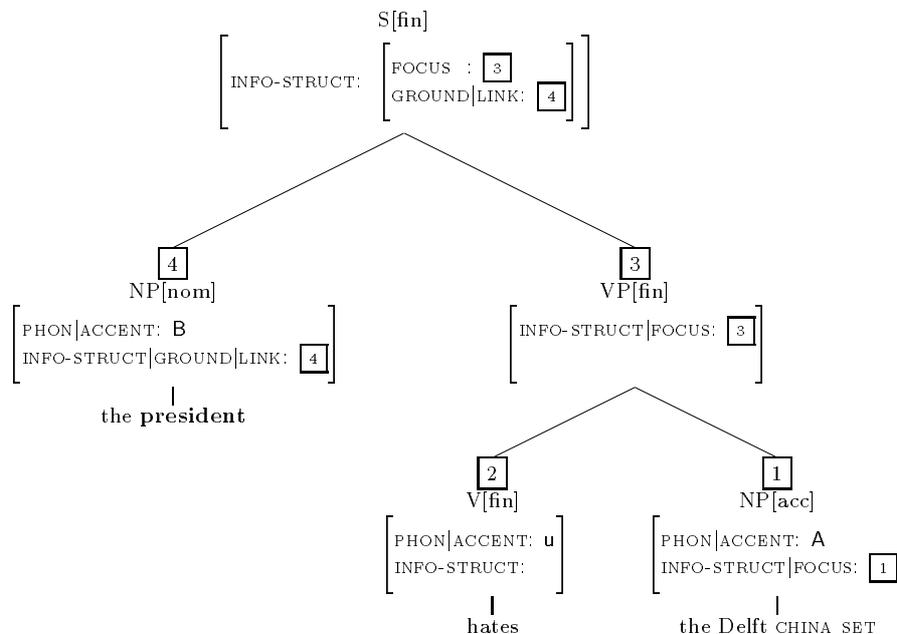
In addition, we have both included values for PHON|ACCENT and typographically marked the type of accent on the leaf, which is redundant but may help the reader.

The mother VP[fin] sign is licensed by the Head-Complement Schema in (37). The information that the object NP is the focus of the sentence is instantiated at the VP level through (39(i)). Once the INFO-STRUCT|FOCUS value of the VP[fin] sign is determined, the unaccented head daughter *hates* must be interpreted as instantiating the value of the mother's GROUND|TAIL (since, as noted in Section 2.1, every element in the sentence *must* contribute to information structure).

The sentential S[fin] sign is licensed by the Head-Subject schema in (38) and, once again, the mother sign inherits the INFO-STRUCT instantiations from its daughters by (39(i)): the object NP is the focus, the verb is a tail, and the subject NP is a link.

The structure for (41), given in (43), is identical to (42) except for the instantiation of the FOCUS value in the VP[fin] and S[fin] signs. Since the most oblique daughter's FOCUS is instantiated, (39(ii)) may apply and the FOCUS value of the mother is the sign itself.

(43) *VP focus:*



The pair of examples in (40)-(41) shows that the same string may be associated with two focus-ground partitions. (41) differs from (40) in that the whole VP rather than the object NP is interpreted as focus. This is the phenomenon commonly referred to as *focus projection*. In English, a VP may be interpreted as focal, if, as Bresnan (1971) noted, its rightmost constituent is focal. This explains why a wide-focus reading is available in (44a) but not in (44b):¹²

- (44) a. The butler [F offered the president some COFFEE.]
 b. * The butler [F offered the PRESIDENT some coffee.]

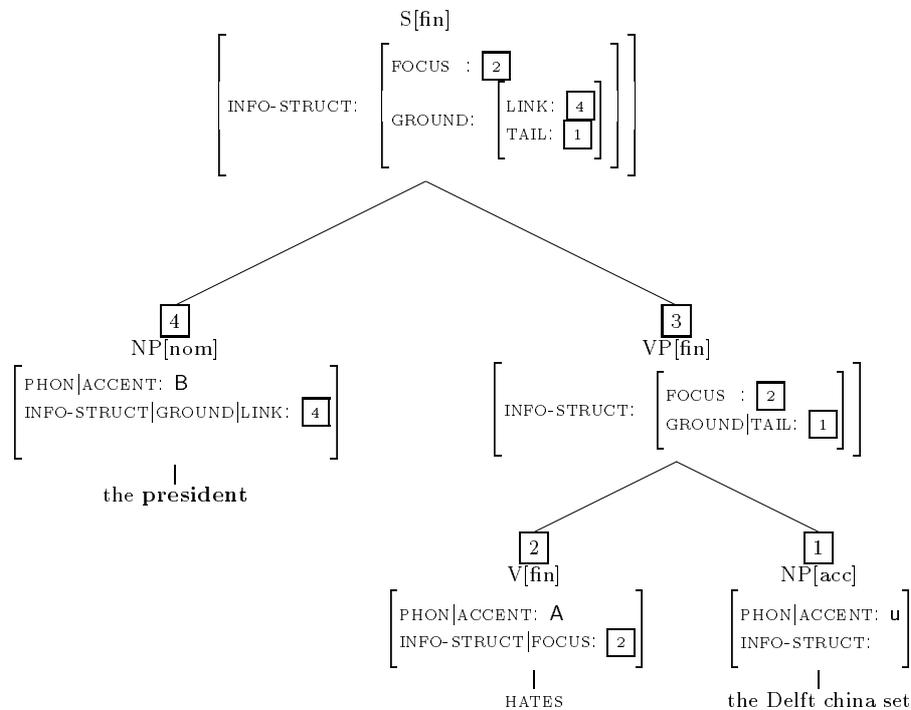
¹²As noted in Section 2.2, we are ignoring the possible licensing of (44b) via some independent process of deaccenting (Ladd 1980, 1983) due to lack of interestingness (Zacharski 1993) or concept-givenness (van Deemter 1994). Deaccenting is responsible for 'accent shifts' within both focus and link in specific contexts.

In our HPSG analysis, we can capture the generalisation that wide-focus readings are only available when the rightmost constituent is focal by referring to the FOCUS instantiation on the most oblique complement daughter in (39(ii)). Given the way the obliqueness hierarchy interacts with word order in English (Pollard & Sag 1987), in cases where there is more than one complement daughter the most oblique daughter is linearised as the rightmost constituent. Principle (39(i)), then, is responsible for cases of focus inheritance (where there is no projection) and principle (39(ii)) is responsible for cases of focus projection.

Let us now compare the string in examples (40) and (41) to example (45), which is a case of narrow focus on the verb. The instruction encoded by (45) is a link-focus-tail instruction. The structure of (45) is shown in (46):

(45) The president [_F HATES] the Delft china set.

(46) *Verb focus:*



The important point to note here is that if, FOCUS in VP[fin] is inherited from the head daughter, then there is no option for wide focus interpretation, i.e. (45) cannot make the same type of contribution as (41) above. This follows from the fact that (39(ii)) cannot apply because no complement daughter of VP[fin] has an instantiated INFO-STRUCTURE|FOCUS feature. Instead, the mother sign must inherit the INFO-STRUCTURE|FOCUS value of the daughter by (39(i)). As a consequence, as in example (42) above, the unaccented NP[acc] daughter of VP[fin] cannot be interpreted as focal and instantiates the value of GROUND|TAIL in VP[fin].

The principles in (39) also account for the structural ambiguity present in a certain class of strings where the subject is associated with an A accent and which allow for both narrow focus on a subject as in (47a) and an all-focus reading in so-calledthetic sentences as (47b) (see Section 2.2).

(47) a. [_F The PRESIDENT] called.

(47) b. [F The PRESIDENT called.]

Focus projection, i.e. the all-focus interpretation in (47b), is licensed by (39(ii)). Principle (39(ii)) may apply because the subject is the only complement daughter of S[fin] and, hence, the most oblique one. We also predict that in cases like (48a) and (48b) there is no focus projection:

- (48) a. The **president** [F CALLED.]
b. The president [F CALLED.]

The verb *called*, whose FOCUS feature is instantiated, is not a complement daughter and, therefore, focus inheritance by (39(i)) rather than focus projection by (39(ii)) applies.¹³

The fact that we can capture a considerable portion of focus realisation in English with the principles in (39) lends support to the systematic distinction between head and complement daughters in HPSG. We believe that (39(i)) applies to all ID schemata and that (39(ii)) applies to all structures of sort *head-comp-struct*, but further research is needed here.

3.2.3 Structural mismatches

As we see it, a big advantage of using the multidimensional representation in HPSG is that we are not forced to assume that focus-ground partitioning corresponds directly to structural units either in PHON or in DTRS. For instance, in (42) the GROUND material does not form a syntactic constituent, but the appropriate instantiations are achieved by a combination of bottom-up (accent assignment) and syncategorematic processes (Head-Complement schema). The same applies to the case in (43) where only the verb is focussed. We are thus not forced to assume, as does Steedman (1991), that informational partitioning must correspond both to syntactic constituency and intonational phrasing.

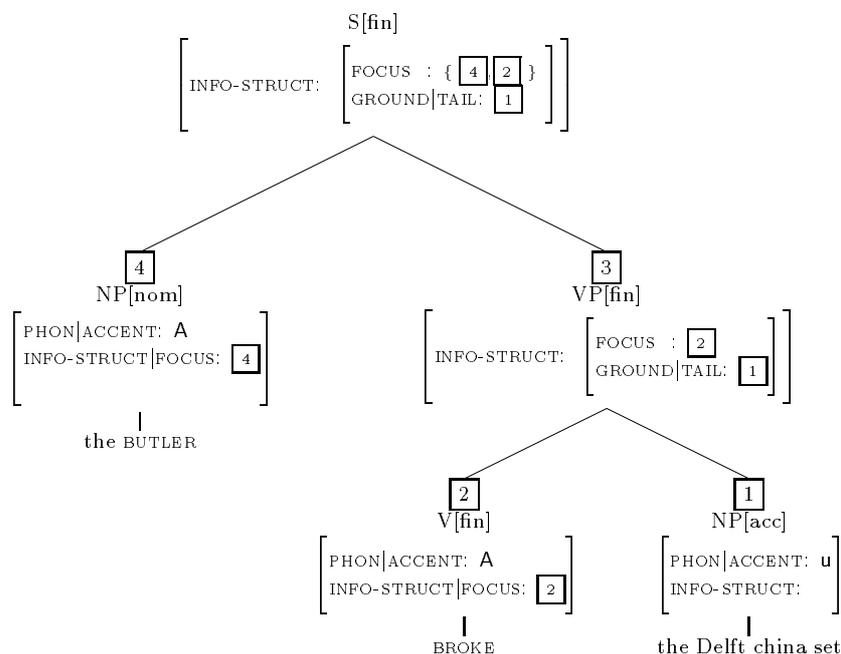
Let us consider one type of example, illustrated in (49), for which it has been claimed that the subject and the verb must form a constituent. This example is analogous to example (56) in Steedman (1991:284):

- (49) What happened to the china set?
[F The BUTLER BROKE] the set.

The focus, as identified by the question in (49) is constituted by the subject NP and the verb. The structure we would assign to (49) is given in (50):

¹³It has been claimed that examples like (48) may have an all-focus reading. However, Vallduví 1992, among others, argues that the subject in these sentences is always ground, even when such sentences answer questions of the type *What's new?*

(50) *Subject-verb focus:*



The top sentential sign reflects the appropriate informational structure: (49) is a focus-tail instruction in which both the subject and the verb belong to the focus. However, the two elements do not form a single syntactic constituent in any sense. Both *the butler* and *broke* are associated with an A accent and so are interpreted as foci. In accordance with (39 (i)), their INFO-STRUCTURE|FOCUS values are inherited by their mother nodes.

Example (51) is an adapted version of Steedman’s (1991:283) example (54). Sentence (51) is also parallel to (49) but for one thing: even though the verb is part of the focus, there is no pitch accent on it:

(51) [F FRED ate] the beans.

A sentence of this type is problematic for our approach because, without the association of the verb with an A accent, it is impossible to recover its focal value. However, such strings are only possible when the verb is highly predictable or uninteresting (see Bolinger 1989, Zacharski 1993) (e.g. a version of (49) with an unaccented *broke* is not viable) and even then, as Steedman himself admits (1991:283) the accented version represents an improvement over the unaccented one. In light of these facts, we suggest that in examples like (51) we are witnessing the effects of an independent process of deaccenting (see Section 2.2). This view appears to be in harmony with the phonological evidence (Bob Ladd, personal communication).¹⁴

Note, furthermore, that the representation in (50) shows that FOCUS can take a set of feature structures of sort *con-struc* as value (cf. the use of set-valued features like SLASH in Pollard & Sag 1994).¹⁵ The same point can be made with examples like (11b) in Section 2.2, repeated here as (52), where the focus is made up of two elements that clearly do not form a syntactic constituent:

¹⁴How to express the phenomenon of deaccenting in a declarative framework like HPSG is an important issue that has to be addressed but remains outside the scope of our research.

¹⁵See Manandhar 1994a for an attributive logic for set-valued feature terms.

- (52) Where can I find the cutlery?
 a. The **forks** [_F are in the CUPBOARD]
 b. and I [_F left] the **knives** [_F in the DRAWER.]

Examples like (52) are problematic for an approach like Steedman (1991) where a one-to-one correspondence between information structure and syntactic structure is assumed.

3.2.4 Clitic-dislocation and clitics

We now turn to Catalan, a language in which the informational primitives are signalled by syntactic position rather than by accent type. In Catalan, nuclear stress appears in a fixed position, namely the end of the sentential core. The word order within the sentential core is also fixed to verb-obj-subj (see Vallduví 1993b and references therein). This means that if a subject appears postverbally, it will be associated with nuclear stress and interpreted as being part of the focus, as illustrated in (53):

- (53) Ahir [_F va tornar el PRESIDENT.]
 yesterday 3s-past-return the president
 ‘Yesterday the president returned.’

In fact, every major constituent within the sentential core is interpreted as focal in the same fashion. In (54) the string verb+oblique+subj must be interpreted as focal:

- (54) Ahir [_F va tornar a Barcelona el PRESIDENT.]
 yesterday 3s-past-return to Barcelona the president
 ‘Yesterday the president returned to Barcelona.’

If an argument of the verb is to be interpreted as nonfocal, it must be clitic-dislocated or, equivalently, detached away from the sentential core.¹⁶ As noted in Section 2.2, phrases associated with a LINK interpretation are left-detached whereas phrases associated with TAIL interpretation are right-detached:

- (55) a. A Barcelona₁ [_F hi₁ va tornar el PRESIDENT.]
 b. [_F Hi₁ va tornar el PRESIDENT,] a Barcelona₁.

Remember that dislocated direct and indirect objects, as well as locatives, necessarily cooccur with a clitic in the core clause. There are no subject clitics, but there is overt verb agreement with subjects.¹⁷

We propose a language particular ID schema for Catalan that introduces left- and right-detached phrases as sisters of S (Baltin 1972, Rochemont 1989) and simultaneously determines

¹⁶We use the terms ‘clitic-dislocation’ and ‘detachment’ interchangeably to denote a configuration where a left- or right-sister of S binds a clitic or subject agreement in the clause. Clitic-dislocation differs from English left-dislocation along a number of parameters (Cinque 1990). In particular, the degree of connectivity between the detached phrase and the clause is much higher in the former, making it in some respects closer to English topicalisation.

¹⁷Catalan verbs can sometimes vacuously remain within the sentential core without a focal interpretation. The examples in (53) and (55) are amenable to a reading where the subject is a narrow-focus. This option, however, is not available in (54), because the presence of the oblique complement, which must be interpreted as focal, forces a wide-focus reading. A solution is to treat this informationally inert verbs in the same way in which inert weak pronominals are treated (see Section 2.2). In fact, verbs do act as weak proforms in the constructions illustrated in examples (27) and (28) in Section 2.2.

their INFO-STRUCT|GROUND value as LINK or TAIL, respectively. Because of systematic differences between this kind of detachment on the one hand and question and relative clause formation on the other hand, we have chosen to introduce a separate *Dislocation Schema* rather than subsuming these constructions under the *Head-filler Schema* which is used to account for unbounded dependencies. Reasons for distinguishing the two types are the lack of clitic doubling in questions and relative clauses and less sensitivity to island constraints in detachments (see Cinque 1990, Sanfilippo 1990b).

Pollard & Sag's *Head-Filler Schema* (Schema 6) is given here in (56) (1994:403):

(56) *Head-Filler Schema:*

The DTRS value is an object of sort *head-filler-struct* whose HEAD-DTR|SYNSEM|LOCAL|CATEGORY value satisfies the description [HEAD *verb*[VFORM *finite*], SUBCAT <>], whose HEAD-DTR|SYNSEM|NONLOCAL|INHERITED|SLASH value contains an element token-identical to the FILLER-DTR|SYNSEM|LOCAL value, and whose HEAD-DTR|SYNSEM|NONLOCAL|TO-BIND|SLASH value contains only that element.

This schema, together with the percolation principles for SLASH values, ensures that a FILLER-DTR is matched up with a gap and the CONTENT of the FILLER-DTR is unified with the CONTENT of the gap. The situation in detachment constructions is somewhat different. Here a detached phrase cooccurs with a clitic or agreement marker. The detached phrase provides additional information concerning an argument which is realised as a clitic or constrained by a particular choice of subject agreement. It would seem appropriate to think of the clitic and the detached phrase as co-specifying that argument as any incompatibility between the two will lead to ungrammaticality. Compare the acceptable dislocation sentence in (57a) with the unacceptable one in (57b).

- (57) a. El Pau₁ no el₁ conec.
 the-masc Pau no CL-masc 1s-know
 'Paul I don't know.'
- b. *El Pau₁ no la₁ conec.
 the-masc Pau no CL-fem 1s-know

The schema for clitic-dislocation in Catalan is given in (58).

(58) *Head-Dislocation Schema for Catalan:*

The DTRS value is an object of sort *head-disloc-struct* whose HEAD-DTR|SYNSEM|LOCAL|CATEGORY value satisfies the description [HEAD *verb*[VFORM *finite*], SUBCAT <>] and whose DISLOC-DTRS|CONTEXT|INFO-STRUCT|GROUND value is instantiated and for each DISLOC-DTR, the HEAD-DTR|SYNSEM|LOCAL|CONTENT value contains an element which stands in a *binding* relation to that DISLOC-DTR.

The first clause requires the head-daughter to be a finite sentence. The second clause requires that the informational contribution of dislocated phrases be GROUND. Note that the schema allows for more than one dislocated phrase which is desirable given that there are no ordering restrictions on dislocations. The relation between the dislocated phrase(s) and the sentence is required to satisfy a *binding* relation, in the sense proposed by Dorrepaal *et al.* for nominal anaphora in discourse. The type of binding relation will typically depend on the category of the dislocated phrase. In case of dislocated NPs, the appropriate binding relation might involve coindexation, maybe interpreted as subsumption, between the INDEX of the dislocated

As we noted earlier, in English it is the choice of accent, together with a language-particular principle for focus instantiation, that determines the informational status of a constituent. We have tried to express this fact by simultaneously specifying the ACCENT field and the INFO-STRUCT field in the English signs and by subjecting them to the instantiation principles in (39). In Catalan what determines the information-packaging contribution of a phrase is its syntactic position. Again, we have linked the instantiation of INFO-STRUCT to a grammatical schema, in this case, an ID schema which licenses a particular configuration. We have thus employed analogous strategies in handling the diverse ways in which focus-ground articulation is realised in the two languages.

3.2.5 Dislocated phrases as sentential modifiers

We will briefly mention an alternative approach to the dislocation data which we consider worth exploring further. Sanfilippo 1990a,b proposes an account of clitic dislocation in Italian in the framework of UCG. The core idea is that dislocated phrases are modifiers whose CATEGORY field contain the value MOD S and which may unify with the sentential sign if they are compatible with the semantic information expressed by clitics and/or subject agreement in the sentence. The argument structure of the sentence is recovered through this agreement link. In order to adapt Sanfilippo's account, we need to assume rules which turn a phrase into a modifier of S and instantiates its INFO-STRUCT|GROUND value. In addition we would need to provide a slightly different version of Pollard & Sag's Head-Adjunct Schema (1994:403), given here in (61).

(61) *Head-Adjunct Schema:*

The DTRS value is an object of sort *head-adjunct-struct* whose HEAD-DTR|SYNSEM value is token-identical to its ADJUNCT-DTR|SYNSEM|LOCAL|CATEGORY|HEAD|MOD value . . .

This schema requires that an adjunct daughter's MOD value be token-identical to the head daughter's SYNSEM value. However this is too strong in the case of dislocation structures, as we have seen. Again it appears that a weaker constraint is needed, one that involves binding and coindexation.

4 Additional issues

4.1 On 'multiple foci'

Cases of so-called multiple focus have played a significant role in arguing for the adequacy and superiority of particular approaches to focus (see Rooth 1985, Krifka 1991-92). This section discusses how 'multiple foci', illustrated in (62), are handled in our proposal:

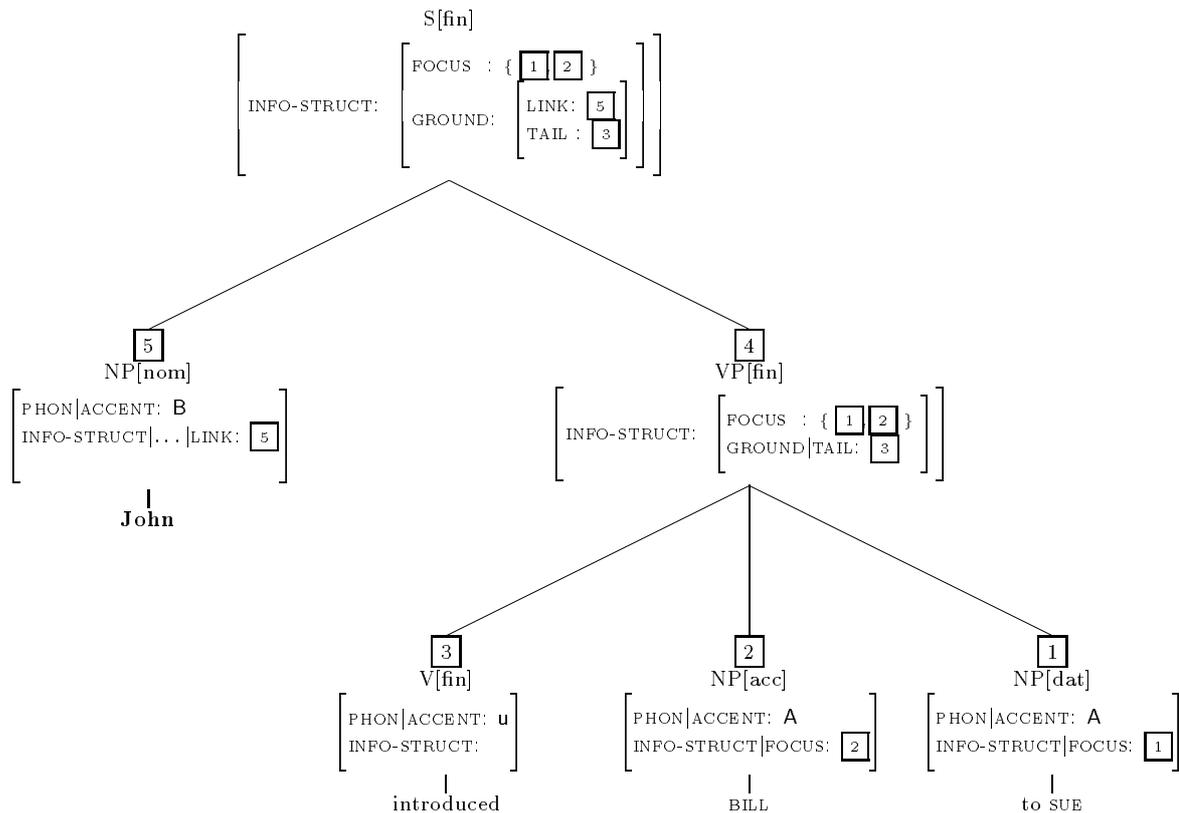
(62) Who did John introduce to whom?
John introduced BILL to SUE.

In the answer in (62) there are two constituents, *Bill* and *Sue* that appear to behave like a foci. They are associated with an accent and instantiate a wh-element in the corresponding question.

We will follow Krifka (1991-92:21) in analysing cases like (62) not as multiple foci but rather as a single complex focus. Sentence (62) has one single ground and one single, albeit complex, focus. Once this step is taken, multiple focus constructions are handled by the

mechanisms introduced in Section 3.2.3 in a straightforward way. We use the same set notation used to represent the value of the INFO-STRUCT|FOCUS feature in sentence (49) (see the tree for this sentence in (50)), where the focus consists of the subject NP and the verb. The structure of (62) is illustrated in (63):

(63) *Complex focus:*



Inheritance of INFO-STRUCT values works according to (39(i)): the mother nodes VP[fin] and S[fin] inherit the INFO-STRUCT values of their daughters. The NP[nom] *John* is the link and its INFO-STRUCT|midGROUND|LINK value is inherited by the mother S[fin]. The FOCUS values of NP[acc] and NP[dat] are inherited by VP[fin]. In (63), as in example (50). The unaccented verb *introduced*, then, instantiates the INFO-STRUCT|GROUND|TAIL value of VP[fin], as in (40) above.

Krifka 1991-92 also allows for 'true' multiple foci in sentences with more than one focus-sensitive operator. Krifka argues that an example like (64) contains two separate foci that act as quantificational nuclei of the two instances of *only*:

(64) Only [_F John] eats only [_F rice.]

The view that (64) contains two foci stems from the belief that the quantificational nucleus of operators like *only* is necessarily a focus in a focus-ground partition. For Krifka 1991-92 and others (e.g. Rooth 1985, Partee 1991) *only* necessarily depends on focus-ground to express its quantificational force, i.e. they 'associate' with focus. Vallduví 1992 (Chapter 7) and Vallduví & Zacharski 1994, however, argue that *only* may associate with elements other than foci (see Section 5). Thus, the fact that these sentences contain more than one quantificational nucleus

does not entail they contain more than one focus. From this perspective, the focus-ground partition of (64) would be as in (65a) or (65b), depending on context:

- (65) a. Both John and Mary are very poor eaters,
but only John eats [_F only rice.]
b. Who, among them, eats only rice?
[_F Only John] eats only rice.

In (65a), for instance, one *only* associates with the link *John* and the other with the focus *rice*.

4.2 Focus-ground articulation and word order domains

The research reported here has, for reasons of time, been limited in linguistic coverage. We have essentially restricted our attention to two types of language and shown how it is possible to give analogous implementations in HPSG of the diverse ways in which focus-ground articulation is realised. Despite the fact that we have emphasised the role that constituent order plays in Catalan in establishing the informational contribution of a phrase, we have not been very explicit about the way linearisation principles should be implemented. The reason for our remaining agnostic is, as mentioned above, that this is currently a hot topic of research in HPSG. One obvious extension of the present work would be to integrate the analysis with Reape's (1991, 1994) flexible approach to constituent ordering in terms of *word order domains*. His proposal was largely motivated by the existence of so-called scrambling phenomena in German, as illustrated in (66). The German verb *versprechen* takes a dative object and an infinitival complement as shown in (66a). However, the object of the infinitival complement, *den Kühlschrank* may also occur scrambled out of its clause as in (66b).

- (66) a. daß ich dem Kunden [den Kühlschrank zu reparieren] versprochen habe.
that I the customer the fridge to repair promised have
'that I promised the customer to repair the fridge.'
b. daß ich den Kühlschrank dem Kunden [zu reparieren] versprochen habe
that I the fridge the customer to repair promised have

Reape provides the mechanisms for deriving alternative word orders but does not attempt to restrict their occurrences. See Manandhar 1994b (this volume) for an initial proposal. We suspect that these are constrained by focus-ground considerations since these play a role in determining German word order more generally. In Uszkoreit's (1987) multi-factorial analysis of German word order, the FOCUS status of a constituent is one of the determining factors.

4.3 How much in CONTEXT?

The approach taken here to enrich the CONTEXT field with an INFO-STRUCT field raises a big question: just how much contextual information should be explicitly represented in a sign? We believe that the interaction between informational status and the phonology or constituent order seen in our examples is evidence that information packaging needs to be included in the grammar. However, when we consider how the integration of information packaging would be implemented in detail, i.e. how the specification of the knowledge states of the speaker and hearer could be carried out, the amount of potentially relevant information

is daunting. Nevertheless, speakers and hearers are very good at immediately extracting the contextually most plausible interpretation of a given utterance, which suggests that the packaging instructions play an important role.

One possible advantage of representing focus-ground articulation explicitly in a sign is that having access to the INFO-STRUCT of a sentence should help extract the intended contribution (the intended update) of a subsequent sentence. This seems particularly true for question-answer pairs, as knowledge of the focus-ground articulation of the question would help filter out implausible focus-ground articulations of the answer. One way that this could be done would be to have both a CONTEXT-IN and a CONTEXT-OUT feature for utterances, although this might prove to be costly in terms of an implementation.¹⁹ Another way might be to develop a dialogue handler that predicts likely utterance type chains using both information packaging notions and domain knowledge. Although this paper has looked primarily at spoken language, this might prove especially important for the processing of written texts. The fact that people do not have noticeable problems with written English, which lacks the prosodic cues for focus-ground identification, suggests that they use top-down expectations, partially generated as a consequence of the successful unpackaging of previous utterances.

4.4 Comparison with other approaches

4.4.1 CCG

Steedman 1991 proposes an integration of information structure into grammar using a Combinatory Categorical Grammar (CCG). CCG and HPSG share the idea that each linguistic unit—signs or categories—contains all phonological, syntactic, and semantic information pertaining to that unit. Steedman 1991, much as we have done here, enriches categories with an intonational dimension which is intimately tied in with information structure. His information structure contains two primitives: RHEME, which corresponds to focus, and THEME, which corresponds to ground. There is no equivalent of the distinction between link and tail. The phenomena of focus inheritance and focus projection are handled through standard combinatory rules that apply on a rich intonational structure, involving not only two types of pitch accent but also different types of boundary tones. In this respect, Steedman’s coverage of the intonational facts of English is wider than the one achieved here.

Steedman, however, assumes complete isomorphy between information structure, intonational structure, and syntactic constituency. His Prosodic Constituent Condition (1991:279) states that two syntactic categories can combine only if their prosodic categories can also combine. Since, from his perspective, prosodic category is inherently tied in with information structure, it is required that, say, the focus of a sentence—which is associated with a particular intonational phrase—correspond to a syntactic constituent. This was noted already in discussing example (49) in Section 3.2.3, where the focus is a subject-verb sequence. In the CCG proposal this subject-verb sequence has to be treated as a syntactic constituent. Our HPSG proposal differs in that no syntactic constituency is required for any informational unit as long as inheritance of INFO-STRUCT values proceeds in the permitted fashion. In fact, we do not require syntactic contiguity either. Given the existence of examples like (45) and (52) where ground and focus, respectively, are made up of discontinuous segments, we consider this a positive feature of the HPSG analysis.

¹⁹This move was suggested at the DYANA-2 meeting in Oslo in April 1994 and independently by S.Manandhar.

The HPSG analysis differs from the CCG analysis in another respect. As noted, in the CCG analysis there is an intimate tie between intonational structure and information structure. Such intimate tie, perhaps well motivated when considering the English facts, is rendered less desirable if we consider the realisation of information structure across languages. For instance, as noted in Section 2.2, linkhood is associated with a B accent in English, an A accent in Finnish, and a left-hand syntactic slot in Catalan, and focushood, while free to associate with any constituent in English, is inherently associated with the core S[fin] sign in Catalan. This variation suggests that a more modular view of the relationship between intonation and information structure is required. This way it is possible to express the combination of focus and ground elements in Catalan independently of the phonological dimension, just as we largely ignored the syntactic dimension of the sign in expressing the realisation of information structure in English.

4.4.2 GB

Vallduví 1992 (Chapter 6) uses a GB-based multiple-level architecture to explore the relationship between information structure and other dimensions of grammar. In (most versions of) GB each sentence is a bundle of abstract levels of representation (although PF, for ‘phonetic form’, is not abstract). Each level of representation structurally represents one of the different linguistic aspects of the sentence. For instance, D-structure is a pure representation of argument or θ -structure and LF is a representation of operator-variable relations.

Which level should information-packaging relations be represented at? Vallduví 1992 proposes that the mapping between information packaging and the structural components through which it is realised be effected through a distinct, pure level of representation called IS (for information structure). This level feeds and bleeds the interpretive information-packaging component and consists of an unambiguous syntactic representation of the instructions discussed in Section 2.1. The motivation for a separate level of representation is the same motivation that led us here to propose a separate INFO-STRUCT in CONTEXT, namely, the syntactic and intonational contrasts stemming from crosslinguistic comparison and issues concerning the relationship of information structure and quantificational structure, some of which are discussed in Section 5. In addition, IS is taken to interface S-structure in parallel with D-structure, LF, and PF by way of principled transformational mechanisms. S-structure is viewed as a ‘contact’ level between abstract fundamental levels of representation (cf. Chomsky 1991:419), where all information must be reflected to allow for the interface with the physical reality of the utterance.

Such a model differs from the HPSG proposal put forth here in a number of respects. For one thing, the GB architecture does not allow for direct interaction between (suprasegmental) phonology and the interpretive components. Thus, in accounting for the English facts, we cannot bypass syntactic realisation in the way we did in Section 3. For instance, in the analysis above, the presence of ACCENT:B in a feature structure makes this feature structure the value of INFO-STRUCT|GROUND|LINK. It does not matter where the B-accented constituent is in the sentential structure. However, in Vallduví’s (1992) proposal, linkhood has to necessarily be associated with a structural position, since there is no room for prosodic information at IS. The solution is to propose that at IS all links appear in the same structural position (i.e., those B-accented items that appear elsewhere in the clause move to that position in the mapping from S-structure to IS) and that it is this particular structural position which, at IS, is inherently associated with a link interpretation. Of course, the choice of structural position

is not completely arbitrary: a left-hand IP-adjunction (or S-adjunction) slot. Indeed, English links may optionally appear in such a slot and Catalan links *must* appear in such a slot. But the fact that in English accent seems to be the crucial determinant of linkhood plays only a secondary role in such a model.

Analogous observations can be made with respect to tails and focus. The structural ambiguities that arise in contexts where both focus inheritance and focus projection are possible are confined to PF and S-structure. At IS all ground elements must move to designated slots outside the sentential core. For instance, examples (40) and (41) in Section 3, repeated here as (67a) and (68a), would not be ambiguous at IS. At IS, the tail *hates* in (67a) moves to a tail position. In (68a), in contrast, no such movement takes place:

- (67) a. SS: [IP the **president** hates [F the delft CHINA SET.]]
 b. IS: [IP The president₁ [IP [IP=F t₁ t₂ the delft china set] hates₂.]]
- (68) a. SS: [IP the **president** [F hates the delft CHINA SET.]]
 b. IS: [IP the president₁ [IP=F t₁ hates the delft china set.]]

A standard way of dealing with crosslinguistic variation in GB is to assume that differences are located in the overt part of grammar and that at the abstract levels of representations all languages look, modulo a few parameters of variation, the same. The IS configurations in (67b) and (68b) look conspicuously like Catalan S-structure configurations (cf. examples (21) and (22) in Section 2.2). English differs from Catalan in that the former carries out in abstract syntax the syntactic operations that the latter carries out overtly.²⁰

5 Information structure and CONTENT

In the analysis presented in Section 3 information structure is represented in the CONTEXT field rather than the CONTENT field. In effect, this means that information structure is viewed, in principle, as independent of the truth-conditional dimension of meaning. This view of informational structure as essentially a communicative dimension is not universally shared. There have been several recent attempts to fold informational notions into the logico-semantic component (see references in Section 1).

While it is true that the information structure of sentences interacts with a number of quantificational elements in an interesting way, we believe that such interaction must be represented in the grammar in a modular way. The separate representation of INFO-STRUCT and CONTENT is intended to capture this belief. Of course, taking this approach means that, at some point, we must undertake the task of describing how the interaction between information structure and the logico-semantic content is effected. The issue is currently under investigation and not much will be said about the specifics of the analysis here. Instead, this section discusses the empirical motivation for an architecture where information structure and logico-semantic content are represented in a modular way.

A number of recent papers have analysed the focus-ground partition as a determinant of quantificational partition, where the focus identifies the nucleus (nuclear scope) of an

²⁰Some versions of GB make use of feature-annotated syntactic nodes. In these, the structural manifestation of linkhood need not be configurational. Rather, any constituent with a [+link] feature can be associated with linkhood independent of structural position. Most GB analyses of focus projection use some sort of feature notation to handle the phenomenon. The feature-based approaches are closer to the HPSG proposal defended here.

operator and the ground identifies its restrictor (Partee 1991, Krifka 1992). The stimulus for such an approach is the behaviour of so-called focus-sensitive operators (e.g. *even*, *only*, quantificational adverbs, negation, modals). Jackendoff (1972:248), among others, notices that sentences (69a-c) cease to be equivalent in propositional content in the presence of these focus-sensitive operators (70):

- (69) a. What did John do?
 John [_F gave his daughter a new BICYCLE].
 b. What did John give his daughter?
 John gave his daughter [_F a new BICYCLE].
 c. Who did John give a new bicycle?
 John gave [_F his DAUGHTER] a new bicycle.
- (70) a. John even [_F gave his daughter a new BICYCLE].
 b. John even gave his daughter [_F a new BICYCLE].
 c. John even gave [_F his DAUGHTER] a new bicycle.

The VP-external adverb *even* in (70a-c) is interpreted as being construed with, i.e. as associating with, the constituents enclosed in brackets. Having identified the bracketed constituents as foci, Jackendoff concludes that *even* associates with focus. Thus, configurations where the nucleus of an operator coincides with the focus of the sentence have been called instances of ‘association with focus’.

From the aforementioned recent semantic perspective, the primary function of focus-ground is to provide a quantificational structure for these focus-sensitive operators. The communicative use of focus-ground is merely one of the uses this quantificational structure serves (assuming there is a covert focus-sensitive communicative operator akin to ASSERT in Jacobs 1984). Given this view of focus-ground it is actually imperative that focus-sensitive operators take focus-ground partitions as arguments, since they crucially depend on the structure provided by focus-ground to express their meaning. This type of analysis makes two predictions. First, it predicts that the quantificational structure of a focus-sensitive operator is *always* homomorphic to the focus-ground articulation of the sentence, and, second, it predicts that simplex sentences with more than one focus-sensitive operator contain multiple focus-ground partitions (overlapping or recursive), something which is at odds with the traditional view of focus-ground.

The first prediction is not met. On the one hand, it is well known that some operators, e.g. negation, display optional association with focus. Thus, example (71c), with a focal *because*-phrase, can be an answer to both (71a) and (71b). In the association-with-focus reading something the utterer of (71c) admits to having done something while negating that the querier was the reason for her doing it. In the reading where negation does *not* associate with focus—it remains in the ground—the utterer of (71c) simply provides a reason for why she did not do whatever she did:

- (71) a. Why did you do it?
 b. Why didn't you do it?
 c. I didn't do it [_F because of YOU].

On the other hand, there are clear mismatches of quantificational partition and focus-ground even with strongly focus-sensitive operators. Example (72), where the verb phrase is focal, is a case in point involving the quantificational adverb *often*:

(72) Scandinavians often [_F win the Nobel PRIZE.]

In (72) the focus should provide the quantificational nucleus and the ground should provide the restrictor. If this were so, (72) would mean that, given those situations/times in which Scandinavians do something (among a relevant set of alternatives), this something is often winning the Nobel prize. While this is a marginally possible reading in some contexts, it is not the most accessible reading of (72). Rather, what (72) means is that given those situations/times in which someone wins the Nobel prize, it is often Scandinavians that win it. The quantificational nucleus is provided by *Scandinavians*, a ground element, and the restrictor is provided by the informational focus. Similar observations can be made about Westerståhl's (1985:403) original example, which does not involve adverbial quantification but rather determiner quantification:

(73) Many Scandinavians [_F have won the Nobel prize in LITERATURE.]

The meaning of (73) is that, out of all the people who have won the Nobel prize in literature, many are Scandinavians, precisely the reading where the focus acts as restrictor. If the focus were the nucleus, the meaning of (73) would have been that, out of all Scandinavians, many are Nobel prize winners, something which is blatantly false. This behaviour, quite unexpected from the perspective that focus-ground equates quantificational partition, is perfectly legitimate from a perspective where information packaging and logico-semantic content may constrain each other as separate dimensions.

It is harder to check the validity of the second prediction—that every quantificational nucleus is a focus and, thus, that simplex sentences may have multiple focus-ground articulations—because of disagreement on what exactly should count as focus or ground. Some analysts take accentedness to be a necessary and sufficient condition to identify a focus. Others judge it to be a sufficient condition but not a necessary one: it is argued that, even though simplex sentences with more than one focus-sensitive operator contain more than one focus, one of the foci may remain unaccented. The end result is that, on some occasions, we identify a constituent as focal uniquely on the basis of it being in association with a focus-sensitive operator.

The issue is discussed in Vallduví & Zacharski 1994, where the relationships between informational focus, quantificational nucleus, and intonational focus (pitch accent) are explored in detail. They show that quantificational nuclei can be informational foci, informational links, or even unaccented constituents within a larger focus. In addition, it is known that the focus-sensitive operators themselves may be focal or may be ground (Koktová 1987). The conclusion Vallduví & Zacharski 1994 arrive at is that quantificational partition is independent of focus-ground and that, therefore, the presence of more than one so-called focus-sensitive operator in a simplex sentence does not entail the presence of more than one focus-ground articulation. It is true that quantificational partition and the focus-ground articulation are very often isomorphic, but unless their independence is maintained, the numerous examples where there is a mismatch between the two dimensions remain unaccounted for.

As we saw, in examples (72) and (73) the quantificational partition of the sentence is not provided by the focus-ground partition. Rather, the information about what should go into the restrictor and what should go into the nucleus comes from the more general context of utterance, probably knowledge about the world (e.g. about the Nobel prize competition, about the number of Scandinavians out there). The need to appeal to more general background knowledge is not restricted to this type of sentences, though. Take, for instance, an example like (74), based on a similar example in Schubert & Pelletier (1989:215):

(74) John always hits the target.

In (74) the quantification is restricted to events in which John is shooting, although there is no overt expression of this restriction in the sentence. Clearly, the restriction to events of this type, the *reference ensemble* in Schubert & Pelletier's terms, must be made available by previous context or by world knowledge. In all these examples we need to resort to a source other than focus-ground for the quantificational partition of the sentence.

The issue is whether this same source—whatever it is exactly—is what determines quantificational partition even in cases in which this partition is isomorphic with focus-ground. In other words, are cases in which the ground is the restrictor just a subset of the cases in which the restrictor is made available from context? If this is so, then the grammar should not require the identity of ground and restrictor, but rather support the generalisation that grounds possess the necessity attributes to be premium sources of quantificational restriction.

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