

In defense of an HPSG-based theory of non-constituent coordination: A reply to Kubota and Levine

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1 Introduction

Kubota and Levine (2015) argue that the HPSG-based theories of non-constituent coordination proposed in Yatabe (2001), Beavers and Sag (2004), and later works compare unfavorably with a theory that can be formulated using a version of Categorical Grammar (CG) that they call Hybrid Type-Logical Categorical Grammar. At the heart of their criticism of the HPSG-based theories is the long-known fact that sentences involving non-constituent coordination can mean something different from what is meant by the supposedly corresponding sentences involving only constituent coordination, as shown by the examples below.

- (1) a. Terry gave no man a book on Friday or a record on Saturday.
b. Terry gave no man a book on Friday or gave no man a record on Saturday.
- (2) a. I said different things to Robin on Thursday and Leslie on Friday.
b. I said different things to Robin on Thursday and said different things to Leslie on Friday.

According to Kubota and Levine, the above-mentioned HPSG-based theories claim that sentences like (1a) and (2a) are generated by applying prosodic ellipsis to sentences like (1b) and (2b) respectively, and as a result, the theories are unable to capture the semantic contrast between (1a) and (1b) and between (2a) and (2b) without recourse to some ad-hoc mechanism.

In this response to Kubota and Levine (2015), we will first show, in section 2, that these authors' characterization of the HPSG-based theories is inaccurate and that the HPSG-based theory proposed in Yatabe (2001) and modified in Yatabe (2012) does not have the problems that Kubota and Levine claim it does. We will then argue, in section 3, that there are in fact empirical reasons to prefer this HPSG-based theory over the CG-based theories like Kubota and Levine's.

2 A synopsis of an HPSG-based theory of non-constituent coordination

Kubota and Levine say the following about the HPSG-based theories of non-constituent coordination.

In this approach (Yatabe 2001; Crysmann 2003; Beavers and Sag 2004; Chaves 2007), advocated by several authors in the recent HPSG literature utilizing the so-called linearization-based architecture of HPSG, examples like those in (1) receive analyses roughly along the following lines:

- (2) a. [_S I gave Robin a book] and [_S (~~I~~)gave Terry a pair of pliers].
- b. [_S I gave Robin a ~~pair of pliers~~] and [_S Leslie offered Terry, a pair of pliers].
- c. [_S Leslie bought a CD], and [_S Robin ~~bought~~ a book].

The key claim, which is effectively the same as the old idea of CONJUNCTION REDUCTION (Gleitman 1965; Jackendoff 1971) from the transformational literature, is that the apparent non-constituent coordination in these examples is in fact only apparent, and that these examples all involve full-fledged coordination in the ‘underlying’ combinatoric structure feeding into semantic interpretation. The surface form of the sentence is obtained by ellipsis of the relevant part of the sentence via identity in form to some string in the other conjunct. (p. 522)

This is arguably an accurate characterization of what is proposed in Beavers and Sag (2004), except that the sentence cited as (2c) here is an instance of Gapping, a phenomenon that is generally distinguished from non-constituent coordination in the HPSG literature.

However, the passage above is demonstrably inaccurate as a description of the theory proposed in Yatabe (2001), the first document cited in it. On the first page of that document, it is stated that “In the theory proposed, it is claimed that semantic composition (including ‘quantifier retrieval’) takes place not when some signs are syntactically combined to produce a new, larger sign but when some domain objects (which are essentially prosodic constituents) are merged (by the total or partial compaction operation) to produce a new domain object (i.e. a new, larger prosodic constituent).” In other words, the structure that feeds into semantic interpretation in this theory is not the ‘underlying’, i.e. pre-ellipsis, syntactic structure but rather the surface, i.e. post-ellipsis, prosodic structure.

In this section, we will explain exactly how the theory in question computes the meaning of a sentence on the basis of its surface prosodic structure, as opposed to its syntactic structure. What is presented below is largely a recapitulation of what is proposed in Yatabe (2001) and Yatabe (2012), but fills in some details that are left unspecified there. We will presuppose familiarity with the basics of the textbook version of HPSG (see Sag *et al.* (2003)) but nothing more.

2.1 Linearization-based HPSG

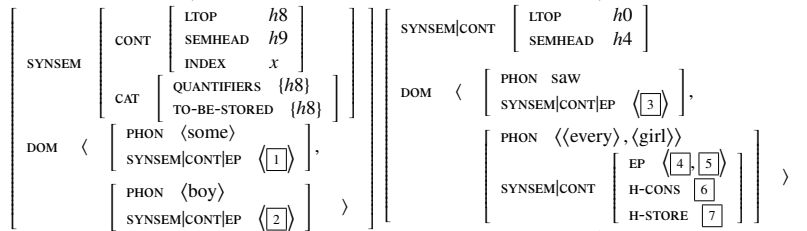
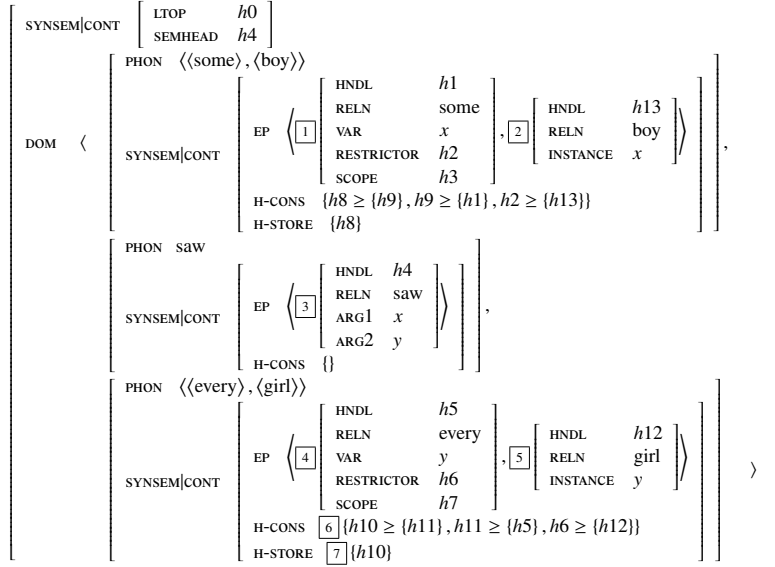
The syntactic framework that we use to develop our theory is Linearization-based HPSG, the version of HPSG proposed in works such as Reape (1994) and Kathol and Pollard (1995). In this framework, each node in a syntactic phrase-structure tree is associated with a list of prosodic constituents that the words dominated by that

node are assembled into. We will illustrate how this works using Figure 1, which depicts part of the structure that is assigned to the sentence *Some boy saw every girl*. Linearization-based HPSG is, just like the textbook version of HPSG, a constraint-based formalism in which each grammatical rule or principle is employed not to build a phrase-structure tree from the bottom up but rather to determine whether a given, fully formed representation is admissible or not, but throughout this article, we will talk as if a phrase-structure tree were constructed from the bottom up when that way of talking makes the presentation easier to follow.

In the syntactic phrase-structure tree shown in Figure 1, a determiner *every* and a noun *girl* combine to form a DP, which combines with a transitive verb *saw* to become a VP, which then combines with a subject DP *some boy* (whose internal structure is suppressed in this figure) to become a sentence. The sign at each node in the representation is associated with the *SYNSEM* feature and the *DOM* feature. The value of the *SYNSEM* feature is a feature structure that is equipped with the *CATEGORY* feature, which is called *SYNTAX* in Sag *et al.* (2003) and is abbreviated here as *CAT*, and the *CONTENT* feature, which is called *SEMANTICS* in Sag *et al.* (2003) and is abbreviated as *CONT* here. The value of the *DOM* feature is an order domain, which is a list of domain objects, each of which has the *PHON* feature and the *SYNSEM* feature. Each domain object represents a prosodic constituent, whereas each sign represents a syntactic constituent. Departing from the usual assumption adopted in Linearization-based HPSG, we will assume in the present article that morphosyntactic constituency is represented not by an unordered tree but by a tree, and that the order of domain objects in an order domain largely reflects the order of the signs that have given rise to those domain objects. (More specifically, we assume that the order of domain objects is subject to the set of constraints stated in Appendix A.)

We say that a sign has been *totally compacted* when the sign, whose order domain may contain one or more domain objects, is turned into a single domain object. The domain object that has resulted from totally compacting a sign is placed in the order domain of the mother of that sign. In Figure 1, the subject NP node is totally compacted and the resulting domain object, to be pronounced “some boy,” is placed in the order domain of the top node. The object NP node and its daughter nodes are likewise totally compacted. So are the daughter nodes of the subject NP, although they are shown only in an abbreviated form in the figure. A precise definition of total compaction will be given in Figure 5 below.

We say that a sign has been *partially compacted* when (i) zero or more domain objects are excised from its order domain and (ii) the sign thus altered is totally compacted. Note that, by definition, total compaction is a type of partial compaction. When a sign is partially compacted, the domain objects that were excised from its order domain (if any) are inherited by the order domain of the mother of that sign, and the domain object that is newly created by total compaction is also placed in the order domain of the mother. We will say that those domain objects that were excised from the order domain of a sign and inherited by the order domain of the mother of that sign have *escaped compaction*, and we will say that the domain objects that were not excised and thus were part of the sign that was totally compacted (in stage (ii) of partial compaction) have *undergone compaction*. The tree shown in Figure 1 contains no node that is compacted partially but not totally. We assume that, when a sign is partially compacted in a head-initial language like English, the leftmost domain object in the order domain of that sign must stay in it and undergo total compaction as part of that sign. In the original definition of partial compaction presented in Kathol and Pollard (1995), it is assumed that only domain objects corresponding to extraposable types of expressions (such as domain objects corresponding to relative clauses in



some boy

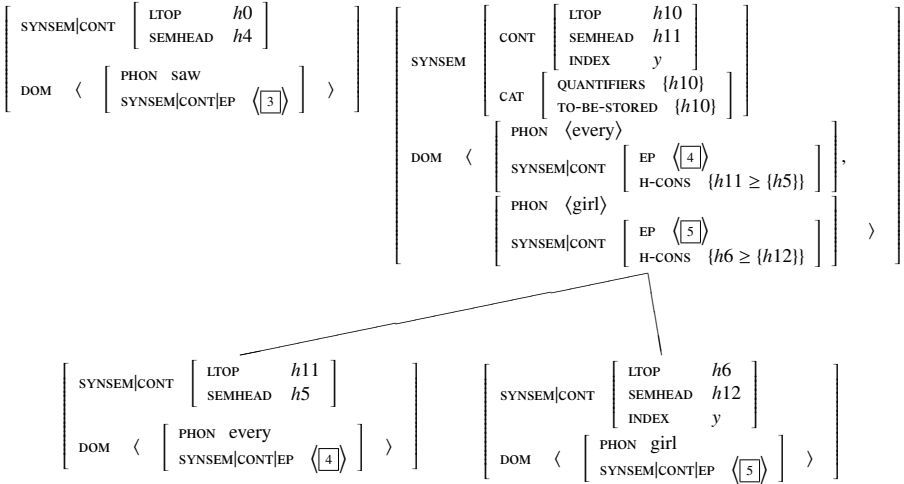


Figure 1: Part of the structure assigned to the sentence *Some boy saw every girl*

English) can escape compaction, but here we drop that restriction and assume that any domain object can escape compaction as long as it is not the leftmost element of an order domain.

And we say that a sign has been *liberated* when it is not compacted even partially. When a sign is liberated, the domain objects in its order domain are all inherited by the order domain of the mother of that sign. The VP node is liberated in Figure 1. The two domain objects in the order domain of the VP, namely the one to be pronounced “saw” and the other one “every girl”, are both inherited by the order domain of the top node.

What happens to each sign must conform to the following set of constraints.

- (3) a. In a head-complement structure whose head is not nominal and in a head-subject structure, the head is liberated and the non-head is partially compacted.
- b. In a head-adjunct structure whose head is not nominal, the head and the adjunct are both partially compacted.
- c. In a headed structure whose head is nominal (i.e. an N, a D, or a projection thereof) and whose non-head is not a marker, the head is totally compacted and the non-head is partially compacted.
- d. In a head-marker structure, the head and the marker are both liberated.
- e. In a coordinate structure, each conjunct is partially compacted.

We assume that a phrase like *some boy* is headed by the determiner, so the signs *boy* and *girl* in Figure 1 are both only required to be partially compacted, although in this case they both happen to be totally compacted.

2.2 Compaction-driven meaning assembly

Now we turn to the issue of semantic composition. We make essential use of a modified version of Minimal Recursion Semantics (MRS), a theory of semantic composition proposed in Copestake *et al.* (2005), so we need to present the basics of MRS first.

MRS is one of the several mutually related semantic formalisms in which semantic representations are allowed to be underspecified so that they can stand for more than one reading of a sentence simultaneously. In MRS, the meaning of a word is expressed by what is called an elementary predication, which consists of a predicate and its arguments, and the meaning of a phrase is expressed by a sequence of elementary predications. Each elementary predication in such a sequence is given a handle, which indicates precisely how that elementary predication is to fit into the overall semantic representation. Let us take the following sequence of five elementary predications as an example.

- $$(4) \quad \langle \begin{array}{l} h0 : \text{every}(x, h1, h2), \\ h1 : \text{smart}(x), \\ h1 : \text{student}(x), \\ h3 : \text{probably}(h4), \\ h5 : \text{agrees}(x) \end{array} \rangle$$

These five elementary predications, each prefaced with its handle, represent the meaning of the words *every*, *smart*, *student*, *probably*, and *agrees* respectively, and the sequence as a whole is supposed to represent the two possible meanings of the sentence *Every smart student probably agrees*, one in which *every smart student* outscopes

probably and another in which the universal quantifier is outscoped by the adverb. The three arguments of the predicate *every* are the variable that the quantifier binds, the restriction of the quantifier, and the (nuclear) scope of the quantifier, respectively.

In an MRS representation, elementary predications that are prefaced by the same handle are interpreted as being conjoined with each other. Thus, the second and the third elementary predication in this example, which both have the handle *h1*, are interpreted as conjoined with each other.

The capacity of an MRS representation to serve as an underspecified representation that can stand for more than one semantic interpretation comes from the fact that handles that are given different names (such as *h5* and *h9*) may or may not denote the same handle. The representation in (4) becomes (5) if $h2 = h3$ and $h4 = h5$, and becomes (6) if $h4 = h0$ and $h2 = h5$.

- (5) \langle *h0* : every(*x*, *h1*, *h2*),
h1 : smart(*x*),
h1 : student(*x*),
h2 : probably(*h4*),
h4 : agrees(*x*) \rangle
- (6) \langle *h4* : every(*x*, *h1*, *h2*),
h1 : smart(*x*),
h1 : student(*x*),
h3 : probably(*h4*),
h2 : agrees(*x*) \rangle

The representation in (5), in which *h0* is the top handle, i.e. the outermost handle, can be rewritten as (7), and (6), in which *h3* is the top handle, can be rewritten as (8). The former is the reading in which the universal quantifier takes wide scope over the adverbial and the latter is the reading in which the adverbial takes scope over the universal quantifier.

- (7) every(*x*, smart(*x*) \wedge student(*x*), probably(agrees(*x*)))
(8) probably(every(*x*, smart(*x*) \wedge student(*x*), agrees(*x*)))

These two are the only meanings that correspond to the underspecified representation in (4) because it is assumed (i) that every handle argument (i.e. every argument slot whose name starts with *h*) must be equated with the handle of some other elementary predication and (ii) that the handle of an elementary predication cannot be equated with more than one handle argument. The second assumption, which requires that elementary predications in an MRS representation should form a tree, prevents *h5* from being equated with *h1* and with *h2* at the same time, for example.

MRS representations are integrated into the HPSG framework as the values of the CONTENT feature. Both a sign and a domain object (contained in the DOM value of a sign) have the SYNSEM feature, whose value is a feature structure with the feature CONTENT. Since what is referred to as a sign here is always a node in a syntactic phrase-structure tree, we will sometimes use the words *sign* and *node* interchangeably below. The value of the CONTENT feature is a feature structure with the following features: LTOP, SEMHEAD, INDEX, KEY, H-STORE, H-CONS, and EP. The LTOP value of a sign or domain object is the local top handle of that sign or domain object. The SEMHEAD value of a node is, intuitively, the handle that will become the local top handle of that node if no quantifier is retrieved from the quantifier store and takes scope at that node; the LTOP value and the SEMHEAD value of a node diverge from each other only when one or more quantifiers are retrieved and take scope at that node. The INDEX value is used in the

grammar the same way that it is used in the standard version of HPSG. The `KEY` value of a phrase, which is determined according to the rules in (9), shows the meaning of the head of that phrase.

- (9) a. The `KEY` value of a word is identical to its `EP` value.
- b. The `KEY` value of a headed phrase is identical to the `KEY` value of the head daughter.
- c. The `KEY` value of a coordinate structure is the list obtained by concatenating the `KEY` values of the conjuncts.

The `H-STORE` value of a domain object is a set that consists of the handles of those quantifiers that are contained in that domain object and that are yet to be retrieved from the quantifier store. The `H-CONS` value of a domain object is a set of constraints that are imposed on the relationship between the handles mentioned in the `EP` value of that domain object. And the `EP` value of a domain object is a list of elementary predications that represents the meaning of that domain object. As noted in Yatabe (2001), this version of MRS, which is closer to the unpublished 1997 version than it is to the version presented in Copetake *et al.* (2005), makes it easy to capture the fact that some phrases function as scope islands.

The `LTOP` value and the `SEMHEAD` value of a sign are used to maintain the relationship between the `HNDL` values of elementary predications, i.e. their handles, and they are subject to the following set of constraints.¹

- (10) a. The `LTOP` value and the `SEMHEAD` value of a headed structure whose head is liberated are identical to the `LTOP` value and the `SEMHEAD` value of the head respectively.
- b. The `SEMHEAD` value of a head-complement structure whose head is totally or partially compacted is identical to the `LTOP` value of the head.
- c. In a head-adjunct structure such that the `KEY` value of the non-head daughter contains a scopal elementary predication (i.e. an elementary predication that takes a handle as an argument), the `SEMHEAD` value of the mother is identical to the `LTOP` value of the non-head daughter.
- d. In a head-adjunct structure such that the `KEY` value of the non-head daughter does not contain a scopal elementary predication, the `SEMHEAD` value of the mother, the `LTOP` value of the non-head daughter, and the `LTOP` value of the head are identical to each other.
- e. The `SEMHEAD` value of a coordinate structure is identical to the `HNDL` value of the elementary predication that is constructionally introduced by that coordinate structure (i.e. the elementary predication whose `RELN` value is something like *or*).

Figures 2, 3, and 4 show part of the lexical entries that we are assuming for the words *saw*, *every*, and *girl*, respectively. Notice that, in each lexical entry, the `SEMHEAD` value of the sign is identified with the `HNDL` value of an elementary predication contained in the `EP` value of a domain object. The `SEMHEAD` value of a leaf node is thus always linked to the `HNDL` value of some elementary predication.

Domain objects rather than signs are the principal carriers of semantic information in this theory. Thus, the `EP` value, the `H-CONS` value, and the `H-STORE` value of a sign (i.e. a node in a syntactic phrase-structure tree) are always an empty list, an empty set, and

¹The theory described in Yatabe (2001) did not have a mechanism for interpreting intersective modifiers, a task that is achieved here by (10d).

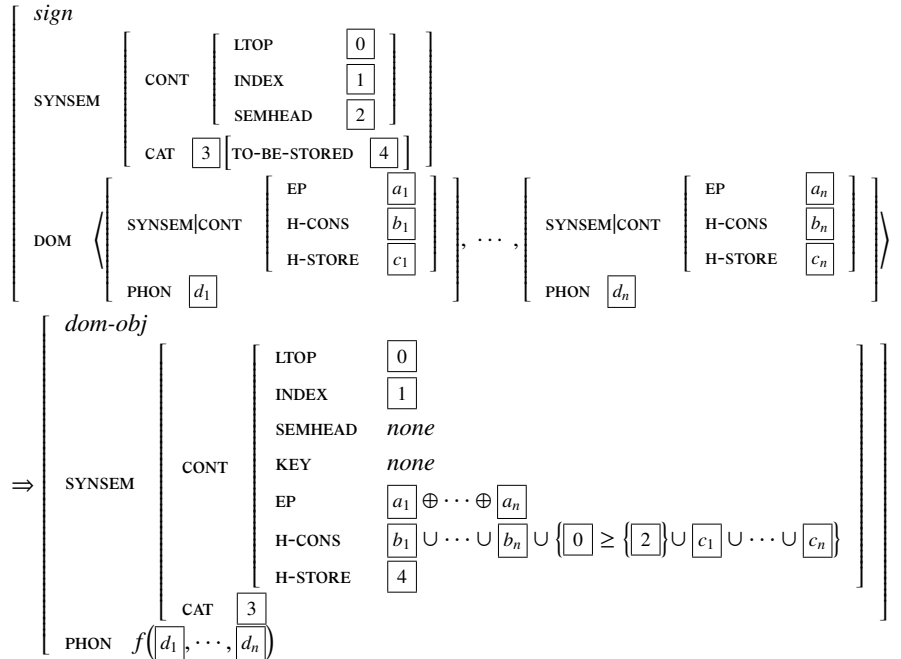


Figure 5: Definition of total compaction

an empty set, respectively. The meaning of a larger prosodic constituent (i.e. a larger domain object) is computed by amalgamating the meaning of the smaller prosodic constituents that make it up (i.e. the smaller domain objects contained in the order domain of the sign whose compaction gave rise to the larger domain object). For instance, in Figure 1, the meaning of the first domain object in the order domain of the top node (i.e. the EP value and the H-CONS value of the domain object which is to be pronounced “some boy”) was computed by amalgamating the meaning of the two domain objects contained in the order domain of the subject NP node, i.e. its first domain object, which is to be pronounced “some”, and its second domain object, which is to be pronounced “boy”. This way of performing semantic composition, which we call compaction-driven meaning assembly, is achieved by the total compaction operation as it is defined in Figure 5.² What this figure means is that, when a sign that has the form specified in the first line is totally compacted, the domain object that is produced as a result must have the form specified in the second line. The symbol \oplus used here represents list concatenation. Each time a sign is compacted according to this definition, a new domain object is created whose CONTENT value is the result of putting together the CONTENT value of each domain object in the order domain of that sign.

When a sign is compacted, the H-CONS value of the newly created domain object contains (i) all the handle constraints that were in the H-CONS sets of the domain objects in the order domain of that sign and (ii) a new handle constraint of the form $h_0 \geq A$,

²The definition of total compaction given here differs from that given in (24) of Yatabe (2001) in several respects. First, the definition used here constrains the SEMHEAD value and the KEY value of the newly created domain object, while the old definition did not. Second, the specification of the H-CONS value of the newly created domain object now utilizes only the canonical kind of set union, without requiring the disjointness of the members of the sets that are put together. And third, the semantics of a handle constraint has been altered, as will be explained in the text shortly. While the first two modifications do not have empirical consequences, the third modification does; quantifier lowering is allowed by this new definition whereas it was not in the old definition.

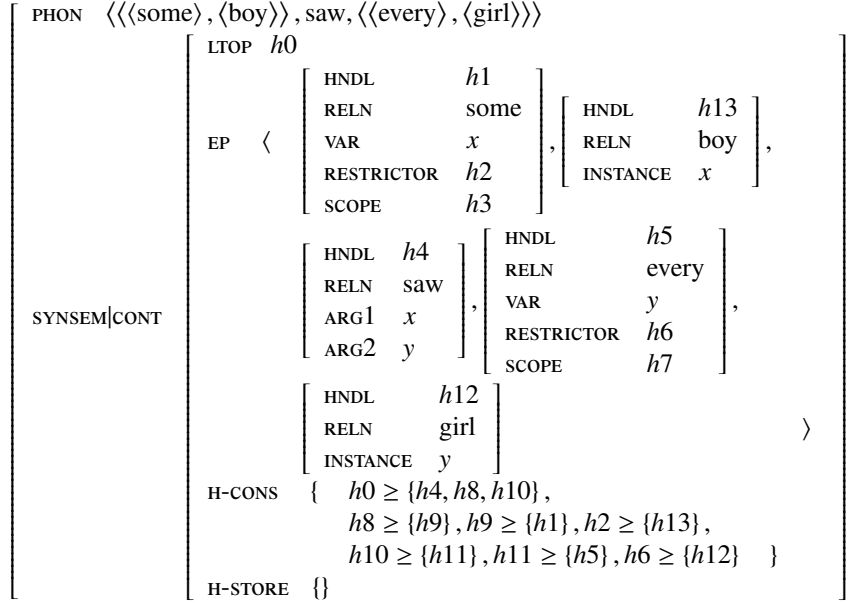


Figure 6: The result of totally compacting the top node of the tree shown in Figure 1

where h_0 is the LTOP value of the compacted sign and A is the set consisting of the SEMHEAD value of the compacted sign and the handles contained in the H-STORE sets of the domain objects in the order domain of that sign. A handle constraint of the form $h_0 \geq A$ is satisfied if and only if, for each h_i in A , either h_0 is identical to h_i or h_0 outscopes h_i . (This semantics of handle constraints is slightly different from what is proposed in Yatabe (2001) and is similar to one of the possibilities considered in Copestake *et al.* (2005).)

What total compaction does with the H-CONS values enables the present theory to capture the apparent fact that certain syntactic configurations (such as conjuncts in Japanese (see Yatabe (2007))) can act as scope islands. The handle constraint that is created by the compaction operation and added to the H-CONS set of a newly formed domain object states that the local top handle of the compacted sign must either be identical to or outscope all the handles contained in the H-STORE values of the domain objects that underwent compaction. This means that, every time a sign is totally compacted, the quantifiers whose handles were in the H-STORE set of a domain object in the order domain of that sign are all required to take scope within that sign.

The function f in the definition of total compaction is a function that constructs an appropriate prosodic structure out of smaller prosodic constituents. For the sake of concreteness, we assume the following, which is in fact adequate in most cases.

$$(11) \quad f(\boxed{d_1}, \dots, \boxed{d_n}) = \langle \boxed{d_1}, \dots, \boxed{d_n} \rangle$$

Intuitively, the value of the TO-BE-STORED feature on a node is the set consisting of the handles representing the quantifiers that are to be put in the quantifier storage through compaction at that node. The way the value of this feature is constrained is presented in Appendix B.

The semantic content of a sentence as a whole is obtained by first totally compacting the top node of the syntactic representation and then resolving the values of the handles in the EP value in conformity with all the grammatical constraints including

the handle constraints that have been collected in the \mathbb{H} -CONS set. Figure 6 shows the domain object that results when the top node in Figure 1 is totally compacted. Its LTOP value indicates that $h0$ is the top handle. The handle constraints in the \mathbb{H} -CONS set, taken together, require, among other things, that $h0 \geq h4$, $h0 \geq h8 \geq h9 \geq h1$, and $h0 \geq h10 \geq h11 \geq h5$, where we use the notation of the form $A \geq B$ to mean that A either outscopes or is identical to B . Since the elementary predication labeled by $h4$ contains variables that must be bound by the quantifiers labeled by $h1$ and $h5$, $h4$ needs to be outscoped by $h1$ and $h5$, and thus cannot be identical to $h0$. On the other hand, $h1$ and $h5$ can be identical to $h0$; in fact, $h0$ *must* be identical either to $h1$ or to $h5$, since there is no other handle that could come between $h0$ and $h1$ and between $h0$ and $h5$. If $h0$ is taken to be identical to $h1$, then $h3$ must be taken to be identical to $h5$, yielding the reading in which the subject takes scope over the object; if $h3$ is not taken to be equal to $h5$, then there is no way to obtain a resolved semantic representation in which every handle argument has been equated with the label of some elementary predication. If, on the other hand, $h0$ is taken to be identical to $h5$, then $h7$ must be taken to be identical to $h1$, yielding the reading in which the object takes scope over the subject. The handle $h4$ is identified with $h7$ in the former case and with $h3$ in the latter case. In both cases, $h2$ must be equal to $h13$ and $h6$ must be equal to $h12$. Thus, the only meanings represented by the CONT value of the domain object in Figure 6 are the ones shown in the conventional notation in (12).

- (12) a. $\text{some}(x, \text{boy}(x), \text{every}(y, \text{girl}(y), \text{saw}(x, y)))$
 b. $\text{every}(y, \text{girl}(y), \text{some}(x, \text{boy}(x), \text{saw}(x, y)))$

2.3 Non-constituent coordination in the HPSG-based theory

The theory of non-constituent coordination presented in Yatabe (2001) and modified in later works such as Yatabe (2012) posits that there are two types of right-node raising (RNR) and two types of left-node raising (LNR): a phonological kind of RNR and LNR that is merely prosodic ellipsis and a syntactic kind of RNR and LNR that involves merging of multiple domain objects that has the potential of affecting semantic interpretation. We will illustrate the way this theory works using the example in (13). Figure 7 shows the structure assigned to this sentence when the verb *drove* is assumed to have been syntactically left-node-raised and the preposition *to* is assumed to have been phonologically left-node-raised. Coordinators like *and* are assumed to be introduced into the syntactic structure by a linearization-related mechanism, and does not appear as a node in the syntactic phrase-structure tree (see Yatabe (2012)).

- (13) John drove to Chicago in the morning and Detroit in the afternoon.
 (from Dowty (1988))

Syntactic LNR (or RNR) extracts a list of domain objects at the left (or right, respectively) edge of each daughter, fuses those domain objects item by item to create a possibly modified list of domain objects, and places the resulting list of domain objects at the left (or right, respectively) edge of the order domain of the mother. In Figure 7, a domain object corresponding to the verb *drove* is extracted from the left edge of the order domain of the first daughter and from the left edge of the order domain of the second daughter. Those two domain objects are then fused with each other to create a new domain object, and that new domain object, which is to be pronounced “drove” like the two domain objects that have given rise to it, is placed at the left edge of the order domain of the mother. Syntactically LNRred or RNRred

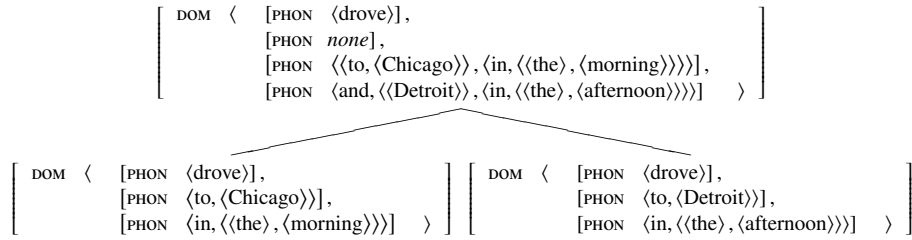


Figure 7: Part of the structure assigned to example (13)

domain objects continue to exist as separate domain objects in the order domain of the mother, rather than becoming part of some larger domain objects.

The second domain object in the order domain of the mother node in Figure 7 is there to represent the meaning of conjunction and does not have any phonological content. It is added to the order domain of a coordinate structure by the phrase-structure schema that licenses coordinate structures (see Yatabe (2012) for the details of this analysis).

The third domain object in the order domain of the mother node in Figure 7 was created by totally compacting that portion of the first daughter node that did not undergo syntactic LNR, and the fourth domain object in the order domain of the mother node was created by totally compacting that portion of the second daughter node that did not undergo syntactic LNR. The PHON value of the fourth domain object was later modified first by applying phonological LNR to its left edge (and thus eliding the string *to* that was there) and then by adding the string *and* to the left edge. (See Yatabe (2012) for the details of the process that adds a string that corresponds to a coordinator at the beginning of the PHON value of a conjunct.)

Phonological LNR (or RNR) simply deletes some phonological material at the left (or right, respectively) edge of non-initial (or non-final, respectively) daughters, on condition that the same phonological material is contained in the initial (or final, respectively) daughter. In Figure 7, the phonological material *to* in the second conjunct is allowed to be deleted because (i) it is at the left edge of the second conjunct after the domain object for the verb *drove* is removed by syntactic LNR and (ii) the same phonological material appears in the corresponding position (viz. the left edge, modulo the syntactically left-node-raised material) in the first daughter. Phonologically LNRed (or RNRed respectively) material generally becomes part of the domain object corresponding to the initial (or final respectively) daughter. In Figure 7, *to* becomes part of the domain object that is to be pronounced *to Chicago in the morning*, which corresponds to the first daughter, more precisely, that part of the first daughter that has not been syntactically left-node-raised or right-node-raised.

When syntactic LNR or RNR amalgamates n domain objects of the form shown in (14) (each coming from a different daughter) to produce a single domain object of the form shown in (15) (to be placed in the order domain of the mother), one of the three conditions shown in (16) must be satisfied. If the local subtree involved is not a coordinate structure whose semantic head is *and* but either a coordinate structure whose semantic head is *or* or a non-coordinate structure, then one of the first two conditions has to be satisfied.³

³A more precise definition of this amalgamation relation is provided in the Appendix of Yatabe (2012), but there is a slight discrepancy between the definition given there and the description provided here; the condition given in (16c) is different from the corresponding condition included in Yatabe (2012), in that the latter did not require the H-CONS set of each daughter to be identical to that of the mother.

$$(14) \left[\begin{array}{l} \text{SYNSEM} \mid \text{CONT} \end{array} \left[\begin{array}{l} \text{INDEX} \\ \text{EP} \\ \text{H-CONS} \\ \text{H-STORE} \end{array} \begin{array}{l} \boxed{a_1} \\ \boxed{b_1} \\ \boxed{c_1} \\ \boxed{d_1} \end{array} \right] \right], \dots, \left[\begin{array}{l} \text{SYNSEM} \mid \text{CONT} \end{array} \left[\begin{array}{l} \text{INDEX} \\ \text{EP} \\ \text{H-CONS} \\ \text{H-STORE} \end{array} \begin{array}{l} \boxed{a_n} \\ \boxed{b_n} \\ \boxed{c_n} \\ \boxed{d_n} \end{array} \right] \right]$$

$$(15) \left[\begin{array}{l} \text{SYNSEM} \mid \text{CONT} \end{array} \left[\begin{array}{l} \text{INDEX} \\ \text{EP} \\ \text{H-CONS} \\ \text{H-STORE} \end{array} \begin{array}{l} \boxed{a_0} \\ \boxed{b_0} \\ \boxed{c_0} \\ \boxed{d_0} \end{array} \right] \right]$$

- (16) a. $\boxed{a_0} = \boxed{a_1} = \dots = \boxed{a_n} \wedge \boxed{b_0} = \boxed{b_1} = \dots = \boxed{b_n}$
 $\wedge \boxed{c_0} = \boxed{c_1} = \dots = \boxed{c_n} \wedge \boxed{d_0} = \boxed{d_1} = \dots = \boxed{d_n}$
- b. $\boxed{a_0} = \text{none} \wedge \boxed{b_0} = \boxed{b_1} \oplus \dots \oplus \boxed{b_n}$
 $\wedge \boxed{c_0} = \boxed{c_1} \cup \dots \cup \boxed{c_n} \wedge \boxed{d_0} = \boxed{d_1} = \dots = \boxed{d_n}$
- c. $\boxed{a_0}$ is $\boxed{a_1 + \dots + a_n}$, and $\boxed{b_1} \dots \boxed{b_n}$ all become $\boxed{b_0}$ when $\boxed{a_1} \dots \boxed{a_n}$ that occur inside $\boxed{b_1} \dots \boxed{b_n}$ respectively are all replaced by $\boxed{a_1 + \dots + a_n}$. In addition,
 $\boxed{c_0} = \boxed{c_1} = \dots = \boxed{c_n} \wedge \boxed{d_0} = \boxed{d_1} = \dots = \boxed{d_n}$

The condition in (16a) states that the domain objects coming from the daughters must be identical to each other and it also requires that the domain object to be placed in the order domain of the mother be identical to those domain objects. When this condition is applied to syntactically right-node-raised or left-node-raised domain objects representing a quantifier, those domain objects, which are equated with each other, turn out to represent a single quantifier, and that quantifier therefore has to take wide scope over all the daughter nodes, since otherwise some of the variables to be bound by the quantifier would remain unbound. This aspect of this theory makes it somewhat analogous to the theories that analyze right-node raising in terms of multidominance, for example the one proposed in Bachrach and Katzir (2007); in all these theories, a single quantifier that is to be interpreted only once can nevertheless be contained in multiple, distinct syntactic phrases.

The second condition, namely condition (16b), allows syntactic RNR and LNR to have no semantic effect. When the domain object corresponding to a syntactically right-node-raised or left-node-raised expression obeys this condition, the sentence as a whole is given the same interpretation that it would receive if the expression in question did not undergo RNR or LNR. This is because the effect that condition (16b) has on the EP, the H-CONS, and the H-STORE values parallels what total compaction does to those values.

When a new domain object to be placed in the order domain of the mother is created according to the condition in (16c), the newly created domain object is, roughly speaking, the semantic sum of the domain objects coming from the daughter nodes. This condition is used to deal with sentences like *I borrowed, and my sister stole, a total of \$3000 from the bank*, discussed in Abbott (1976). We use a string of the form $i_1 + \dots + i_n$ to represent an index whose interpretation is required to be the sum of the interpretations of i_1, \dots, i_n . Additionally, we are assuming that, when the denotation of the tags $\boxed{t_1}, \dots, \boxed{t_n}$ are indices i_1, \dots, i_n respectively, the denotation of a tag of the form $\boxed{t_1 + \dots + t_n}$ is the index $i_1 + \dots + i_n$.

Phonological LNR and RNR are always meaning-preserving, whereas syntactic LNR and RNR can be either meaning-preserving (due to the existence of the option (16b)) or meaning-changing (due to the existence of the options (16a) and (16c)).

Thus, whether a particular instance of RNR or LNR is of the syntactic kind or the phonological kind is not necessarily determined by the semantic interpretation of the sentence involved. On the other hand, the prosodic property of the sentence involved generally does determine which type of RNR or LNR is involved, since order domains are, by assumption, representations of prosodic structure. Let us assume that we are dealing with RNR out of a coordinate structure. If the right-node-raised string is pronounced as a normal part of the final conjunct, then what is involved must be phonological RNR; if the right-node-raised string is pronounced as a sequence of one or more independent prosodic constituents separate from the conjuncts that share it, then what is involved must be syntactic RNR. An analogous criterion is applicable in the case of RNR out of a non-coordinate structure and in the case of LNR as well.

We will now demonstrate that, unlike a theory that views RNR and LNR only as prosodic ellipsis, this theory correctly accounts for the kinds of observations that Kubota and Levine claim are problematic for the HPSG-based theories in general.

2.3.1 Quantifier scope

First, we will illustrate how the theory allows LNR to affect quantifier scope without recourse to any ad hoc mechanism. Figure 8 shows part of the structure that the theory assigns to sentence (17), when the string *gave no man* is taken to have undergone the syntactic type of LNR.

(17) Terry gave no man a book on Friday or a record on Saturday.

What is shown in Figure 8 is the local subtree where the two VPs (viz. *gave no man a book on Friday* and *gave no man a record on Saturday*) are conjoined by the coordinator *or* to become a larger VP (viz. *gave no man a book on Friday or a record on Saturday*). As noted above, coordinators like *or* are assumed to be introduced into the syntactic structure by a linearization-related mechanism, and does not appear as a node in the syntactic phrase-structure tree.

The first domain object in the order domain of the mother represents the verb *gave*, which has been syntactically left-node-raised. This domain object is the result of amalgamating the first domain object in the order domain of the first daughter and the first domain object in the order domain of the second daughter. The relationship between this domain object and the two domain objects that gave rise to it conforms to the condition in (16b). The two handle constraints listed in the $\mathcal{H}\text{-CONS}$ value of this domain object (viz. $h17 \geq \{h4\}$ and $h25 \geq \{h5\}$) both arose when a VP to be modified by an adjunct underwent partial compaction in accordance with (3b). Figure 9 depicts the local subtree in which the VP *gave no man a book* combines with the adjunct *on Friday* to become the first conjunct in sentence (17). Although the two daughters in this local subtree are both only required to undergo partial compaction, the second daughter, i.e. *on Friday*, undergoes total compaction. On the other hand, the compaction that the first daughter, i.e. the VP *gave no man a book*, undergoes is not total. The two non-initial domain objects (viz. the one representing *no man* and the one representing *a book*) escape compaction and are inherited by the order domain of the mother. As a consequence of this, a VP sign whose order domain consists only of the domain object representing the verb *gave* undergoes total compaction, producing a domain object whose $\mathcal{H}\text{-CONS}$ set contains the handle constraint $h17 \geq \{h4\}$. The constraint $h25 \geq \{h5\}$ was added to a $\mathcal{H}\text{-CONS}$ set in an analogous fashion in the second conjunct.

As Kubota and Levine do, we treat the meaning of a phrase like *on Friday* as an unanalyzed unit, for the sake of simplicity; we represent it using a single elementary

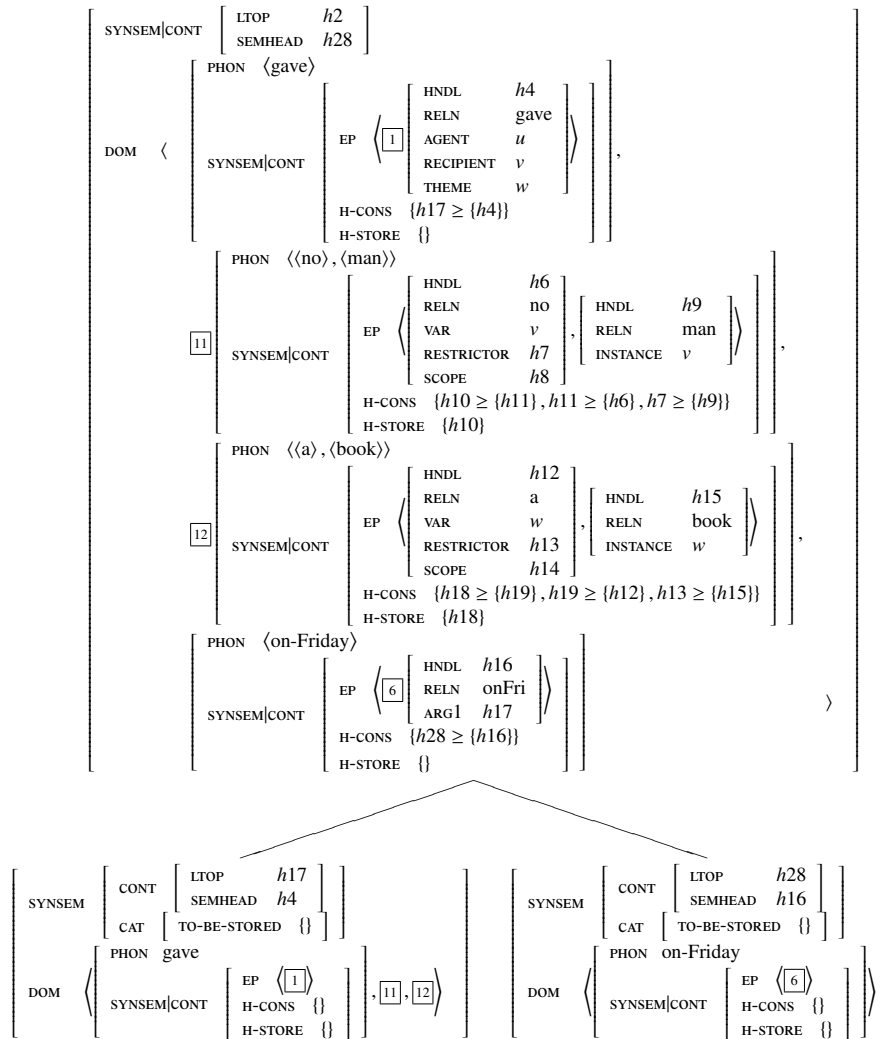


Figure 9: Part of the structure assigned to the first conjunct of sentence (17)

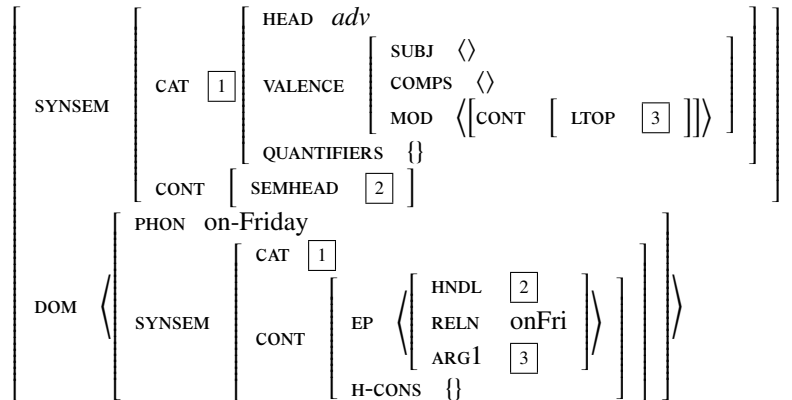


Figure 10: Part of the lexical entry for the expression *on Friday*

predication. Figure 10 shows the lexical entry we are assuming for this expression.

The second domain object in the order domain of the mother in Figure 8 represents the quantifier *no man*, which is also assumed to have been syntactically left-node-raised. This domain object is the result of amalgamating the second domain object in the order domain of the first daughter and the second domain object in the order domain of the second daughter. It conforms to the condition in (16a) above; the three domain objects involved are identical to each other and represent a single quantifier. Since domain objects rather than signs are the principal carriers of semantic information in this theory, the fact that the order domain of the mother node contains only one set of elementary predications corresponding to this quantifier means that the semantic representation of this sentence is going to contain only one instance of that quantifier, which is thus required to take scope over the entire coordinate structure.

The third domain object in the order domain of the mother node is there to represent the meaning of disjunction, and has no phonological content. This domain object is created by the phrase structure schema that licenses coordinate structure, as we noted at the outset of this subsection, i.e. subsection 2.3.

The fourth domain object of the mother node in Figure 8 is the result of totally compacting the first daughter or, more precisely, the sign that is obtained by excising the first two domain objects of the first daughter, which were syntactically left-node-raised out of it. This means that the sign whose total compaction gave rise to this domain object had only two domain objects (viz. the one representing *a book* and the one representing *on Friday*) in its order domain. The first handle constraint in the H-CONS value of this fourth domain object (viz. the constraint $h2 \geq \{h28, h18\}$) was produced by the application of total compaction that led to the creation of this domain object. The second, the third, and the fourth handle constraint in the H-CONS value (viz. the constraints $h18 \geq \{h19\}$, $h19 \geq \{h12\}$, and $h13 \geq \{h15\}$) were produced by the three applications of total compaction that were involved in generating the DP *a book*. And the fifth handle constraint in this H-CONS value (viz. the constraint $h28 \geq \{h16\}$) was produced when the adjunct *on Friday* was compacted within the first conjunct (see Figure 9).

The fifth domain object of the mother node in Figure 8 is the result of totally compacting the second daughter or, more precisely, the sign that is obtained by excising the first two domain objects of the second daughter, which were syntactically left-node-raised out of it. The first element of its PHON value, namely “or”, was added here after this application of total compaction.

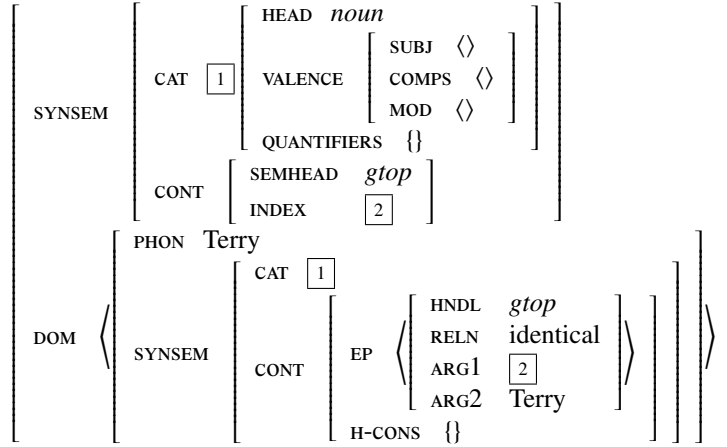


Figure 11: Part of the lexical entry for the proper noun *Terry*

The lexical entry we assume for the proper noun *Terry* is shown in Figure 11. The symbol *gtop* used in this lexical entry represents a designated handle that is always identified with the global top handle of an MRS representation.

When the VP shown in Figure 8 is combined with the subject DP *Terry* and the resulting sentential sign is totally compacted, we obtain a domain object whose H-CONS value is (18) (where *h30* is the LTOP value of the subject DP).

$$(18) \{ h0 \geq \{h1, h10\}, h30 \geq \{gtop\}, h17 \geq \{h4\}, h25 \geq \{h5\}, h10 \geq \{h11\}, h11 \geq \{h6\}, h7 \geq \{h9\}, h2 \geq \{h28, h18\}, h18 \geq \{h19\}, h19 \geq \{h12\}, h13 \geq \{h15\}, h28 \geq \{h16\}, h3 \geq \{h29, h26\}, h26 \geq \{h27\}, h27 \geq \{h20\}, h21 \geq \{h23\}, h29 \geq \{h24\} \}$$

This means, among other things, that $h2 \geq h18 \geq h19 \geq h12$, which means that the DP *a book* has to take scope within the first disjunct. Likewise, the DP *a record* is required to take scope within the second disjunct. On the other hand, the DP *no man* has to take wide scope over the disjunction because it has to bind all the occurrences of the variable *v*, which is used in both disjuncts. The scope relation between the DP *a book* and the adjunct *on Friday* is underspecified, as is the scope relation between the DP *a record* and the adjunct *on Saturday*.

The CONT value of the domain object representing the sentence as a whole therefore corresponds to the four representations in (19) in the conventional notation.

- (19) a. $u = \text{Terry} \wedge \text{no}(v, \text{man}(v), \text{onFri}(a(w, \text{book}(w), \text{gave}(u, v, w))) \vee \text{onSat}(a(x, \text{record}(x), \text{gave}(u, v, x))))$
- b. $u = \text{Terry} \wedge \text{no}(v, \text{man}(v), a(w, \text{book}(w), \text{onFri}(\text{gave}(u, v, w))) \vee \text{onSat}(a(x, \text{record}(x), \text{gave}(u, v, x))))$
- c. $u = \text{Terry} \wedge \text{no}(v, \text{man}(v), \text{onFri}(a(w, \text{book}(w), \text{gave}(u, v, w))) \vee a(x, \text{record}(x), \text{onSat}(\text{gave}(u, v, x))))$
- d. $u = \text{Terry} \wedge \text{no}(v, \text{man}(v), a(w, \text{book}(w), \text{onFri}(\text{gave}(u, v, w))) \vee a(x, \text{record}(x), \text{onSat}(\text{gave}(u, v, x))))$

The four representations in (19) are truth-conditionally equivalent to each other and are all adequate representations of the reading of sentence (17) in which the quantifier *no man* takes wide scope over the coordinate structure. Thus, we see that this reading of sentence (17) does not pose a problem for the HPSG-based account.

The other reading of this sentence, in which the quantifier is outscoped by the disjunction, is not a problem for the account either. That reading can be generated in the following two ways. First, if the quantifier *no man* is taken to have undergone phonological LNR, the sentence will be given the same interpretation as *Terry gave no man a book on Friday or no man a record on Saturday*, which is precisely the interpretation in which the quantifier *no man* is interpreted within each disjunct and is outscoped by the disjunction. Second, the same reading can be obtained by taking the quantifier *no man* to have undergone syntactic LNR and utilizing condition (16b) instead of condition (16a) in licensing the merging of two domain objects corresponding to that left-node-raised quantifier.

Thus, Kubota and Levine’s claim that a sentence like (8) poses an empirical challenge to the HPSG-based account is incorrect.

2.3.2 Symmetric predicates

Next, we will illustrate the way the HPSG-based theory analyzes (20), another sentence that Kubota and Levine claim poses a problem for the theory.

(20) I said different things to Robin on Thursday and Leslie on Friday.

The reading that we are interested in is one where this sentence means that the thing that the speaker said to Robin on Thursday was different from the thing that the speaker said to Leslie on Friday. Kubota and Levine imply that the fact that such a reading exists is not addressed anywhere in the HPSG literature,⁴ but it *is* addressed in Yatabe (2012), and we are going to present the analysis that is proposed in that article below, again filling in some details that are left unspecified there.

Figure 12 shows part of the structure that the HPSG-based theory under discussion assigns to this sentence. It depicts the local subtree in which two VPs are conjoined to become a larger VPs.

The first domain object in the order domain of the mother node, i.e. the one to be pronounced “said”, is the result of fusing the first domain object in the order domain of the first daughter and the first domain object in the order domain of the second daughter. The relationship between these three domain objects conforms to the constraint stated in (16b).

The second domain object in the order domain of the mother node in Figure 12, i.e. the one to be pronounced “different things”, is the result of fusing the second domain object in the order domain of the first daughter and the second domain object in the order domain of the second daughter. The relationship between these three domain objects conforms to the constraint stated in (16c).

Apart from the fact that (16c) was invoked for the second domain object instead of (16a), the way the structure in Figure 12 is licensed is analogous to the way the structure in Figure 8 is licensed. The reason that the domain object corresponding to *said* and the domain object corresponding to *different things* both exist as independent domain objects at this point is that the VP that is modified by the temporal adjunct underwent partial compaction in each conjunct. When the VP *said different things to Robin* was modified by the adjunct *on Thursday* in the first conjunct, the two non-initial domain objects in the order domain of the VP (viz. the one corresponding to

⁴Here is what is said on p. 538 in Kubota and Levine (2015): “The situation is exactly parallel with symmetrical and summative predicates. In short, with ‘respective’, symmetrical and summative predicates, essentially the same problem arises as in the case of quantifiers when they interact with coordination, but the situation for the LBE approach is worse: currently, there is not even an attempt at addressing this problem.” (LBE stands for Linearization-Based Ellipsis.)

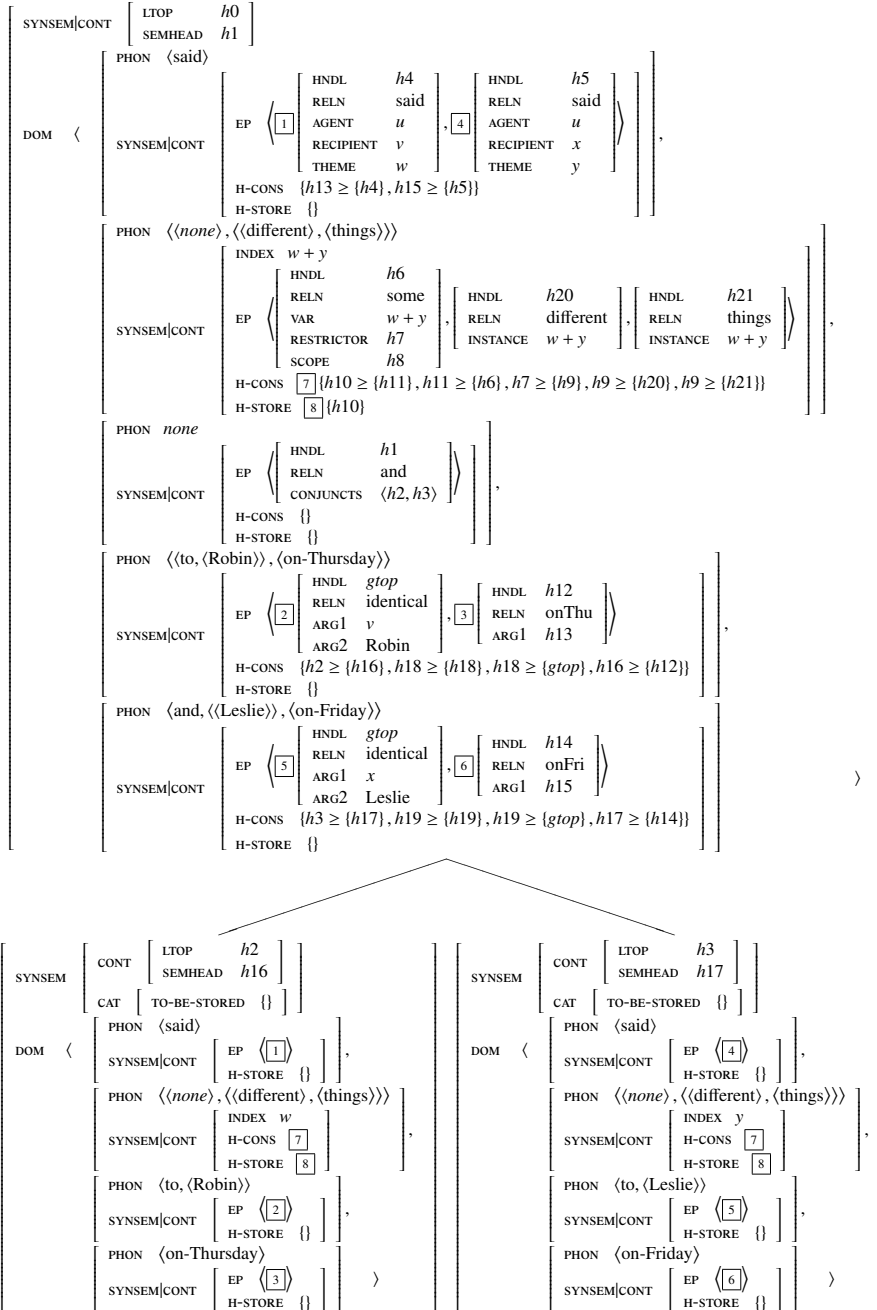


Figure 12: Part of the structure assigned to sentence (20)

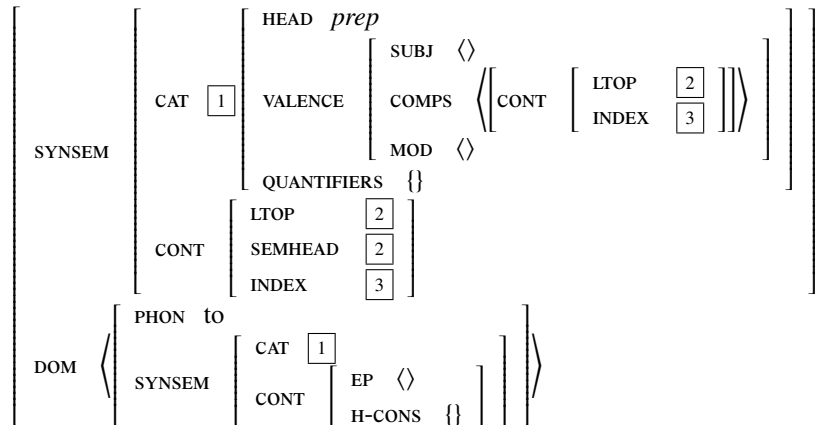


Figure 13: Part of the lexical entry for the marking preposition *to*

different things and the one corresponding to *to Robin*) escaped compaction. Likewise, when the VP *said different things to Leslie* was modified by the adjunct *on Friday* in the second conjunct, the two non-initial domain objects in the order domain of the VP (viz. the one corresponding to *different things* and the one corresponding to *to Leslie*) escaped compaction. Partial compaction of the VP *said different things to Robin* in the first conjunct gave rise to the first handle constraint in the H-CONS set of the first domain object in the order domain of the mother node in Figure 12 (viz. $h13 \geq \{h4\}$), while partial compaction of the VP *said different things to Leslie* in the second conjunct gave rise to the second handle constraint in that H-CONS set (viz. $h15 \geq \{h5\}$).

The third domain object in the order domain of the mother node in Figure 12 merely represents the meaning of conjunction, and does not have phonological content.

The fourth domain object, i.e. the one to be pronounced “to Robin on Thursday”, is the result of totally compacting the first daughter or, more precisely, the sign that is obtained by excising the first two domain objects in the order domain of the first daughter, which were syntactically left-node-raised. The first handle constraint in the H-CONS set of this domain object (viz. $h2 \geq \{h16\}$) was created when this compaction took place. The second handle constraint in the set (viz. $h18 \geq \{h18\}$), which is tautological, was created when the PP *to Robin* underwent total compaction. (The lexical entry we assume for the marking preposition *to* is shown in Figure 13.) The third handle constraint (viz. $h18 \geq \{gtop\}$) was created when the DP *Robin* underwent total compaction. And the fourth handle constraint (viz. $h16 \geq \{h12\}$) was created when the adjunct *on Thursday* underwent compaction.

And the fifth domain object in the order domain of the mother node in Figure 12, i.e. the one to be pronounced “Leslie on Friday”, is the result of (i) totally compacting the second daughter or, more precisely, the sign that is obtained by excising the first two domain objects in the order domain of the second daughter, which were syntactically left-node-raised, (ii) applying phonological left-node raising to the left edge of its PHON value and deleting the string “to” there, and (iii) adding the string “and” to the left edge of its PHON value.

Figure 14 shows part of the internal structure of the DP *different things* in the first conjunct of sentence (20). For concreteness, we assume that this DP is headed by a phonologically empty determiner whose semantics is identical to that of *some*. Figure 15 shows part of the lexical entry that we are assuming for the word *different*.

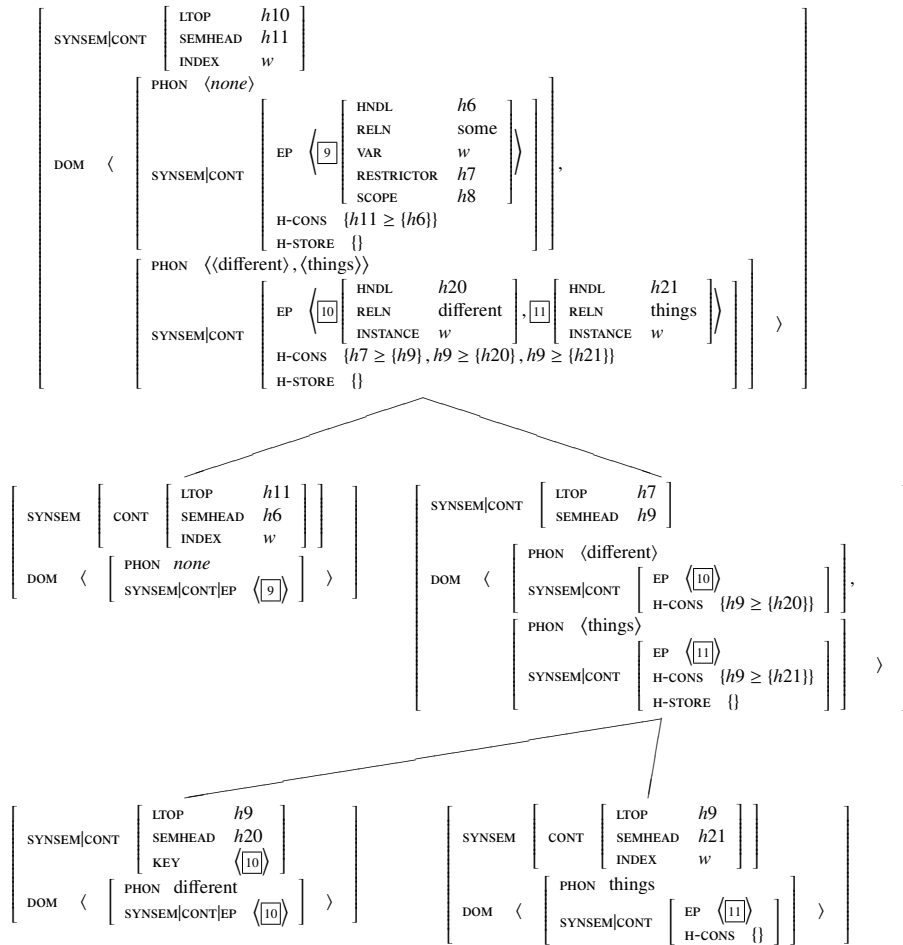


Figure 14: Part of the structure assigned to the DP *different things* in the first conjunct of Figure 12

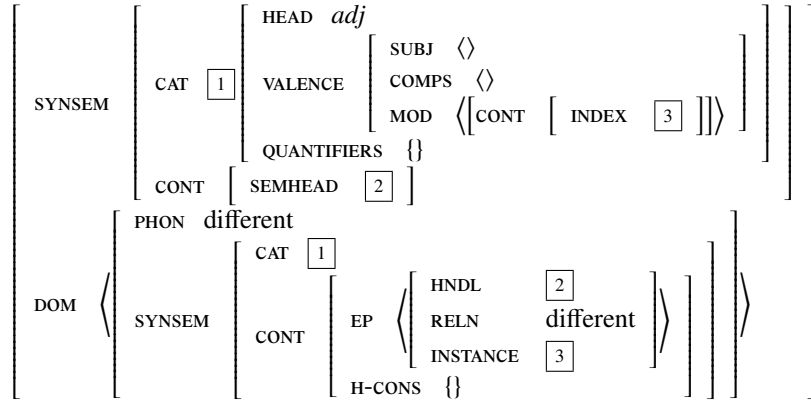


Figure 15: Part of the lexical entry for the adjective *different*

The DP *different things* in the second conjunct is generated in an almost identical fashion but with a distinct index, namely y instead of w . The second domain object in the order domain of the mother node in Figure 12 has the `INDEX` feature whose value is $w + y$ because it was created by fusing a domain object whose `INDEX` value is w and an almost identical domain object whose `INDEX` value is y in accordance with the condition (16c).

When the VP as a whole is combined with the subject DP I and the resulting S is totally compacted, we obtain a domain object whose `CONT` value represents the meaning of the sentence. That meaning is expressed by the representation in (21) in the conventional notation.

$$(21) \quad u = \text{Speaker} \wedge v = \text{Robin} \wedge x = \text{Leslie} \wedge \text{some}(w+y, \text{different}(w+y) \wedge \text{things}(w+y), \text{onThu}(\text{said}(u, v, w)) \wedge \text{onFri}(\text{said}(u, x, y)))$$

This is an adequate representation of the reading in question, on the assumption (i) that a variable whose name is of the form $X_1 + \dots + X_n$ is to denote the set consisting of the denotations of X_1, \dots, X_n and (ii) that an elementary predication whose `RELN` value is *different* and whose argument is a variable whose name is of the form $X_1 + \dots + X_n$ means that the denotations of X_1, \dots, X_n are different from each other. Kubota and Levine’s claim that the HPSG-based theory is incapable of accounting for the interpretation of a sentence like (20) is thus incorrect.

There are two respects in which the HPSG-based theory as it has been described here has a narrower empirical coverage compared to the theory proposed by Kubota and Levine. First, the theory described here does not apply to cases of the internal reading of a symmetric predicate like *different* that do not involve non-constituent coordination. It will be necessary to make the theory more generally applicable by incorporating some semantic theory of symmetric predicates such as that proposed in Brasoveanu (2011). Second, the theory proposed in Kubota and Levine (2015) and Kubota and Levine (2016) uses a common grammatical mechanism to treat the internal reading of symmetrical predicates and the interpretation of sentences like *John and Bill ran and danced, respectively*, whereas the theory that we have described in this section does not generate *respectively*-type readings, and thus needs to be augmented by a special interpretive mechanism. We recognize that these are limitations of the theory we have presented. However, as we noted in passing, they both seem to us to be kinds of problems that can be dealt with by adding something to the theory, rather than insurmountable problems at its foundation.

3 Problems with CG-based theories

Now we will argue that there are several empirical reasons to prefer the HPSG-based theory of non-constituent coordination over CG-based ones.

First, the HPSG-based theory is able to capture a phenomenon that could be called summative agreement, exemplified by the example in (22) from Postal (1998), while the CG-based theories arguably cannot.

- (22) The pilot claimed that the first nurse, and the sailor proved that the second nurse, were spies.

As shown in Yatabe (2003), the availability of summative agreement is affected by the type of coordinator involved, as shown by (23), and by the kinds of subject DPs involved, as shown by (24).

- (23) ??The pilot claimed that the first nurse, or the sailor proved that the second nurse, were spies.

- (24) ?*The pilot claimed that the nurse from the United States, and the sailor claimed that no one, were spies.

Intuitively, the verb *were* is agreeing, or is failing to agree, with a nonexistent DP of the form *the first nurse and the second nurse* in (22), *the first nurse or the second nurse* in (23), and *the nurse from the United States and no one* in (24). This intuition is easy to express in a constraint-based grammatical theory like HPSG, as shown in Yatabe (2003), but cannot be captured in a natural fashion in a theory like CG; information about the syntactic and semantic content of each subject DP in the embedded clauses must become unavailable before the coordinated main clauses are merged with the sentence-final, right-node-raised VP.

Second, as shown in Abeillé and Mouret (2011) and Abeillé and Shiraishi (2016), there are acceptable instances of right-node raising in which the right-node-raised expression has a form that is appropriate for the second, final conjunct but not for the first conjunct. (25) is one such example.

- (25) Ce parti ne parvient pas, voire ne souhaite pas, surmonter les contradictions idéologiques qui entravent son action et rendent ses choix confus.
(Cf. Ce parti ne parvient pas *[surmonter ses contradictions idéologiques] / [à surmonter ses contradictions idéologiques].)
(from Abeillé and Mouret (2011))

In an HPSG-based theory, an example like this can be generated if one type of right-node raising is assumed to be prosodic ellipsis (like what is called phonological RNR in our theory) that disregards minor differences in pronunciation between two occurrences of the expression that is to be right-node-raised. CG-based theories, on the other hand, seems incapable of generating such examples in a principled way.

And third, there are instances of RNR and LNR in which the right-node-raised or left-node-raised expression is pronounced at a location other than the right or left edge of the coordinate structure involved. (26) is one such example involving RNR. The phenomenon exemplified by this example, which we call medial RNR, has been discussed in the context of CG in works such as Whitman (2009), Kubota (2014), and Warstadt (2015), but it can be shown that this particular example is problematic for all these CG-based theories.

- (26) Are you talking about a new or that ex-boyfriend you used to date?
(from Chaves (2014))

In (26), the right-node-raised expression *boyfriend* is pronounced at a medial position within the second conjunct, rather than at its right edge. Appendix C presents the result of a small questionnaire study concerning the acceptability of this example, which showed that it is acceptable if not perfect. Since the slight awkwardness of the sentence can plausibly be ascribed to the degraded parallelism between conjuncts that always accompanies medial RNR, we regard the sentence as grammatical.

If we are to apply one of the CG-based theories to this example, we need to view the prepositional object in this example (viz. *a new or that ex-boyfriend you used to date*) as the result of combining a coordinate structure of the form *a new or that ex-you used to date* with a noun *boyfriend* and then phonologically infixing the latter into the former. As noted in Yatabe (2015), such an analysis requires the assumption that a sequence of prenominal modifiers like *that ex-* and a postnominal modifier like *you used to date* can form a constituent in English, and once we make such an assumption, it is no longer obvious how we can rule out an ill-formed phrase like (27), which the theory predicts could be generated by combining [*a new [who you're dating now]*] or [*that ex- [you used to date]*] and *boyfriend* and then phonologically infixing the latter into the former.

(27) *a new [who you're dating now] or that ex-boyfriend [you used to date]

Thus, an example like (26) appears to be a genuine problem for CG-based analyses of non-constituent coordination. Yatabe (2016) notes the existence of similarly problematic examples involving LNR.

The HPSG-based theory, on the other hand, has no problem explaining why (26) is possible while (27) is not. (27) is illicit because it involves RNR of a non-final part of the first conjunct and such RNR necessarily violates the constraint stated in (28a); notice that the string *boyfriend* precedes the string *who you're dating now* in the order domain of the first conjunct but that the former follows the latter in the order domain of the coordinate structure as a whole, in violation of (28a). (26) is licit because it does not violate this or any other constraint in the grammar.

The second and the third issue seem to indicate that at least some instances of RNR and LNR have to be viewed as a type of ellipsis, as claimed in the HPSG-based account. That leaves open the possibility that there are two types of RNR and LNR (as is claimed in the HPSG-based account) and that the CG-based analysis is adequate for those cases of RNR and LNR for which the ellipsis-based account is not applicable. It seems to us, however, that the first issue, involving summative agreement, is likely to rule out even that possibility. Examples involving summative agreement cannot be viewed as results of simple prosodic ellipsis, and at the same time, they do not seem to be amenable to the CG-based account either.

We do not claim to have presented conclusive evidence against the CG-based account of non-constituent coordination, but the foregoing seems to justify a certain amount of prejudice against it.

4 Summary

We have shown that Kubota and Levine's characterization of the HPSG-based theory of non-constituent coordination proposed in Yatabe (2001) and later works is inaccurate, and that the theory in question is consistent with the long-known fact that right-node raising and left-node raising can affect semantic interpretation. In the course of demonstrating this, we have filled in some details of this HPSG-based theory that

were left unspecified in the previous literature, and we have also corrected some minor errors in that literature. Furthermore, we have argued that there are three empirical reasons to prefer this theory over theories like Kubota and Levine's: summative agreement, phonological mismatches in RNR, and medial RNR and LNR.

Appendix

A The relation between syntactic trees and order domains

We assume that the correspondence between syntactic phrase-structure trees and order domains is subject to the following constraints.

- (28) Principles governing the order of domain objects:
- a. If a string *s* precedes another string *t* in the order domain of a sign that is not the top node, *s* must precede *t* in the order domain of the mother of that sign as well.
(Here we are using the term *string* to refer to the PHON value or a part of the PHON value of a domain object.)
 - b. Suppose that signs *B* and *C* are both daughters of a sign *A*, and that *B* precedes *C*. Then, in the order domain of *A*, non-extraposable domain objects that come from *B* but not from *C* must each precede all the non-extraposable domain objects that come from *C* but not from *B*.
(Here, we say that a domain object *x* contained in the order domain of a sign *comes from* a daughter *y* of that sign if and only if either (i) *x* is also contained in the order domain of *y* or (ii) *x* is a domain object that is newly created by compacting *y*. (The meaning of the term *to compact* is going to be explained in the second half of subsection 2.2.) And we say that a domain object is *non-extraposable* if its SYNSEM|CAT|EXTRAPOSITION value is $-$. All domain objects that we deal with in the present article are non-extraposable.)

To simplify slightly, (28a) says that the order of strings cannot be reversed once it is fixed in some order domain, and (28b) says that, apart from the effects of extraposition, the order of strings in an order domain reflects the order of those strings in the phrase-structure tree.

B Quantifier storage

We employ two features, the QUANTIFIERS feature and the TO-BE-STORED feature to place the handle of each quantifier into the quantifier storage at an appropriate location. The value of the QUANTIFIERS feature on a sign is the set consisting of the handles representing all the quantifiers contained in that sign that have yet to be put in the quantifier storage. The value of the TO-BE-STORED feature on a sign is the set consisting of the handles representing all the quantifiers that are to be put into storage at that node. (See how the TO-BE-STORED feature is used in the definition of total compaction in Figure 5.) The values of the TO-BE-STORED and the QUANTIFIERS feature are subject to the following set of constraints.

- (29) Principles governing the value of the TO-BE-STORED feature
 - a. The TO-BE-STORED value a sign must be a subset of its QUANTIFIERS value.
 - b. The TO-BE-STORED value of a sign that is not totally or partially compacted must be an empty set.
- (30) Principles governing the value of the QUANTIFIERS feature
 - a. The QUANTIFIERS value of a phrasal sign that is not a DP (i.e. a saturated phrase headed by a determiner) is the set obtained by subtracting the union of the TO-BE-STORED values of its daughters from the union of the QUANTIFIERS values of those same daughters.
 - b. The QUANTIFIERS value of a DP whose KEY value contains a scopal elementary predication is the union of (i) the singleton consisting of its LTOP value and (ii) the set obtained by subtracting the union of the TO-BE-STORED values of its daughters from the union of the QUANTIFIERS values of those same daughters.
 - c. The QUANTIFIERS value of a DP whose KEY value does not contain a scopal elementary predication is the set obtained by subtracting the union of the TO-BE-STORED values of its daughters from the union of the QUANTIFIERS values of those same daughters.
 - d. The QUANTIFIERS value of a phrase headed by a verb or an adjective must be an empty set.

In this theory, a handle corresponding to a quantificational determiner like *every* does not ‘start out’ in a quantifier storage. Figure 16 shows how the two quantifiers in the sentence *One apple in every basket was rotten* enter into storage in accordance with the principles in (29) and (30). The handles for the two quantifiers are both put into storage (i.e. placed in the H-STORE set) at the top node in the figure. They are ‘retrieved’ from the quantifier storage when the top node undergoes compaction, as are the two quantifiers in Figure 1.

The reason that we need the features like QUANTIFIERS and TO-BE-STORED has to do with our decision to define the total compaction operation the way we did in Figure 5. As noted in subsection 2.2, every time a sign is totally compacted, the quantifiers whose handles were in the H-STORE set of a domain object in the order domain of that sign are all required to take scope within that sign. This prevents us from assuming that the handle of a quantifier starts out in the H-STORE set; if it were in the H-STORE set at the word level, then the quantifier would have to take scope within the D node, since that node is required to undergo total compaction (by (3c)).

C Collection of acceptability judgments on example (26)

We used the method described in Sprouse (2011) to test the acceptability of example (26) on the Amazon Mechanical Turk (AMT) platform.

We included a total of 11 test sentences including (26) in our questionnaire, published on the AMT platform. The other 10 test sentences were also examples of RNR taken from the literature. Besides the test sentences, we also included three questions for (i) verifying that our participants were native speakers of English, (ii) checking whether they were monolingual, and (iii) finding out whether they had the experience of studying linguistics. Every participant was shown the same set of test sentences

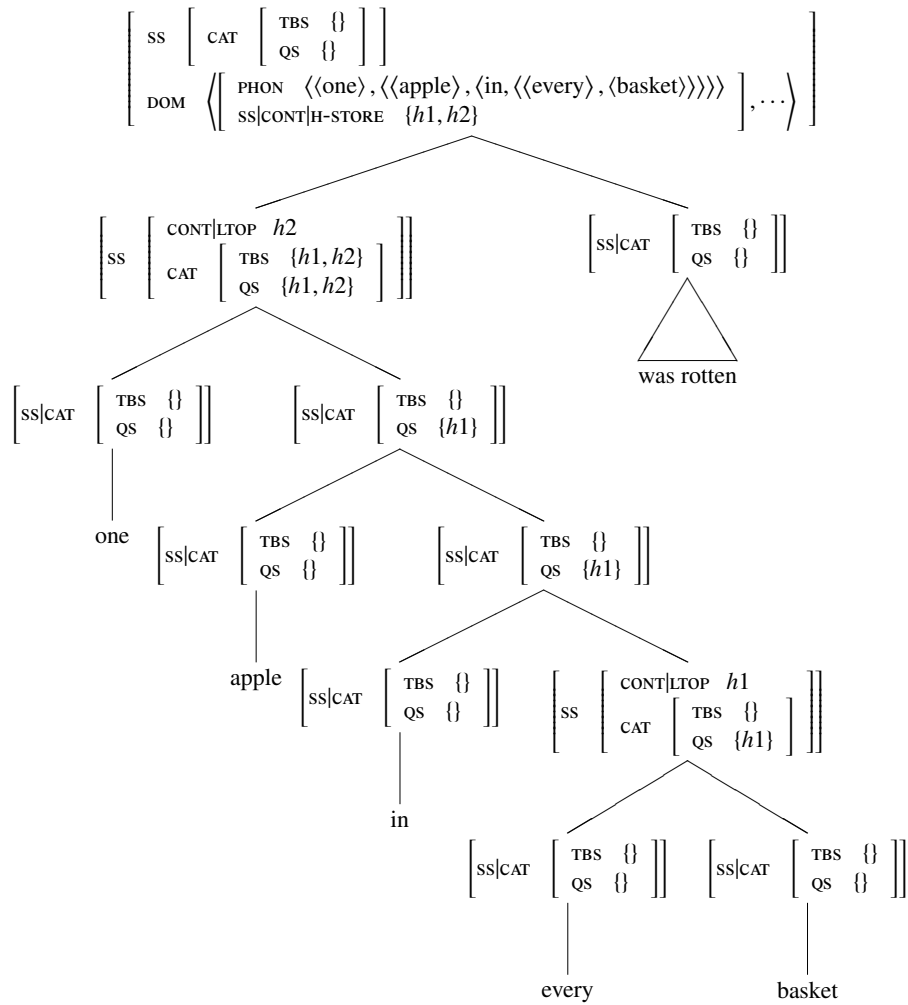


Figure 16: How the quantifiers enter into storage in the sentence *One apple in every basket was rotten*. The feature names SYNSEM, TO-BE-STORED, and QUANTIFIERS are abbreviated as ss, TBS, and QS, respectively.

but in a different, randomized order. Each sentence was followed by a parenthesized sentence that indicated what the intended meaning of the preceding sentence was, and the participants were instructed to rate each of the sentences on a 4-point scale, with 1 meaning “perfectly natural under the intended interpretation”, 2 meaning “slightly unnatural under the intended interpretation”, 3 meaning “considerably unnatural under the intended interpretation”, and 4 meaning “impossible under the intended interpretation”. The participants were each paid three US dollars.

Our questionnaire was completed by 10 participants. It turned out that all our participants had some experience of studying linguistics. We excluded from analysis two participants who did not choose the answer yes for the question of whether they were native speakers of English (and who, incidentally, both rated the sentence (26) as 1).

The result for sentence (26) was as follows: it was rated as 1 by two people, as 2 by three people, as 3 by two people, and as 4 by one person.

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