SINGLE CONJUNCT AGREEMENT AND THE FORMAL TREATMENT OF COORDINATION IN LFG

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Abstract

In cases of single conjunct agreement (SCA), the features of one conjunct within a coordinate structure control syntactic agreement between the coordinate NP and agreement targets external to that NP. This requires agreement processes to see inside the f-structure representation of the coordinate structure. Despite its intuitive simplicity, it has turned out to be surprisingly difficult to develop an approach to SCA in LFG, and existing approaches to SCA suffer from a range of technical inelegancies and/or empirical difficulties. We propose a novel approach to SCA which challenges the use of unordered sets for the representation of coordination at f-structure. Instead we propose a slightly more structured representation, which we call local f-structure sequences, for the representation of coordinate structures. Furthermore, we add more fine-grained subdistinctions to the standard LFG classification of features into distributive and non-distributive ones. This distinction controls the interpretation of feature path expressions as they interact with sets (of conjuncts) in f-structure, and the refined feature classification makes it possible to deal with SCA while keeping a simple, non-disjunctive formulation of the agreement constraints on the targets (such as verbs, which may combine with coordinate or simple NPs).

1 Introduction

In cases of single conjunct agreement (SCA), the features of one conjunct within a coordinate structure control syntactic agreement between the coordinate NP and agreement targets external to that NP (for example, a single conjunct like the feminine singular *kočka* ("cat", FSG) in the Czech example (1) controls subject-verb agreement with the target verb *seděla* ("was sitting", FSG)). This contrasts with the more familiar strategy of agreement with coordinate structures based on syntactic resolution, whereby the (resolved or calculated) features of the NP as a whole control agreement, i.e., an NP coordination of two or more singular NPs combines with a plural target verb etc.[1] In SCA it is usually the conjunct closest to the target which controls agreement (and SCA occurs much more frequently where the target precedes the controller as in (1)).

(1) Na rohožce seděla kočka a pes. Czech
on mat was.sitting.FSG [cat.FSG and dog.MSG]
"The cat and the dog were sitting on the mat."

A crucial fact about SCA is that while a single conjunct controls certain syntactic agreement processes, other more semantically based agreement processes in the same language may be controlled by the resolved feature values of the coordinate structure as a whole. The Welsh example (2) demonstrates both strategies in a single sentence: subject-verb agreement with the target verb *gwelaist* ("saw", 2SG) is an instance of SCA, while the anaphoric *eich hunain* ("yourselves") agrees with the resolved features of the coordinate structure, 2nd person plural.

(2) Gwelaist ti a'th frawd eich hunain. Welsh
saw-2SG 2SG and-2SG brother 2PL self
2SG [2SG & 3SG] 2PL
"You and your brother saw yourselves."

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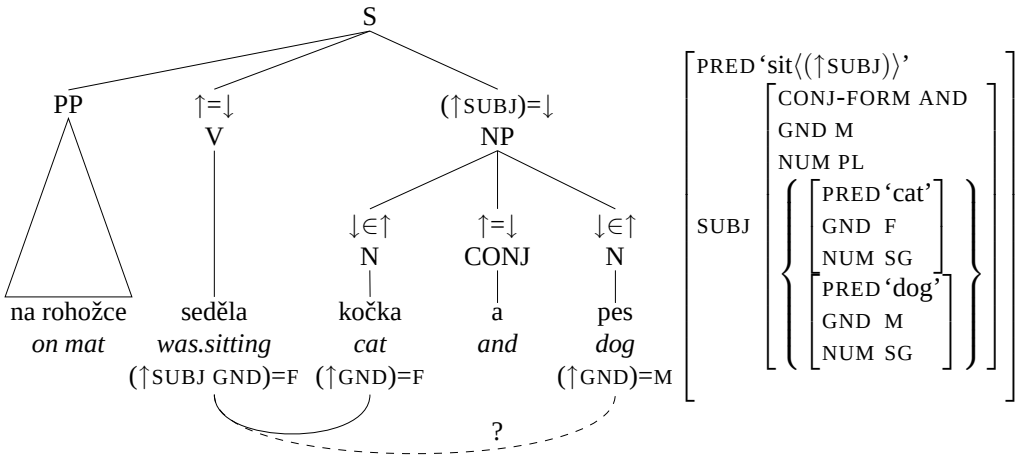
[1] Single conjunct agreement is often referred to as partial agreement, terminology which is potentially confusing, since cases in which targets agree in person and gender but not in number are also referred to as partial agreement.

This observation indicates that both sets of features must be simultaneously available to control agreement in the syntax. As previous attempts at a precise formal account (which will be discussed in Section 3.2) show, it is an interesting challenge to accomodate these requirements while maintaining a general theory of agreement – i.e., without introducing a coordination-specific special case in the description of the agreement targets (e.g., the verb). It is, of course, desirable that agreement targets are blind to the status of their agreement controllers with respect to the presence or absence of coordination.

The (inconsistent) LFG analysis sketch for sentence (1) in (3) provides a visual characterisation of the issue: to maintain a principled account of agreement, the lexical annotation of the verb ((↑SUBJ GND)=F) should remain as it is. However, in the standard representation of a coordinate NP, the features available at the coordination level are only the resolved (masculine plural) features, and processes involving the conjunct-level features are only expected to work "across the board", i.e., assuming that all conjuncts would have to be marked identically as feminine singular. So, based on a standard conjunct-level process, (1) should be ungrammatical.

(3) *The challenge for an* LFG *analysis*



There are technical ways of making the features of the appropriate single conjunct available at the level of the coordinate structure (by introducing a distinction of different types of agreement features alongside each other, see Section 3.2.1), but to describe the full range of observable phenomena, the otherwise very elegant f-structure representation of coordinate structures has to be amended with a number of technical and construction-specific elements.

An alternative is to leave the f-structure representation unaltered, but introduce an explicit disjunction in the agreement constraints on the agreement target (the verb). This also has a very technical flavour and may run into problems with nested coordinations (Section 3.2.2).

The account we propose in this paper resolves the issue at a more abstract level. Previous attempts have left the status of unordered sets as the appropriate f-structure level representation for coordinate NPs unquestioned. It is one of the guiding principle of LFG that formal representations in particular components of the theory are chosen in such a way that they reflect the crucial empirical properties of the modelled phenomena: constituency is modelled by phrase structure trees (c-structure), which encode linear precedence and hierarchical structure in a natural way, while grammatical relations are modelled by feature structure representations (f-structure), which have no intrinsic concept of linear precedence. We appeal to this meta principle and argue that while plain, classical *sets* of f-structures model certain properties of coordinate NPs, some of the mathematical properties of sets turn out to be

less adequate. If we use a slightly different formal device (which we call "local f-structure sequences", the descriptions used in the constraints describing a phenomenon like agreement may be interpreted in a way that caters more readily for the typological differences between languages we observe, including SCA).[2] By (slightly) altering the *interpretation* of the descriptional apparatus available for the formulation of constraints, we keep the case-by-case distinctions that would otherwise be required in agreement constraints, e.g. for verbs, "behind the scenes": no disjunctions are necessary in the actual lexical f-annotations or rule annotations. This is a move wholy in sympathy with the basic architectural philosophy of LFG.

The paper is organized as follows: after a discussion of the standard LFG analysis of coordination in Section 2, we review the relevant SCA data in some more detail in Section 3, as well as discussing previous LFG accounts. In Section 4, we present and discuss our approach, before concluding in Section 5.

2 Coordination in LFG

2.1 Set representation and distribution

The classical LFG analysis of coordination is based on two important assumptions (the former going back to Andrews (1983), the second due to Kaplan and Maxwell (1988/95)): First, the contribution of each conjunct is represented as an f-structure which forms an element of a *set* of f-structures. (A set of f-structures is defined as (a special case of) an f-structure.) The use of a set captures the fact that the number of conjuncts in a coordinate structure is in principle unbounded.

The second assumption combines this very intuitive *representational* idea with a clever notational short-hand, i.e., a way of allowing for simple, non-disjunctive *descriptions* in grammatical constraints. In terms of representation, no special feature is used to embed a coordinate structure's f-structure (set) within the larger f-structure that it contributes to: the set is inserted directly where the plain f-structure of a non-coordinated constituent would have gone (see (4), a slightly simplified f-structure for *I saw Bonnie and Clyde*). This captures the intuition that there is no difference between this sentence and *I saw the robbers* in terms of the depth of hierarchical embedding at the level of grammatical functions.

(4)
$$\begin{bmatrix} \text{PRED} & \text{'see}\langle(\uparrow\text{SUBJ})\,(\uparrow\text{OBJ})\rangle\text{'} \\ \text{SUBJ} & \begin{bmatrix} \text{PRED} & \text{'pro'} \end{bmatrix} \\ \text{OBJ} & \left\{ \begin{bmatrix} \text{PRED} & \text{'Bonnie'} \end{bmatrix} \begin{bmatrix} \text{PRED} & \text{'Clyde'} \end{bmatrix} \right\} \end{bmatrix}$$

The NP coordination rule is shown in (5): by virtue of the set membership annotations on the daughter NP nodes the entity referred to by ↑ is coerced into a set that will appear in the position of a non-coordinated NP's plain f-structure wherever the NP coordination rule is used.

(5)
$$\begin{array}{lcl@{\quad}l@{\quad}l@{\quad}l@{\quad}l@{\quad}l@{\quad}l} \text{NP} & \rightarrow & [& \text{NP} & \text{COMMA} &]^* & \text{NP} & \text{CONJ} & \text{NP} \\ & & & \downarrow\in\uparrow & & & \downarrow\in\uparrow & & \downarrow\in\uparrow \end{array}$$

It is important to note that this representational idea of coercing an f-structure into a set can only be made effective in the overall constraint-based system of LFG by a notational convention that Kaplan and Maxwell (1988/95) introduce: in the standard interpretation of f-structure path expressions, the application of a function (i.e., an f-structure feature like CASE, SPEC etc.) to a path denoting a set (like (↑OBJ) in (4), assuming that ↑ is referring to the outermost f-structure) is undefined.

[2] Effectively, we introduce a limited degree of sensitivity to string-level proximity to the resolution of f-descriptions in the cases where a description refers to an element of f-structure sequence (originating from a coordination).

Kaplan and Maxwell extend function application to sets of f-structures by providing a distributive interpretation for (otherwise undefined) path expressions referring to a set: whatever constraint such a path is used in, it will be applied to each of the set elements (a definition is shown in (6)). This extension provides a very elegant way of deriving the "across the board" effect that many constraints stated external to a coordinate structure show. In Figure 1, the rule annotation (↓CASE)=ACC is highlighted. Without the notational convention, this annotation (which would work correctly for a sentence like *I saw them*) would have no interpretation, since the f-structure referred to as ↓ is coerced into a set by the ↓∈↑ annotation further down the tree. With the notational convention, the desired effect follows directly with no further specification from the constraint as originally specified: all set elements have to satisfy the constraint (as ***I saw her and he*** is ungrammatical).

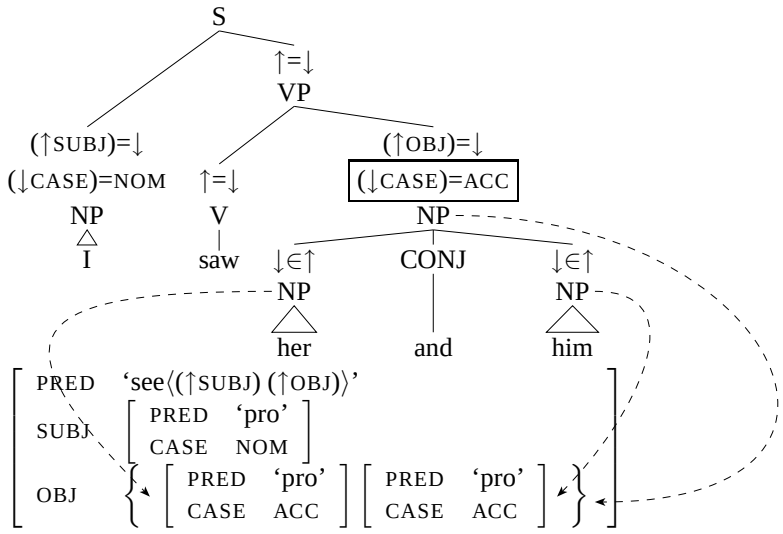


Figure 1: F-Descriptions referring to f-structure set

(6) *Notational convention (version 1)*

If some f-structure f is a set, then the value of an attribute a in f is v (that is, $(f\ a) = v$) iff for every $g \in f$, $(g\ a)$ includes the information in v.

(Kaplan and Maxwell, 1988/95), formulation from (Sells, 1985, 187)

There has been some debate (see e.g., (Maxwell and Manning, 1997)) about the formal relation implementing the intended distribution, with an earlier formulation in terms of generalization superceded by a formulation in terms of subsumption, but this is orthogonal to the current discussion and we do not discuss it further.

2.2 Distributive and non-distributive features

As the illustration in Figure 1 showed, morphosyntactic properties such as CASE distribute across conjuncts in a coordination, as do grammatical functions (even as part of functionally uncertain descriptions). On the other hand, some properties are coordination-level properties, that is they hold of the set itself, not of its members. This is true, for example, of the contribution of the conjunction, i.e., the CONJFORM feature.

Alongside CONJFORM, the agreement features PERS, NUM, GEND should be seen as properties of the coordination as a whole when a language applies a resolution strategy in agreement with coordinate NPs (as in English subject-verb agreement - *Bonnie and Clyde run/*runs*).

To capture this difference, a distinction is made between different classes of f-structure features (as discussed in Dalrymple and Kaplan (2000)): *distributive features* behave as just discussed, while *non-distributive features* are interpreted as properties of the f-structure set itself – i.e., constraints including such non-distributive features will not be distributed across set elements. Figure 2 provides an illustration; the convention is to show non-distributive features of a set inside an extra pair of square brackets surrounding the curly set brackets.

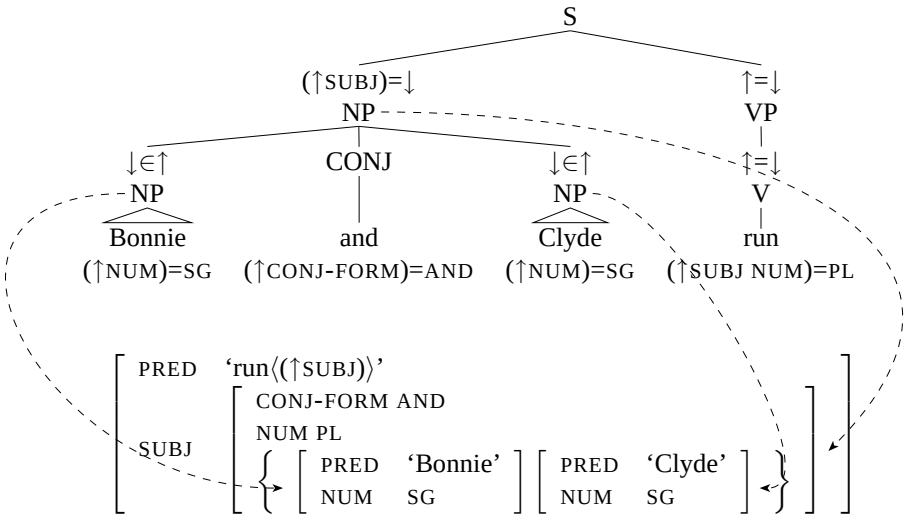


Figure 2: Non-distributive features

A formal LFG grammar must then include a declaration of the class that the features used belong to (typically, the distributive class is assumed to be the default, so just the non-distributive features have to be declared explicitly). Moreover the formulation of the notational convention (6) has to be replaced by (7):

(7) *Notational convention (version 2)*

Interpretation of $(f\ a) = v$:

- If (i) f is a plain f-structure,
  or (ii) f is a set and a is declared as a non-distributive feature,
  then $(f\ a)$ includes the information in v.
- Otherwise, if f is a set, then for every $g \in f$, $(g\ a)$ includes the information in v.

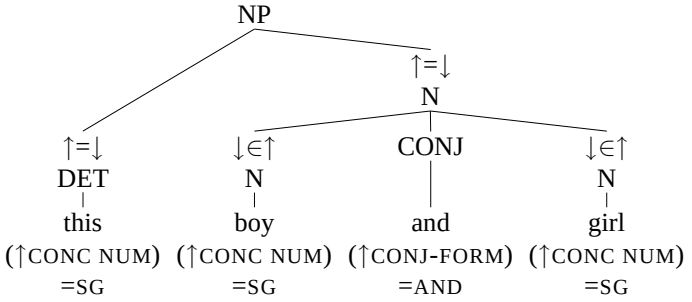
2.3 Semantic and morphosyntactic aspects of agreement

Before proceeding to a more detailed discussion of SCA in Section 3, we mention two further recent innovations which are relevant to coordination and motivated by agreement processes, but largely orthogonal to the specific issues of SCA.

King and Dalrymple (2004) (building on (Wechsler and Zlatić, 2000, 2003) and other work in HPSG) introduce a representational distinction between two sets of agreement features (compare (8)): (i) features under INDEX – for resolved features at the coordination level (which are semantically

determined); and (ii) features under CONCORD – for morphosyntactic conjunct-level features. The former are generally declared as non-distributive, the latter as distributive. This representational distinction makes it possible to distinguish different agreement strategies within the same language by formulating constraints using the appropriate paths. Figure 3 illustrates the role of CONC(ORD) in English NP-internal conjunct-level agreement in number. English subject-verb agreement, on the other hand, involves (resolved) INDEX features, so a plural verb form would include the annotation (↑SUBJ INDEX NUM)=PL in agreement with a coordination of singular NPs. The use of this explicit representational distinction between two sets of agreement features provides for a fine-grained approach to agreement cross-linguistically, as demonstrated by King and Dalrymple (2004) and Dalrymple and Nikolaeva (2006).

(8)
$$\begin{bmatrix} \text{INDEX} & \begin{bmatrix} \text{PER} \ldots \\ \text{NUM} \ldots \\ \text{GEN} \ldots \end{bmatrix} \\ \text{CONC} & \begin{bmatrix} \text{PER} \ldots \\ \text{NUM} \ldots \\ \text{GEN} \ldots \end{bmatrix} \end{bmatrix}$$



$$\begin{bmatrix} \text{CONJ-FORM AND} \\ \text{SPEC THIS} \\ \text{INDEX}\begin{bmatrix} \text{NUM PL} \end{bmatrix} \\ \left\{ \begin{bmatrix} \text{PRED} & \text{'boy'} \\ \text{INDEX} & \begin{bmatrix} \text{NUM SG} \end{bmatrix} \\ \text{CONC} & \begin{bmatrix} \text{NUM SG} \end{bmatrix} \end{bmatrix} \right. \\ \left. \begin{bmatrix} \text{PRED} & \text{'girl'} \\ \text{INDEX} & \begin{bmatrix} \text{NUM SG} \end{bmatrix} \\ \text{CONC} & \begin{bmatrix} \text{NUM SG} \end{bmatrix} \end{bmatrix} \right\} \end{bmatrix}$$

Figure 3: INDEX/CONCORD distinction following (King and Dalrymple, 2004)

Note that since all conjuncts are treated alike for the CONCORD features, the INDEX/CONCORD distinction does not itself provide a solution for SCA.

The second extension is due to Dalrymple and Kaplan (2000), who introduce the notion of (closed) marker sets as feature values for morphosyntactic features (instead of standard atomic values). For instance, in the Romance languages, the value of GEND may be either {} (for feminine) or {M} (for masculine). With such a representation, feature resolution can be simply modelled by set union over each conjuncts marker set – yielding {} if all conjuncts are feminine, or {M} if there is at least one masculine conjunct.

The elements making up the marker sets will differ depending on the distinctions a particular language makes. A possible encoding for PERS values is given in (9). The NP rule based on this analysis is shown in (10). (11) is an example f-structure for *you and John* (note that NUM is treated differently – it is assumed to be semantically rather than syntactically resolved).

(9)
- 1st person: {S} [inclusive 1st person plural: {S, H}]
- 2nd person: {H}
- 3rd person: {}

(10) NP $\longrightarrow$

NP	CONJ	NP
$\downarrow \in \uparrow$		$\downarrow \in \uparrow$
$(\downarrow \text{INDEX PERS}) \subseteq (\uparrow \text{INDEX PERS})$		$(\downarrow \text{INDEX PERS}) \subseteq (\uparrow \text{INDEX PERS})$
$(\downarrow \text{INDEX GEN}) \subseteq (\uparrow \text{INDEX GEN})$		$(\downarrow \text{INDEX GEN}) \subseteq (\uparrow \text{INDEX GEN})$

(11)
$$\left[\begin{array}{l} \text{INDEX}\left[\begin{array}{ll}\text{PERS} & \{\text{H}\}\\ \text{NUM} & \text{PL}\end{array}\right] \\ \left\{\begin{array}{l}\left[\begin{array}{ll}\text{PRED} & \text{`pro'}\\ \text{INDEX} & \left[\begin{array}{ll}\text{PERS} & \{\text{H}\}\\ \text{NUM} & \text{SG}\end{array}\right]\end{array}\right] \\ \left[\begin{array}{ll}\text{PRED} & \text{`John'}\\ \text{INDEX} & \left\{\left[\begin{array}{ll}\text{PERS} & \{\}\\ \text{NUM} & \text{SG}\end{array}\right]\right\}\end{array}\right]\end{array}\right\}\end{array}\right]$$

3 Single Conjunct Agreement

3.1 The challenge posed by SCA data

In SCA, grammatical agreement with a coordinated NP is based on the features of just one of the conjuncts. This poses a number of challenges for an LFG analysis of agreement phenomena: the agreement features of the target are conceptually at the conjunct-level (like distributive features) but do not distribute across all conjuncts – so CONCORD is not the correct analysis. Moreover, as we saw in (2) evidence of contrast with other agreement processes (such as pronominal anaphora) may show that the controlling features in cases of SCA are also distinct from the resolved INDEX features of the coordinate NP as a whole. The distinction between distributive and non-distributive features does not, therefore, account for the the behaviour of the agreement features in cases of SCA.

SCA is not a marginal phenomenon but rather it is found in a broad range of languages, sometimes as an option alongside other patterns. The following brief overview is by no means exhaustive. Welsh, Irish and other Celtic languages show rightward SCA in predicate-argument agreement. In these languages, V, N and P heads preceding coordinated pronominal NPs agree with the initial conjunct (McCloskey, 1986; Rouveret, 1994; Sadler, 1999, 2003). Standard Arabic has the option of closest conjunct agreement in VS order, but uses resolved agreement in SV constructions (Aoun et al., 1994, 1999; Munn, 1999), and SCA is also found in Arabic vernaculars. It is described for Ndebele (Moosally, 1998) and Swahili (Marten, 2000, 2005). There is a variety of SCA data described for a number of Slavic languages, including some cases in Slovene of first conjunct agreement with target to the right ("furthest conjunct agreement") (Corbett, 1983, 1988). Portuguese has an option of both rightward and leftward closest conjunct agreement in head-modifer constructions (i.e. within NP) (Villavicencio et al., 2005) and other cases of SCA in Spanish and Portuguese are discussed in Camacho (2003) and Munn (1999)

Since there has been an extensive discussion of the data in the literature, we will here expand only on two particularly challenging observations: the option of "double edged" SCA in Portuguese, and the option of "furthest conjunct agreement" in Slovene.

3.1.1 Double edged single conjunct agreement

A particularly interesting pattern of SCA within coordinate NPs is found in Portuguese (de Almeida Torres, 1981; Villavicencio et al., 2005). Alongside the standard strategy of resolution illustrated in (12) (the resolution gender for MASC/FEM combinations is MASC), SCA is an option for *postnominal* adjectives, which then agree with the closest conjunct, as shown in (13).

(12) a. a parede e a janela vermelhas/*vermelhos
[the.FSG wall.FSG and the.FSG window.FSG] red.FPL/red.MPL
"the red wall and window"

b. a parede e o teto coloridos
[the.FSG wall.FSG and the.MSG ceiling.MSG] coloured.MPL
"the coloured wall and ceiling"

(13) a. estudos e profissão monástica
[studies.MSG and profession.FSG] monastic.FSG
"monastic studies and profession"

b. As maldições se cumpriam no povo e gente hebreia
The curses REFL fell [in the.MSG people.MSG and persons.FSG] Hebrew.FSG
"The curses fell on the Hebrew people."

c. O objectivo está claro: é perder, em pouco tempo, os quilos e as dobrinhas
the objective is clear: is to lose in little time, [the.MPL kilos.MPL and the fatty tissue.FPL]
acumuladas no inverno.
accumulated.FPL in the winter
"The objective is clear: to lose quickly the kilos and fat accumulated during the winter."

In situations where *prenominal* modifiers take scope over both conjuncts, SCA is highly preferred, and agreement is with the closest conjunct (14). However, some examples showing resolved number agreement (15) were found in the corpus study of Villavicencio et al. (2005).

(14) a. suas próprias reações ou julgamentos
his.FPL own.FPL [reactions.FPL or judgement.MPL]

b. pequenas partículas ou átomos
small.FPL [particles.FPL or atoms.MPL]

(15) a. os novos chefe e vice-chefe
the.MPL new.MPL [chief.MSG and vice-chief.MSG]

b. claras maioria e oposição
clear.FPL [majority.FSG and opposition.FSG]

Since modifiers at both the left and the right of a coordinated NP may show SCA, it follows that it may occur simultaneously *both prenominally and postnominally* with a single coordination.[3]

(16) a. Reconhecendo que a garantia de um tratamento igual para as mulheres e homens
recognising that the guarantee of a treatment equal for the.FPL [women.FPL and men.MPL]
refugiados pode exigir acções específicas a favor das mulheres.
refuge-.ADJ.MPL could demand actions specific to favour of the women
"To recognize that the guarantee of an equal treatment of the female and male refugees could make specific actions in favour of the women necessary."
http://www.cidadevirtual.pt/acnur/acn_lisboa/excom64.html

b. Os mitos e lendas brasileiras
the.MPL [myth.MPL and legend.FPL] Brazilian.FPL

[3]Of course, since MASC is the resolution gender, the occurrences of MASC agreement in these examples could be due to resolution operating alongside SCA within the same structure, but even under the most restrictive interpretation there is clear evidence of SCA both to the left and to the right in Portuguese NPs.

3.1.2 First Conjunct Agreement with rightward targets

A robust generalization about SCA seems to be that it occurs much more frequently in structures in which the agreement target precedes the agreement controller. Cases of SCA where the target is to the right of the nominal controller include the following from Slovene. These examples are also crosslinguistically unusual in that it is the furthest (rather than the closest) conjunct which is controlling agreement.

(17) a. Groza in strah je prevzela vso vas.
[horror.FEM.SG and fear.MASC.SG] has seized.FEM.SG the-whole village
"Horror and fear have seized the whole village." (Corbett 1983: 180)

b. knjige in peresa so se poražile.
[book.FEM.PL and pen.NEUT.PL] are selves got dear.FEM.PL
"Books and pens have become more expensive." (Corbett 1988: 26)

3.1.3 Data Summary

In summary, we see that the existence of patterns in which a single conjunct controls (some) agreement processes considerably complicates the array of possible strategies for syntactic agreement with (nominal) coordinate structures. In addition to (18-1) and (18-2) we must accommodate a number of further patterns.

(18)
1. Agreement with resolved coordination-level features
2. Grammatical concord at conjunct-level with *all* conjuncts (distributed)
3. Closest conjunct agreement (leftward or rightward)
4. Double edged closest conjunct agreement (both leftward and rightward)
5. First conjunct agreement with rightward targets [rare]

3.2 Previous approaches

Previous work on this phenomenon in LFG has explored a range of possible approaches to SCA using LFG's standard formal devices. We briefly outline some of this work in this section and suggest that it has a number of shortcomings before outlining a rather different approach in the following section. Existing approaches can be classified as *representation-based approaches* (Sadler, 1999, 2003; Villavicencio et al., 2005) or *description-based approaches* (Sadler, 1999, 2003; Falk, 2006); Asudeh (2005) can be characterised as a *"mixed" approach.*

3.2.1 Representation-based approaches

Representation-based approaches encode the agreement features of the appropriate single conjunct on the coordination structure as a whole, as the value of an additional feature alongside the INDEX feature which contains the resolved features of the coordinate structure as a whole. The appropriate annotations are specified on the coordination rule and agreement constraints are specified in terms of this additional feature. For example, in the following, AGR is the feature carrying the agreement features of the distinguished conjunct (Sadler, 1999, 2003).[4]

[4]The template call @ NP-CONJUNCT ensures that the standard f-annotations as in (10) are inserted for each conjunct.

(19) NP ⟶ NP CONJ NP
@ NP-CONJUNCT @ NP-CONJUNCT
(↓IND) = (↑ AGR)

Predicate argument agreement is expressed as a constraint over the AGR feature and the constraint in (20) is intended to feed the appropriate value to AGR in non-coordinate structures, so that the agreeing predicate outside the coordination can simply constrain AGR features irrespective of whether or not the argument is itself a coordination. Other agreement processes, notably pronominal and reflexive anaphora, involve the INDEX feature rather than the AGR feature. The representation of the coordinate NP in an example such as (21) is given in (22).

(20) *Constraint on Nominal Lexemes:* (↑ INDEX) = (↑ AGR)

(21) Dw i a Gwenllian heb gael ein talu. Welsh
am.1S [1S and Gwenllian] without get 1PL pay
"Gwenllian and I have not been paid."

(22)
$$\left[\begin{array}{l} \text{INDEX}\left[\begin{array}{ll}\text{PERS} & \{\text{S}\}\\ \text{NUM} & \text{PL}\end{array}\right] \\ \text{AGR} \\ \left\{\begin{array}{l}\left[\begin{array}{ll}\text{PRED} & \text{'pro'}\\ \text{INDEX} & \left[\begin{array}{ll}\text{PERS} & \{\text{S}\}\\ \text{NUM} & \text{SG}\end{array}\right]\\ \text{AGR} & \end{array}\right] \\ \left[\begin{array}{ll}\text{PRED} & \text{'Gwenllian'}\\ \text{INDEX} & \left[\begin{array}{ll}\text{PERS} & \{\}\\ \text{NUM} & \text{SG}\end{array}\right]\\ \text{AGR} & \end{array}\right]\end{array}\right\}\end{array}\right]$$

There are several drawbacks of this approach. It introduces a technically motivated feature-passing mechanism into the f-structure representation, something which LFG tries in general to avoid, and which is as problematic and inelegant as any other book-keeping feature. This non-distributive, coordination-level feature (AGR) is used to encode properties of an individual conjunct, blurring what is otherwise a clear conceptual separation between distributive (individual) and non-distributive (resolved) agreement features. Moreover double edged closest-conjunct agreement such as that which arises in Portuguese NPs can only be captured with a highly technical book-keeping representation using two sets of single-conjunct agreement features at the coordination level.

Postnominal ADJ agreement in Portuguese might be treated as follows on this approach:[5]

(23) NP ⟶ NP A+
↑ = ↓ ↓ ∈ ↑ ADJ
(↓ A-POSN) =$_c$ POSTNOM

(24) NP ⟶ NP Conj NP
↓ ∈ ↑ ↑ = ↓ ↓ ∈ ↑
(↓ IND GEN) ⊆ (↑ IND GEN) (↓ IND GEN) ⊆ (↑ IND GEN)
(↓IND) = (↑ LAGR)

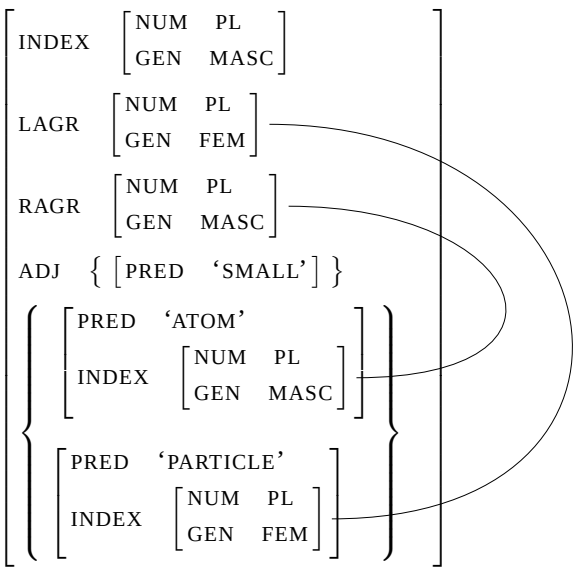
(25) *acumuladas* (↑ PRED) = 'ACCUMULATED'
(↑ A-POS) = POSTNOM
{ ((ADJ ∈ ↑) LAGR GEND) = FEM
((ADJ ∈ ↑) LAGR NUM) = PL
| ((ADJ ∈ ↑) IND GEND) = FEM
((ADJ ∈ ↑) IND NUM) = PL }

[5]Note that (25) includes inside-out designators for "leaving" the ADJUNCT set in which the adjective is introduced – these have nothing to do with the set we are dealing with for coordination.

To allow for percolation of features from both the rightmost and the leftmost conjunct you need in fact to distinguish both LAGR and RAGR at the level of the coordination (Villavicencio et al., 2005), leading to an f-structure along the following lines.

(26) pequenas partículas ou átomos
small.FPL [particles.FPL or atoms.MPL]

(27)



3.2.2 Description-based approaches

In contrast to a representation-based approach, a description-based approach would assume no additional representation either at the level of the coordinate structure or at the level of the individual conjunct. One possibility is to resort to a more complicated description on the agreement target itself to ensure that it is the agreement features of the distinguished conjunct that are picked up when the argument is a coordinate structure. The appropriate agreement controller might be picked out using f-precedence (Sadler, 1999; Falk, 2006).

(28) *F-precedence* (Kaplan and Zaenen, 1989/95)
f_1 f-precedes f_2 if and only if there are c_1 and c_2 such that c_1 is a rightmost element in $\phi^{-1}(f_1)$, c_2 is a rightmost element in $\phi^{-1}(f_2)$, and c_1 precedes c_2. (formulation of Bresnan (2001))

Description-based approaches formulate constraints in the lexical entry of agreement target (outside the coordination) that agree directly with the distinguished conjunct.[6] Thus in the case of Welsh, the V, N, or P expresses constraints over the linearly first member of the coordinate structure.[7] Consider for example the case of prepositional agreement in (29).

[6] A possible alternative is to use a tree-logic description of the SCA configuration (Kuhn, 2003) to avoid recourse to f-precedence. However this means using a very powerful tool to describe what is intuitively quite a simple relationship. Since agreement is clearly an f-structure phenomenon, any attempt to adress SCA by explicitly referring to c-structural aspects of the coordinate structure *in the lexical descriptions of the targets* does not seem to be quite appropriate.

[7] This account abstracts away from a number of subsidiary complications in the Celtic data involving the interaction with unbounded dependency constructions. Since these are orthogonal to our essentially formal point about types of approaches to SCA we do not discuss these intricacies further here.

(29) Roedd Wyn yn siarad amdanat ti a Siôn. Welsh
was.3S Wyn PROG speak about-2S [2S and Siôn]
"Wyn was talking about you and Siôn."

The relevant agreement constraint on the agreement target (the preposition, which agrees with its OBJ), would require something along the following lines:[8]

(30) *amdanat* (↑ PRED) = 'ABOUT⟨(↑ OBJ)⟩'
{ (↑ OBJ) = %A
| %A ∈ (↑ OBJ)
¬[(↑ OBJ ∈) $<_f$ %A] }
(%A PERS) = 2
(%A NUM) = SG

Although this sort of approach avoids the need to litter the representation with otherwise unmotivated features, a description-based approach along these lines necessitates a disjunctive formulation of all agreement constraints (on the target side), to allow for the presence or absence of coordination in the argument. Since the agreement contraints pick out the distinguished conjunct (from the set) directly, the account as outlined above does not generalize directly to cases of nested coordination, and such cases do exist, as shown in (31).

(31) Wyt ti a fi neu Peter a Mary yn mynd i ennill.
is.2SG [[2SG and 1SG] or [Peter and Mary]] PT go PT win
"Either you and I or Peter and Mary are going to win."

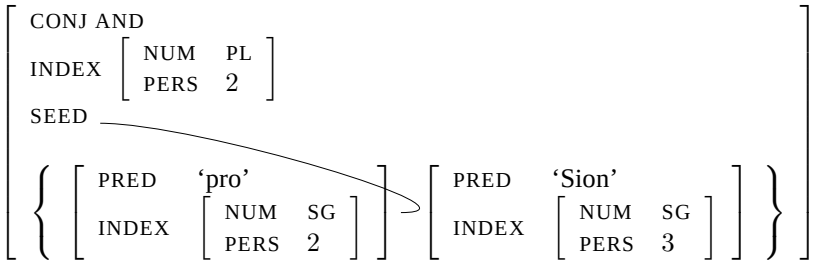
F-precedence itself is a very powerful tool and provides a very indirect way of referring to something that is intuitively quite simple, namely finding the "leftmost" or "rightmost" set element.

3.2.3 "Mixed" SCA account

Finally, it should be pointed out that elements of the description-based and the representation-based accounts can be combined, as they are in the proposal of Asudeh (2005). Asudeh proposes a representation in which the distinguished conjunct is both a member of the set (corresponding to the coordinate structure) and also the value of an additional attribute SEED within this same (hybrid) structure. He argues that this is independently motivated by its role as the "seed" in meaning construction for conjunction (Asudeh and Crouch, 2002). The representation of the coordinate NP in (32) is shown in (33).

(32) Daethost ti a Siôn.
came-2S [2S and Siôn]
"You and Siôn came."

[8]The use of ∈ in a feature path description such as "(↑ OBJ ∈)" in (30) allows one to pick up an arbitrary set element. The notation "%A" introduces a local variable for an f-structure, so the reference can be fixed across several f-equations. "¬[(↑ OBJ ∈) $<_f$ %A]" says that there cannot be any set elements f-preceding the f-structure fixed as %A – so it must be the leftmost element.

(33)


The relevant conjunct is picked out as the seed conjunct by means of constraints using f-precedence in the annotation of the conjunction, shown in (34), and the agreement constraints on the target make reference to the SEED (in the case of coordinate structures).

(34) *and* $(\uparrow \text{CONJ}) = \text{and}$
$(\uparrow \text{SEED}) = (\uparrow \in)$
$\neg\, [\, (\uparrow \in) <_f (\uparrow \text{SEED}\,)\,]$

(35) *daethost* $(\uparrow \text{PRED}) = \text{‘COME}\langle \text{SUBJ}\rangle\text{’}$
$(\%\text{A PERS}) = 2$
$(\%\text{A NUM}) = \text{SG}$
$(\%\text{A PRED FN}) = \text{PRO}$
$((\,\%\text{A PRED}) = \text{‘PRO’})$
$\{\, (\uparrow \text{SUBJ SEED}) = \%\text{A} \mid (\uparrow \text{SUBJ}) = \%\text{A} \wedge \neg\, (\uparrow \text{SUBJ SEED})\,\}$

Note that on this account too, a disjunctive statement is needed for the agreement constraints (checking for the presence of a SEED feature in the last line of (35)). Moreover it seems that both nested coordinations and double edged SCA are problematic on this account.

3.2.4 Previous accounts: summary

We conclude that all previous accounts of SCA, which are based on the standard unordered set-based analysis of coordination, suffer from a range of technical inelegancies and/or empirical difficulties.

4 Proposal

As discussed in Section 1, the challenge posed by SCA is to keep the statement of agreement constraints maximally general (i.e., to avoid disjunctive, coordination-specific descriptions on the agreement targets such as verbs) while at the same time avoiding the augmentation of the f-structure representation for NP coordination with purely technical book-keeping features.

The solution we propose is a description-based approach in that it does not involve the addition of any additional features or embeddings in the f-structure representation. It does however change the formal character of the original set representation assumed for the coordinate structure. Sets are unordered, so there is no formal way of singling out particular elements by an operation that applies directly to the set. This makes it necessary to employ auxiliary constructs, i.e., either adding one or more explicit technical features at the coordination level, or indirectly falling back to c-structure (via f-precedence or possibly tree-logic descriptions) to recover linear precedence information that is missing from f-structure.

It is a meta principle of LFG to use formal representations displaying the desired modelling properties for the various parts of grammatical theory. We think that the technical issues posed by SCA

for the standard set representation in coordination may be an indication that in this case, the formal properties of the representational device chosen are simply not fully adequate.[9] We propose the use of a slightly more structured representation for the collection of conjunct f-structures, what we call "local f-structure sequences" (lfsq's).

4.1 Singling out the contribution of a particular conjunct at f-structure

It is uncontroversial that agreement is a phenomenon that should be encoded at the level of f-structure. Since SCA facts show that agreement can be not only sensitive to (i) properties of the coordinate structure as a whole, or (ii) common properties of all the individual conjuncts – i.e., distributive properties, but also (iii) to properties of only the first or last conjunct, there should be a direct way *in f-structure* of picking up the relevant properties of the first or last conjunct.

One way of implementing this would be to define a new notation for deterministically picking up a particular element of an ordered set (maybe ($\uparrow$OBJ $\in_{first}$ GEND) for picking up the first element's gender information).[10] This would however be a much more powerful tool than what the SCA issues seem to call for. At the same time, the notation would not resolve the issue that agreement constraints on the agreement target (the verb) should not be disjunctive, distinguishing a coordination and non-coordination case.

What we propose instead is to use the same notational "trick" that Kaplan and Maxwell (1988/95) used to account for the extended space of possible interpretation that a constraint like ($\uparrow$OBJ NUM)=SG can have. Ultimately, we will provide a third version of the notational convention (after (6) and (7)) that will make it possible to use this plain function application notation in the description of agreement targets like verbs, with the effect that they will be interpreted either (i) non-distributively at the coordination level, (ii) by classical conjunct-level distribution, or (iii) according to the SCA strategy, i.e., as applying to just one particular conjunct.

To trigger the various options, we assume a more fine-grained feature distinction affecting conjunct-level f-descriptions (the classical distributive feature descriptions): besides distributive features, there is a new type of "overlay" features, for which only the first or last element of the coordination representation is taken into account (the term "overlay" suggests that when looking at the coordination representation from the left or right, only the features of the peripheral element become

[9] Several of the properties that come with a set representation are questionable to a certain extent. For space reasons we only list them here briefly:

(i) No order among elements:

"I met Sue$_i$ and her$_i$ sister." vs. "I met her$_{*i}$ sister and Sue$_i$."

"Bill went to the city and rented a bike." vs. "Bill rented a bike and went to the city."

(ii) No duplicates

(The effect of this cannot normally be seen in LFG due to the instantiated interpretation of PRED values, but intuitively it is not clear why there should be the principled possibility of having two conjuncts that map to the same set element.)

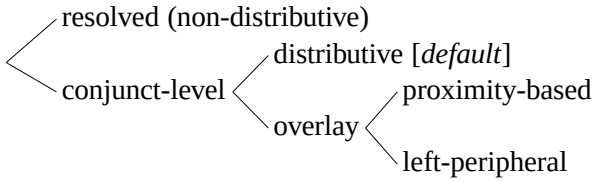
"Our Wednesday schedule is Biology, Maths, Maths and French"

(iii) No reference to a specific element possible from "outside" (only an arbitrary member can be picked); this is the issue brought up by SCA.

[10] The ordering of the set would have to be defined as the elements are added by $\downarrow\in\uparrow$ constraints. For this, the notion of head precedence could be used, as implemented in XLE in order to model for instance the scoping order of adjectival modifiers in an ADJUNCT set. By specifying membership as "$\downarrow\in_{<_h<_s}\uparrow$" (in XLE notation: "! $<h<s ^"), scoping relations among the f-structure set elements are added, which follow the surface (head-precedence) order. An approach for SCA along these lines was suggested by Ron Kaplan in the discussion of the present paper at LFG07. Head precedence is computationally more manageable than full-fledged f-precedence, as the c-structural location at which the instantiated PRED value for an f-structure is introduced provides a clear, unique anchoring point.

visible, hiding the conjunct-level features of the other elements).[11] Features can be declared to be from one of the following classes:

(36) *Classification of features*



4.2 Aspects of locality

In principle, the intuitive "overlay" effect could be modelled in a standard set, augmented with some concept of precedence (either f-precedence, or head precedence, cf. Footnote 10): one could define an alternative to distribution that will pick out the first or last (in terms of the precedence relation) set element instead of distributing to all elements. (The decision of picking out the first vs. last element would have to be taken care of in the grammatical constraints describing agreement targets.)

However, this would not seem to model the effect that is really at play: Imagine a hypothetical c-structural configuration in which set elements are introduced not just within a single coordinate (NP) structure, but there are several, spatially separated exponents in c-structure, each of which contributes one or more elements to the same set in f-structure (a situation in which such an analysis would not be *entirely* unreasonable might be the case of extraposed "additions" to a coordinate structure like in "I saw an elephant and a zebra at the zoo yesterday, and a giraffe" – for our thought experiment, we would put the f-structures from *an elephant*, *a zebra* and *a giraffe* all in the same f-structure set under OBJ). If this phenomenon interacts with SCA and the agreement target sits between c-structural contributors to the set, would we expect that the single conjunct controlling agreement would always be the *globally* peripheral set element? This is what a general set-based approach would force us to assume. If a language has a strategy of SCA with targets preceding the controlling coordinate structure, we would rather expect that the next conjunct to the right of the target would be controlling agreement.

We believe that global aspects of precedence are not the driving force behind SCA. The fact that an overwhelming proportion of SCA phenomena are indeed *closest* conjunct agreement and the existence of double edged SCA point to a c-structural *proximity* effect, which requires a more local account.[12]

4.3 Local f-structure sequences

In order to be able to derive the locality effect, it is not sufficient to compare the set elements in terms of precedence. The relative position of the agreement target has to be taken into account too. We propose a technical solution that folds this check of proximity into the notational convention of function application in the presence of a coordination structure (a revised form of (6) and (7)).

In order to have a handle on the left and right edge of a coordination structure (from the point of view of f-structure), we assume a somewhat more structured and constrained representation structure

[11] A further distinction of overlay feature into proximity-based and peripheral features becomes necessary in order to be able to model the rare "furthest conjunct agreement" phenomenon.

[12] The rare cases of "furthest conjunct agreement" could be seen as evidence for a global effect. However, they would also be compatible with a salience-based, more local explanation: in these special coordinate structures, the speaker's attention may be attached to the first element and agreement – following speaker's attention – will "skip" the closer conjunct. For such a speaker's attention-based account (which would certainly require further elaboration), a locally confined representation would also seem more appropriate than a global representation.

than the classical set: what we call *local f-structure sequences* (lfsq's). Elements are ordered, and crucially, reference to the first and last element is possible: f_L, f_R (this will be used only in the notational convention however, so there seems to be no need to introduce new designators to LFG's functional description language). In order to exclude the puzzling hypothetical cases of multiple exponence for a single coordination, we posit that lfsq's have a unique anchoring point in c-structure, which has to be explicitly defined in the annotations of the coordination rule (see the *lfsq*(↑,$\mathcal{M}*$) annotation in (37), which defines the upper NP node (the mother of the conjunction) as the anchoring point for the lfsq referred to by ↑).[13]

(37) *Coordination rule*

NP	→	NP	CONJ	NP
		$\downarrow \in_{lfsq} \uparrow$	*lfsq*(↑,$\mathcal{M}*$)	$\downarrow \in_{lfsq} \uparrow$
			↑=↓	

We are now in a position to formulate the refined version of the notational convention for the interpretation of function application ((38) below). Since the unique c-structural anchoring point of an lfsq is known (and can be stored during the process of f-structure constraint resolution), we can compare the anchoring point's string range (the word index of the first and last words it dominates) with the string range of any other node – in particular the nodes at which an f-description is introduced that includes a function application "entering" the coordinate structure representation, as it is introduced by the agreement target. For the proximity-based features, the interpretation of a path description will depend on the relation between the two string ranges: the left-most f-structure element of the lfsq will be picked in case the path description is to the left of the anchoring point; the right-most if it is to the right. The description may also originate from inside the coordinate structure, in which case a direct interpretation is chosen.

(38) *Notational convention (version 3)*

Interpretation of $(f\ a) = v$ in an f-annotation at a node with string range s_i-s_j:

- If (i) f is a plain f-structure, or (ii) f is a set or lfsq and a is declared as a **non-distributive** feature, then $(f\ a)$ includes the information in v.
- Otherwise, if f is a set or lfsq:
  - if a is declared as a **left-peripheral** feature, then $(f_L\ a)$ includes the information in v;
  - if a is declared as a **proximity-based** conjunct-level feature:
    - if f's c-structure anchor *precedes* string range s_i-s_j, then $(f_L\ a)$ includes the information in v;
    - if the anchor *follows* the string range, then $(f_R\ a)$ includes the information in v;
    - if the anchor falls into the string range: $(f\ a)$ includes the information in v
  - if a is **distributive**, then for every $g \in f$, $(g\ a)$ includes the information in v.

Since the technical distinctions are defined once and for all as a part of the general machinery (they are "behind the scenes" from the point of view of actual grammar specification), the descriptions needed to deal with SCA in lexical or rule annotations become surprisingly simple. Figures 4 and 5 show essentially the full set of required annotations if in the language under consideration, the agreement features are defined as proximity-based. The target's agreement description is propagated down to

[13] Alternatively, one could introduce the convention that the mother node for a $\downarrow \in_{lfsq} \uparrow$ annotation automatically becomes the anchoring point.

the appropriate set element, thanks to the more fine-grained notational convention. (What is ignored here is the INDEX/CONCORD distinction, which is compatible with the proposed modification of the formalism, and which is required to account for the simultaneous existence of non-distributive and conjunct-level features in one language.)

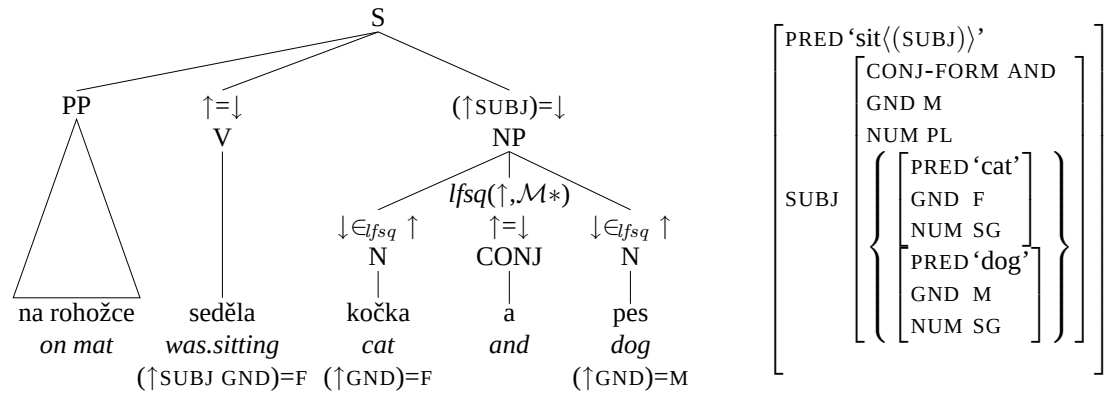


Figure 4: Representations and descriptions in SCA (example (1))

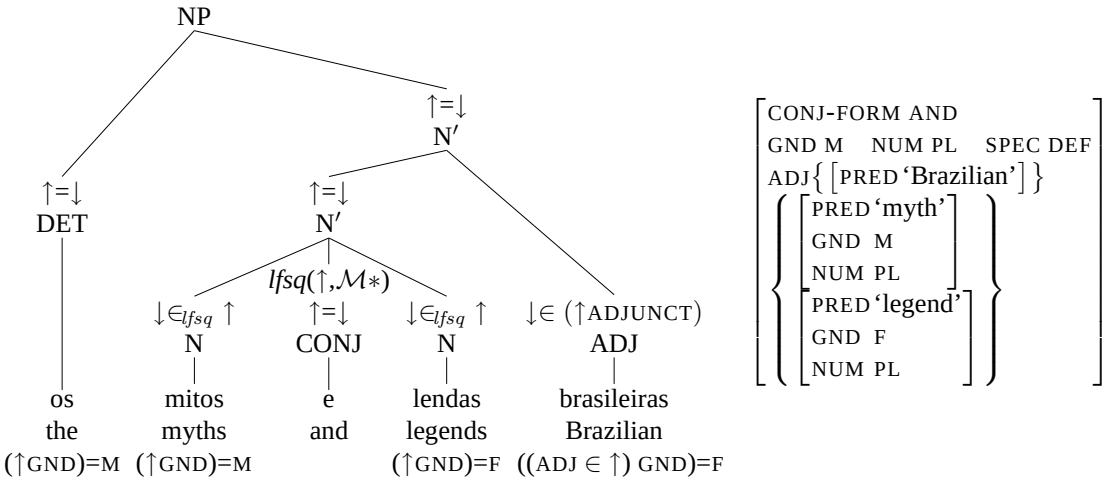


Figure 5: Representations and descriptions in double edged SCA (example (16b))

4.4 Discussion: changes to the LFG formalism

We think that the proposed account follows the original spirit of LFG – division of labour between representation and description, and the assumption of appropriate formal devices to represent the linguistic properties of the described entities. A limited degree of sensitivity to string-level proximity is introduced to the resolution of f-descriptions; this constitutes a considerable change in the character of f-structural constraints. However, the characteristics of the SCA phenomenon suggest that agreement *is* more sensitive to proximity than the classical division of labour between c-structure and f-structure allows the grammarian to express (other than in a rather round-about way). By introducing carefully controlled string precedence conditions in the notational apparatus, the original intuitive constraint formulation can be kept up for agreement in general – now extending to SCA.

The mechanism is less expressive than f-precedence (which is computationally problematic[14]), but more focused on the generalizations underlying the data.

5 Conclusion

We proposed an alternative way of looking at a long-standing issue in LFG and constraint-based theories of SCA more general. All attempts of formalizing SCA within the standard framework for coordination seem overly technical and unintuitive (at least when applied to double edged SCA like in Portuguese, or to nested coordinations).

By introducing a limited sensitivity to string proximity into the *interpretation* of f-descriptions as they are resolved in model construction, the original concise and intuitive descriptions for agreement constraints can be recovered.[15] Our analysis is essentially description-based, since the crucial effects are brought about without adding technical bookkeeping devices to the representation. In order to be able to make this change, we made small adjustments to the formal character of the representation structures assumed: we replaced sets in the f-structure representation of coordinate structures by local f-structure sequences (lfsq's). This is an example of taking LFG's meta principle seriously that underlying representation types and means of description should be chosen to match the needs from clear linguistic generalizations.

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[14] In the XLE implementation of LFG, head precedence is provided as an approximation that relies just on the PRED-introduction c-structural element, not all nodes mapped to a given f-structure. In fact, XLE already goes a fairly long way towards ordered sets, as for instance scope statements can be added to set members (see Footnote 10). XLE also provides ways of influencing f-structure model building in the grammar code: the predefined template @COMPLETE can be used in an f-annotation to enforce "early" checking of constraining equations (compare the XLE online documentation at `www2.parc.com/isl/groups/nltt/xle/doc/`). While this mechanism cannot be used to implement our account, it indicates that there are other situations in which a strictly global view on the full sentence's f-structure is not desirable (at least computationally).

[15] Of course, this type of proposal comes with a certain danger: it is uncommon in linguistic LFG theorizing to propose modifications of the technical LFG devices that are "behind the scenes". This fact is probably quite healthy for the LFG community, as it ensures a clear and technically well-defined common ground shared in practically all LFG work. "Experimentation" is typically done by assuming extra projection levels. But since SCA is a phenomenon that has been tackled many times within the common ground system, it may be legitimate to take deeper modifications into consideration – in particular as they seem to fit into the overall system very smoothly. Of course, future work will have to show whether the approach can also resolve other empirical phenomena, as further justification for the adjustments.

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