AGREEMENT PATTERNS AND COORDINATION IN LEXICAL FUNCTIONAL GRAMMAR

Mary Dalrymple and Bozhil Hristov
University of Oxford

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Abstract

Coordination and its interactions with agreement have been a focus of research in Lexical Functional Grammar over the past decade, though an account that captures the full range of agreement patterns in an elegant manner has proved elusive. Many previous proposals account for patterns of feature resolution but do not extend to single-conjunct agreement. Other proposals address single-conjunct agreement, but provide an account of standard resolution patterns that is less than satisfying. We provide a means of stating a typology of agreement patterns that handles resolution and single-conjunct agreement, as well as agreement requirements that apply in an across-the-board fashion to all of the conjuncts of a coordinate phrase.

1 Agreement in LFG

We begin with basic agreement patterns in Serbian/Croatian/Bosnian (SCB) and their treatment in LFG. In example (1), the determiner *moja* 'my' and the modifier *stara* 'old' show feminine singular agreement with the noun they modify, *knjiga* 'book', which is listed in the lexicon as a feminine singular noun. The predicative past participle *pala* 'fallen' also shows feminine singular agreement.[1]

(1) Modifier and verb agreement (Wechsler and Zlatić, 2003, 18):

my.F.Nom.Sg old.F.Nom.Sg book.F.Nom.Sg Aux.3Sg fall.PPart.F.Sg
'My old book fell.' (SCB)

As in most constraint-based linguistic theories, agreement in LFG is treated as multiple specification of feature values by a controller and target (Kaplan and Bresnan 1982; Bresnan 2001, chap. 8; Dalrymple 2001, chap. 5). In (1), the modifiers, noun, and predicate cospecify the number and gender features of the subject, as shown in (2), where the labels f and s are used as labels for the parts of the functional structure, and s=(f SUBJ):

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[1]Abbreviations: M: masculine; F: feminine; N: neuter; Sg: singular; Pl: plural; PPart: past participle. Examples from other sources use the same transcription conventions as in the source.

(2) *moja* ‘my’: (s GEND) = F
(s NUM) = Sg

stara ‘old’: (s GEND) = F
(s NUM) = Sg

knjiga ‘book’: (s GEND) = F
(s NUM) = Sg

pala ‘fall’ (f SUBJ GEND) = F
(f SUBJ NUM) = Sg

$$f:\begin{bmatrix}\text{PRED} & \text{‘fall’} \\ \text{SUBJ} \quad s: & \begin{bmatrix}\text{PRED} & \text{‘book’} \\ \text{SPEC} & \text{‘my’} \\ \text{ADJ} & \{[\text{PRED} \quad \text{‘old’}]\} \\ \text{GEND} & \text{F} \\ \text{NUM} & \text{Sg}\end{bmatrix}\end{bmatrix}$$

2 INDEX vs. CONCORD agreement

In example (1), a single set of agreement features is proposed for agreement with determiners, prenominal modifiers, and predicates. However, the picture is in fact more complicated.

Traditional grammatical approaches have long recognised two types of agreement features, which Wechsler and Zlatić (2003) call INDEX and CONCORD features (see also Kathol 1999, Corbett 2001). Both are syntactic features, but as Wechsler and Zlatić show, INDEX features are more closely related to semantic features, while CONCORD features are more closely related to morphological declension. Wechsler and Zlatić explore agreement patterns with SCB nouns which have different INDEX and CONCORD features, with CONCORD features often relevant for noun phrase internal agreement, and INDEX features often relevant outside the noun phrase. Syncretism in the nominal paradigms means that determination of which features are involved in agreement is not completely straightforward.

The noun *deca* ‘children’ has mismatched CONCORD and INDEX features: it has feminine singular CONCORD but neuter plural INDEX. An example of *deca* with attributive and predicative agreement is given in (3):

(3) Ta dobr-a deca su došl-a
that.F.Sg good-F.Sg children Aux.3Pl come.PPart-N.Pl
‘Those good children came.’ (SCB; Wechsler and Zlatić, 2003, 51)

The *-a* ending on the determiner, the adjective, and the verb is ambiguous between F.Sg and N.Pl. However, it is easy to show that in general, agreement with determiners and attributive adjectives depends on the CONCORD feature, because all non-nominative attributive modifiers with *deca* are unambiguously F.Sg (Corbett, 1983, 81). Example (4) shows that the unambiguously feminine singular accusative adjective *dobru* ‘good’ is used to modify accusative ‘children’:

(4) ... svoje sestre, koja inače ima dobr-**u** dec-**u**.
own.Gen sister.Gen, who otherwise has good-**F.Sg.Acc** children-**Acc**
'... of my own sister, who, otherwise, has good children.' (SCB)
http://charolija.wordpress.com/2009/01/07/praviti-se-normalan-2/
(accessed on 08.12.09)

Example (5) is similar, with an unambiguously feminine singular accusative possessive determiner:

(5) Kad sam video njegov-**u** dec-**u**, znao sam ...
When Aux.1.Sg seen his-**F.Sg.Acc** children-**Acc**, realised Aux.1.Sg
'When I saw his children, I realised...' (SCB)
http://www.mojheroj.com/heroj.aspx?h=139 (accessed on 08.12.09)

Based on these patterns, we will analyse attributive agreement as involving the CONCORD feature, since — despite nominative attributive elements being ambiguous between F.Sg and N.Pl — non-nominative elements with *deca* 'children' and *unučad* 'grandchildren' are unambiguously F.Sg, and must be analysed as instances of CONCORD and not INDEX agreement.

The predicate in example (3) is also ambiguous between F.Sg and N.Pl. However, the auxiliary is unambiguously plural, and we take this as an indication that the main verbal predicate is plural (and therefore should be analysed as N.Pl rather than F.Sg), following Corbett's Agreement and Predicate Hierarchies (Corbett, 2006). We return to this issue in Section 6 below.

Having established a distinction between INDEX and CONCORD features, we enrich our representation of agreement features to take this distinction into account:

(6)

ta 'that':
(s CONCORD GEND) = F
(s CONCORD NUM) = Sg

dobra 'good':
(s CONCORD GEND) = F
(s CONCORD NUM) = Sg

deca 'children':
(s CONCORD GEND) = F
(s CONCORD NUM) = Sg
(s INDEX GEND) = N
(s INDEX NUM) = Pl

došla 'came':
(f SUBJ INDEX GEND) = N
(f SUBJ INDEX NUM) = Pl

$$f:\begin{bmatrix}\text{PRED} & \text{'come'} \\ \text{SUBJ} \quad s: & \begin{bmatrix}\text{PRED} & \text{'children'} \\ \text{SPEC} & \text{'my'} \\ \text{ADJ} & \left\{\begin{bmatrix}\text{PRED} & \text{'good'}\end{bmatrix}\right\} \\ \text{INDEX} & \begin{bmatrix}\text{GEND} & \text{N} \\ \text{NUM} & \text{Pl}\end{bmatrix} \\ \text{CONCORD} & \begin{bmatrix}\text{GEND} & \text{F} \\ \text{NUM} & \text{Sg}\end{bmatrix}\end{bmatrix}\end{bmatrix}$$

3 INDEX VS. CONCORD in coordination

King and Dalrymple (2004) provide a theory of agreement with coordinated nouns which relies on the distinction between **distributive** and **nondistributive** features

in coordination. Dalrymple and Kaplan (2000) present the following definition of function application for coordinate structures, taking into account the distributive/nondistributive distinction:

(7) For any *distributive* property P and set s, $P(s)$ iff $\forall f \in s.P(f)$.
For any *nondistributive* property P and set s, $P(s)$ iff P holds of s itself.

Features are individually classified as either nondistributive (properties of the coordinate structures as a whole) or distributive (properties of the conjuncts, or members of the coordinate set). King and Dalrymple (2004) provide evidence that INDEX is a nondistributive feature: the coordinate phrase has its own INDEX features, which may be different from the INDEX features of the conjuncts, as will be demonstrated in the next section. In contrast, the CONCORD feature is distributive: the CONCORD feature of a coordinate structure depends on the CONCORD value of each conjunct.

This provides a neat explanation for the otherwise puzzling English pattern shown in (8):

(8) This$_{\text{Sg}}$ boy and girl are$_{\text{Pl}}$ classmates.

English determiners show CONCORD agreement, in line with Wechsler and Zlatić's proposal for SCB. Since CONCORD is a distributive feature, the singular determiner *this* can combine with a coordinate phrase in which each conjunct has singular CONCORD, but is incompatible with plural conjuncts:

(9) *this boys and girl / *this boy and girls

Boy and girl meets the agreement requirements imposed by *this*, since each conjunct is singular, and the noun phrase *this boy and girl* is correctly predicted to be well-formed.

English verbs show INDEX agreement.[2] The coordinate phrase *this boy and girl* is semantically plural, and has plural INDEX. Thus, the phrase *this boy and girl* behaves like any other plural noun phrase, and requires plural verb agreement: the sentence *this boy and girl are classmates* is well-formed for the same reason that the sentence *the boys are classmates* is well-formed, namely that a phrase like *this boy and girl* or *the boys* has plural INDEX.

King and Dalrymple's classification of the INDEX and CONCORD feature allows, then, for the following patterns:

- INDEX agreement with the resolved INDEX features of the coordinate phrase as a whole

[2]This is a well-established generalisation, though research is needed on agreement patterns with certain determiners: both singular and plural agreement are attested with determiners such as *each* in examples like *Each boy and girl is/are required to....*

- CONCORD agreement with the CONCORD features of each conjunct

There are, however, other patterns to take into account, as we will see in the following.

4 Feature resolution in coordination

Resolution rules determine the features of a coordinate structure from the features of the individual conjuncts (Corbett, 1983, 2006; Dalrymple and Kaplan, 2000; Dalrymple et al., 2006). Wechsler and Zlatić (2003) provide the generalisation in (10) for gender resolution in SCB (see also Corbett 1991, chap. 9):

(10) Gender and number resolution in SCB (Wechsler and Zlatić, 2003, 174):

F + F ⇒ F.Pl
elsewhere ⇒ M.Pl

According to this rule, a coordinate phrase with two feminine conjuncts is feminine plural, while any other combination of conjuncts produces a masculine plural coordinate phrase. Wechsler and Zlatić (2003) illustrate this rule with the example in (11), where the predicate shows masculine plural agreement with the resolved features of the coordinate subject:

(11) [[Ogledalo] i [četka za kosu]] su bil-**i** na stolu
mirror.N.Sg and brush.F.Sg for hair Aux.Pl were-**M.Pl** on table
'The mirror and the hairbrush were on the table.' (SCB; Wechsler and Zlatić, 2003, 173)

King and Dalrymple (2004) show that resolution rules apply to the INDEX feature: the INDEX feature of a coordinate structure is computed by applying the resolution rule to the INDEX features of the conjuncts. Under these assumptions, a simplified functional structure for the subject in example (11) is shown in (12):

(12)
$$\begin{bmatrix} \text{INDEX} & \begin{bmatrix} \text{GEND} & \text{M} \\ \text{NUM} & \text{Pl} \end{bmatrix} \\ \left\{ \begin{bmatrix} \text{PRED} & \text{'mirror'} \\ \text{INDEX} & \begin{bmatrix} \text{GEND} & \text{N} \\ \text{NUM} & \text{Sg} \end{bmatrix} \end{bmatrix} \begin{bmatrix} \text{PRED} & \text{'brush'} \\ \text{INDEX} & \begin{bmatrix} \text{GEND} & \text{F} \\ \text{NUM} & \text{Sg} \end{bmatrix} \end{bmatrix} \right\} \end{bmatrix}$$

LFG models coordinate structures as sets: the set containing the f-structures for the nouns *ogledalo* 'mirror' and *četka* 'brush' represents the coordinate structure *ogledalo i četka* 'mirror and brush'. The f-structure in (12) shows that while the INDEX features of the individual conjuncts are F.Sg and N.Sg, respectively, the resolved INDEX features of the whole NP are M.Pl, as specified by the resolution

rule in (10). The participle *bili* 'were' shows INDEX agreement with the resolved masculine plural INDEX features of the coordinate phrase *ogledalo i četka* 'mirror and brush'.

We will not address the question of precisely how the gender and number features of the coordinate structure are computed. Rather, we will simply assume that resolution rules of the general form discussed by Dalrymple and Kaplan (2000), Dalrymple et al. (2006) and Sadler (2006) ensure that the coordinate structure acquires the features specified by the gender resolution rule in (10).

Strikingly, the pattern in (10) is found even when both conjuncts are neuter:

(13) [[Ogledalo] i [nalivpero]] su bil-**i**/*bil-**a** na stolu
mirror.N.Sg and fountain.pen.N.Sg Aux.Pl were.**M.Pl**/***N.Pl** on table
'The mirror and the fountain pen were on the table.' (SCB; Wechsler and Zlatić, 2003, 174)

$$\begin{bmatrix} \text{INDEX} & \begin{bmatrix} \text{GEND} & \text{M} \\ \text{NUM} & \text{Pl} \end{bmatrix} \\ \left\{ \begin{bmatrix} \text{PRED} & \text{'mirror'} \\ \text{INDEX} & \begin{bmatrix} \text{GEND} & \text{N} \\ \text{NUM} & \text{Sg} \end{bmatrix} \end{bmatrix} \begin{bmatrix} \text{PRED} & \text{'pen'} \\ \text{INDEX} & \begin{bmatrix} \text{GEND} & \text{N} \\ \text{NUM} & \text{Sg} \end{bmatrix} \end{bmatrix} \right\} \end{bmatrix}$$

5 Single-conjunct agreement

Wechsler and Zlatić (2003) discuss patterns of **single-conjunct agreement** in SCB, in which agreement is with one of the conjuncts of the coordinate phrase, not with the resolved features:

(14) [[Ova varošica] i [sva sela]] su poplavljen-**a** / ?poplavljen-**i**
this.F.Sg town.F.Sg and all.N.Pl village.N.Pl Aux.Pl flooded-**N.Pl** / ?**M.Pl**
'This town and all the villages were flooded.'(SCB; Wechsler and Zlatić, 2003, 54)

Instead of the expected resolution pattern, according to which masculine plural agreement on the predicate would be expected, example (14) exhibits neuter plural predicate agreement: the predicate agrees with the closest conjunct, *sva sela* 'all the villages', not with the resolved features of the coordinate phrase. Such examples are common; example (15) is from our own fieldwork:

(15) [Nova [[kuča] i [kola]]] su koštal-**a** puno.
new.F.Sg house.F.Sg and car.N.Pl Aux.Pl cost-**N.Pl** a.lot
'The new house and car cost a lot.' (SCB; Ana Vlaisavljević, p.c.)

Again, the predicate agrees with the second conjunct, not with the resolved features of the subject noun phrase (we discuss agreement with the adjective *nova* 'new' in Section 7).

Sadler (1999) was among the first to discuss the treatment of single-conjunct agreement in an LFG setting (see also Sadler, 2003; Arnold et al., 2007), and the first to provide examples to show that single-conjunct agreement can coexist with resolved agreement patterns referencing the same coordinate structure. Kuhn and Sadler (2007) provide the following Welsh example to illustrate this point:

(16)
Gwelaist [[ti] a'th [frawd]] eich hunain.
saw.**2Sg** **2Sg** and-2Sg brother **2Pl** self
'You and your brother saw yourselves.' (Welsh; Kuhn and Sadler, 2007)

The subject of this sentence is *ti a'th frawd* 'you and your brother'. The verb *gwelaist* 'saw' shows second person singular single-conjunct agreement with the first conjunct *ti* 'you', while the reflexive *eich hunain* 'yourselves' shows second person plural resolved agreement with the coordinate structure as a whole. This example shows that it is not possible to treat single-conjunct agreement as a kind of resolution; the two types of agreement must be distinguished, and a coordinate phrase must be able to show both kinds of agreement at the same time.

An exploration of the INDEX/CONCORD distinction in single-conjunct agreement has not so far been undertaken. SCB provides an ideal laboratory for such study, because of its rich patterns of agreement and the existence of nouns with mismatched INDEX and CONCORD features.

6 Single-conjunct INDEX agreement

Under our assumption that predicate agreement depends on the INDEX feature, the examples in (14) and (15) illustrate single-conjunct INDEX agreement. We can ensure that the relevant feature is INDEX and not CONCORD by examining coordinate structures with noun phrases having mismatched CONCORD and INDEX features. In this section, we examine coordinated mismatched nouns modified by a relative clause, and we show that the relative pronoun shows INDEX agreement with the closest conjunct.

To establish patterns of agreement with relative pronouns, we first examine constructions with noncoordinated nouns. The nominative relative pronoun in (17) can be analysed either as showing F.Sg agreement with the CONCORD features of *deca* 'children', or alternatively as showing N.Pl INDEX agreement. Non-nominative relative pronouns do not display this syncretism: the accusative relative pronoun in (18) is unambiguously F.Sg, and in the genitive (19) a choice exists between a relative pronoun which is unambiguously F.Sg and one which is unambiguously plural.

(17) deca koj-**a** su tada bil-a
children who-**F.Sg/N.Pl** Aux.**Pl** there were-F.Sg/N.Pl
'children who were there' (SCB Corbett, 1983, 78)

(18) deca koj-**u** vidite
children who-**F.Sg.Acc** you.see
'children who you see' (SCB; Corbett, 1983, 79)

(19) deca koje/kojih se svi boje
children who.**F.Sg.Gen**/who.**Pl.Gen** Refl all fear
'children whom all fear' (SCB; Corbett, 1983, 79)

We believe that the correct analysis for the *-a* ending on the nominative relative pronoun in (17) is N.Pl (INDEX agreement with the head noun) rather than F.Sg (CONCORD agreement). Our primary evidence for this is that the relative pronoun triggers plural agreement on the relative clause verb, and so must itself be plural. This analysis is supported by the possibility of an unambiguously plural genitive relative pronoun in (19), which must be analysed as INDEX agreement with the head noun. Note, however, that this pattern is not found with the accusative relative pronoun in (18), which unambiguously shows F.Sg CONCORD agreement. We assume that nominative relative pronouns agree in INDEX, while accusative relative pronouns agree in CONCORD, and genitive allows either type of agreement.[3]

The nouns in the coordinate phrases in examples (20) and (21) have feminine singular CONCORD and neuter plural INDEX. We examine patterns of agreement with nominative relative pronouns agreeing in INDEX with the nouns they modify. Recall that according to the resolution rules for SCB, we would expect the coordinate NP to have masculine plural resolved features. However, the relative pronoun instead shows neuter plural agreement, matching the INDEX features of the second

[3]This entails a difference in our treatment of attributive elements and relative pronouns in cases where it is difficult to tell whether CONCORD or INDEX agreement is involved. In constructions with the nouns *deca* 'children' and *unučad* 'grandchildren', nominative attributive modifiers and relative pronouns ending in *-a* can be analysed as either F.Sg or N.Pl, while non-nominative attributive modifiers and relative pronouns are unambiguously feminine singular, except for the genitive relative pronoun, which is either unambiguously F.Sg or unambiguously plural. Accusative relative pronouns are treated as F.Sg (CONCORD agreement) in accordance with their unambiguous morphological marking. By contrast, we treat nominative relative pronouns as N.Pl (INDEX agreement) because they trigger plural agreement on the relative clause verb. For attributive elements, there is no other agreement with them (comparable to the plural verb agreement within the relative clause which is triggered by nominative relative pronouns) to justify a split analysis whereby nominative attributive elements with *deca* 'children' and *unučcad* 'grandchildren' are treated as N.Pl and non-nominative as F.Sg. We therefore treat all attributive elements (including ambiguous nominative ones) as F.Sg. Thus, agreement with attributive elements involves CONCORD features, whereas relative pronouns can pick either the CONCORD (acc or gen) or INDEX (nom or gen) features of the head nominal. This is consistent with their dual role as NP-internal elements as well as pronouns at the same time (as noted by Wechsler and Zlatić 2003). For more discussion of this issue, see Wechsler and Zlatić (2003, 56) and Corbett (1983, 78).

conjunct.[4]

(20) njihov-a [[deca] i [unučad]] koj-**a** su rodjen-a u drugoj
their-F.Sg children and grandchildren who-**N.Pl** Aux.**Pl** born-**N.Pl** in another
državi
country
'their children and grandchildren who were born in another country' (SCB)
www.durmitorcg.com/forum/viewtopic.php?f=9&t=6064&start=0&st=0&sk=t&sd=a
(accessed on 20.03.2009)

(21) [[Tinejdžeri] i [deca]] koj-a preglasno i prečesto slušaju
Teenagers.M.Pl and children who-**N.Pl** too.loudly and too.often listen.to.3Pl
muziku ... riskiraju da ogluva 30 godina ranije od...
music ... risk to go.deaf 30 years earlier than
'Teenagers and children who listen to music too loudly and too often... risk going deaf 30 years earlier than...' (SCB)
www.zdraviilepi.com/Magazin-deca!P7.aspx (accessed on 17.11.2009)

Since *deca* 'children' and *unučad* 'grandchildren' in (20) have F.Sg CONCORD and N.Pl INDEX, it can be argued that the relative pronoun agrees with both of them. Example (21) shows that this is not the case; here, the first conjunct has M.Pl CONCORD and INDEX, whereas the second has F.Sg CONCORD and N.Pl INDEX. The relative pronoun therefore agrees only with the INDEX of the second conjunct.

7 Single-conjunct CONCORD agreement

We have so far encountered the following agreement patterns:

[4]Given the existence of mismatched nouns, we might claim that, in addition to the two homophonous relative pronouns *koja*, there is a third relative pronoun *koja* which has F.Sg CONCORD and N.Pl INDEX. This mismatched relative pronoun could then be claimed to agree in CONCORD with the F.Sg CONCORD of the antecedent ('grandchildren') and in INDEX with the plural auxiliary verb inside the relative clause. This would mean that (20) is actually not an instance of closest-conjunct agreement involving the INDEX feature. However, positing a third *koja* relative pronoun with mismatched features is not entirely empirically justified and violates Occam's Razor, which states that entities should not be multiplied beyond necessity.

We could also argue that SCB has only one relative pronoun with the form *koja* and it has F.Sg CONCORD and N.Pl INDEX. Under this analysis, the pronoun will always agree in CONCORD with feminine antecedents and in INDEX with neuter antecedents. What is more, the relative clause verb will have to sometimes pick the INDEX and sometimes the CONCORD of the relative pronoun. All of these are inelegant and theoretically undesirable consequences. Furthermore, and most importantly, we have examples of closest-conjunct INDEX agreement which is unmediated by relative pronouns (cf. the predicate 'be hungry' in (37), which agrees directly with the antecedent). Since the finite copula verb is plural, this resolves the ambiguity and the rest of the predicate is unambiguously N.Pl. Otherwise, we would have more semantically justified agreement on the verb than on the predicative adjective, which would be a violation of Corbett's otherwise robust Predicate Hierarchy (cf. Corbett (1983, 87)).

- Agreement with resolved INDEX features: examples (8), (11), (13)
- Agreement with CONCORD features of all conjuncts: example (8) (cf. example 9)
- Agreement with INDEX features of a single conjunct: examples (14), (15), (16), (20), (21)

We can also have single-conjunct agreement involving the CONCORD feature. Corbett (1991) provides example (22), in which the predeterminer *sve* 'all' and the possessive determiner *njegove* 'his' show agreement with the first conjunct of the coordinate phrase. Although the noun *molbe* 'prayers' does not have mismatched CONCORD and INDEX feature, we have established on the basis of agreement patterns with mismatched nouns that agreement with attributive elements involves CONCORD and not INDEX features (see Section 2 above and Corbett 1983, 81). Hence, this must be closest-conjunct CONCORD agreement.

(22) sve njegove [molbe i uveravanja] ni-su pomagali ništa
all.**F.Pl** his.**F.Pl** prayers.**F.Pl** and assurances.**N.Pl** Neg-Pl helped.M.Pl nothing
'All his prayers and assurances did not help at all.' (SCB; Corbett, 1991, 283)

Example (22) illustrates the following pattern:

- Agreement with CONCORD features of a single conjunct: example (22)

Kuhn and Sadler (2007) show that it is possible to have single-conjunct agreement with both the first and the last conjunct in the same coordinate structure – what they call **double-edged agreement**. The following example is from Brazilian Portuguese:

(23) os [mitos e lendas] brasileiras
the.M.Pl [myth.M.Pl and legend.F.Pl] Brazilian.F.Pl
'the Brazilian myths and legends' (Brazilian Portuguese; Kuhn and Sadler, 2007, (16b))

This example exhibits two instances of single-conjunct agreement. The first involves the determiner and the first conjunct, and the second involves the second conjunct and the adjective. Examples such as these are also likely to involve CONCORD agreement, though without the possibility of examining agreement patterns with mismatched nouns in Brazilian Portuguese, it is difficult to know for sure. Such examples also show the necessity of being able to refer to the features of both the initial and the final conjunct independently.

In sum, the patterns that our analysis must handle are: agreement with resolved INDEX features; agreement with distributive CONCORD features; agreement with the INDEX features of just one conjunct; and agreement with the CONCORD features of just one conjunct.

8 Our proposal: A typology of agreement patterns

Following Kuhn and Sadler (2007), we propose to handle these agreement patterns by defining functional metavariables to allow reference to peripheral conjuncts in a coordinate phrase. We adopt Kuhn and Sadler's notation f_L and f_R, where f can be replaced by any expression that refers to an f-structure, though we provide different definitions of these expressions: in particular, these expressions may refer to the Leftmost and Rightmost conjuncts in a coordinate structure, but may also refer to a noncoordinated phrase. As discussed below, we also do not adopt Kuhn and Sadler's proposed classification of features, since it does not allow a treatment of the full range of patterns discussed in the previous section; for example, it does not allow for both resolved and single-conjunct agreement with the INDEX feature.

Retaining the assumption that INDEX is a nondistributive feature and CONCORD is a distributive feature, our analysis allows us to state agreement requirements in terms of the following expressions, with f representing an arbitrary f-structure. For the INDEX feature:

- (f INDEX): the INDEX features of a noncoordinate phrase, or the resolved INDEX features of a coordinate phrase (the standard interpretation of this expression)
- ($f_{(L)}$ INDEX): the INDEX features of a noncoordinate phrase, the resolved INDEX features of a coordinate phrase, or the leftmost conjunct of a coordinate phrase (optional single-conjunct agreement with the leftmost conjunct)
- (f_L INDEX): the INDEX features of a noncoordinate phrase or the leftmost conjunct of a coordinate phrase (obligatory single-conjunct agreement with the leftmost conjunct)
- ($f_{(R)}$ INDEX): the INDEX features of a noncoordinate phrase, the resolved INDEX features of a coordinate phrase, or the rightmost conjunct of a coordinate phrase (optional single-conjunct agreement with the rightmost conjunct)
- (f_R INDEX): the INDEX features of a noncoordinate phrase or the rightmost conjunct of a coordinate phrase (obligatory single-conjunct agreement with the rightmost conjunct)

INDEX is a resolving feature, so in a coordinate structure, the INDEX value of the coordinate structure as a whole might be different from the INDEX of the individual conjuncts. We allow for agreement with the resolved INDEX features of a coordinate phrase as well as for agreement (either optionally or obligatorily) with a single conjunct.

For the CONCORD feature, there are fewer options:

- (f CONCORD): the CONCORD features of a noncoordinate phrase or each conjunct of a coordinate phrase (the standard interpretation of this expression)

- (f_L CONCORD): the CONCORD features of a noncoordinate phrase or the leftmost conjunct of a coordinate phrase

- (f_R CONCORD): the CONCORD features of a noncoordinate phrase or the rightmost conjunct of a coordinate phrase

When all conjuncts have the same CONCORD value, it is not possible to distinguish between CONCORD agreement with the closest conjunct and CONCORD agreement with all conjuncts: 'optional' closest-conjunct agreement is not distinguishable from exclusively closest-conjunct agreement. Hence, we do not express agreement constraints in terms of optional closest-conjunct CONCORD agreement: we distinguish only between the stronger requirement of distributive CONCORD agreement with all conjuncts ((f CONCORD)) and the weaker requirement of agreement only with the closest conjunct.

The expressions (f INDEX) and (f CONCORD) have their standard LFG meaning, with INDEX defined as a nondistributive (resolving) feature and CONCORD as a distributive feature. The expression $f_{(L)}$ is defined as follows:

(24) $f_{(L)} \equiv f \begin{array}{c} \in^* \\ \neg[(\leftarrow \in) <_f \rightarrow] \end{array}$

This expression involves functional uncertainty (Kaplan and Zaenen, 1989), and makes use of the following notational conventions (for more discussion, see Dalrymple, 2001, chap. 5):

- The set-membership symbol $\in$ can be used as an attribute to nondeterministically pick out one of the conjunct members of a coordinate set. $\in^*$ picks out an arbitrarily deeply embedded member, to account for nested coordination: coordinate structures whose conjuncts are themselves coordinate structures.

- Constraints appearing under attributes in a functional uncertainty path are **off-path constraints**, regulating the f-structures through which the path may pass. The symbol $\leftarrow$ in an off-path constraint refers to the f-structure which contains the attribute on which the off-path constraint appears, and the symbol $\rightarrow$ refers to the value for that attribute.

- The symbol $<_f$ denotes the relation of functional precedence, a relation that holds between two f-structures if (roughly) a linear precedence relation holds between the constituent structure nodes that correspond to those f-structures. Functional precedence is formally defined as follows, where ϕ is the function that relates nodes of the constituent structure tree to their corresponding functional structures (Kaplan and Zaenen, 1989):
  f *f-precedes* g ($f <_f g$) if and only if for all $n_1 \in \phi^{-1}(f)$ and for all $n_2 \in \phi^{-1}(g)$, n_1 c-precedes n_2.[5]

[5]According to this definition, the functional precedence relation is irreflexive: an f-structure does not f-precede itself.

With these definitions in place, we can paraphrase the constraint in (24) as follows:

(25) $f_{(L)}$ is an f-structure possibly embedded within f as a conjunct in a coordinate set. If $f_{(L)}$ is embedded as a member of f, it must be the leftmost member: this is accomplished by the off-path constraint, which states that there may not be any (other) members of the coordinate structure that f-precede $f_{(L)}$.

The definition of $f_{(R)}$ is similar except for the f-precedence requirement on the other members of the same set, which is reversed:

(26) $f_{(R)} \equiv f \quad \in^* \quad \neg[(\leftarrow \in) >_f \rightarrow]$

These expressions refer to any leftmost or rightmost conjunct, and so with embedded coordinations, they could refer to a coordinate phrase which is leftmost or rightmost with respect to the other conjuncts, but which itself contains conjuncts. In other words, in a multiply embedded coordinate structure as in (27), the definition in (26) allows agreement with any of the underlined phrases:

(27) $[-\&\underline{[-\&\underline{[-\&\underline{-}]}]}]$

We do not have direct evidence for the possibility of agreement with closest conjuncts which are themselves coordinate structures — the relevant structures would be very complex — but we do not rule out this possibility in principle.

The definitions of f_L and f_R are similar, but add the requirement that the f-structure that is the controller of agreement must not itself be a coordinate structure:

(28) $f_L \equiv f \quad \in^* \quad : \neg(f_L \in) \quad \neg[(\leftarrow \in) <_f \rightarrow]$

f_R is defined similarly, but with the functional precedence constraints reversed, as in the definition of $f_{(R)}$.

We can also provide a definition of "closest-conjunct" agreement which relies on the linear relation between the agreement controller and the target.[6] This is useful in cases in which the controller can appear either before or after the target, as for example in free word order languages like Latin or Russian. The definition given in (29) assumes that the relevant relation is between the f-structure of the agreement target, which we assume is $\downarrow$, and the controller f; the closest conjunct is the leftmost one if the controller is on the left, and the rightmost one if the controller is on the right. The definition in (29) is for obligatory closest-conjunct agreement, and relies on the definitions of f_L and f_R given above:

(29) $f_c \equiv \{ \; f_L : \downarrow <_f f_L \mid f_R : f_R <_f \downarrow \}$

[6] Thanks to Anna Maykova for discussion of this point.

The definition in (30) is for optional closest conjunct agreement, and is stated by reference to the definitions of $f_{(L)}$ and $f_{(R)}$ given above:

(30) $f_{(C)} \equiv \{ \; f_{(L)} : \downarrow <_f f_{(L)} \mid f_{(R)} : f_{(R)} <_f \downarrow \}$

In the next section, we show how these are used in characterising the agreement patterns that we have seen so far.

8.1 Single-conjunct CONCORD agreement

We have seen that single-conjunct agreement with the CONCORD feature is attested in SCB (example 22) and perhaps in Portuguese (example 23). We provide the following lexical entry for the SCB possessive determiner *njegove* 'his', which shows CONCORD agreement with a noncoordinated noun, or with the closest conjunct of a coordinate structure:

(31) njegove 'his': ($\uparrow_C$ CONCORD GEND) = F
($\uparrow_C$ CONCORD NUM) = Pl

This lexical entry assumes that the possessive determiner is an f-structure co-head with the noun it modifies. In (32), there is no coordinate structure: $\uparrow_C$ refers to the f-structure labelled p, and requires it to have feminine plural CONCORD. This constraint is satisfied, and the example is grammatical.

(32) njegove molbe
his prayers
'his prayers'

$$p: \begin{bmatrix} \text{PRED} & \text{'prayers'} \\ \text{SPEC} & \text{'his'} \\ \text{INDEX} & \begin{bmatrix} \text{GEND} & \text{F} \\ \text{NUM} & \text{Pl} \end{bmatrix} \\ \text{CONCORD} & \begin{bmatrix} \text{GEND} & \text{F} \\ \text{NUM} & \text{Pl} \end{bmatrix} \end{bmatrix}$$

The subject phrase of example (22), repeated here, involves single-conjunct agreement with the closest (leftmost) noun in the coordinate structure:

(33) njegove molbe i uveravanja
his.F.Pl prayers.F.Pl and assurances.N.Pl
'(all) his prayers and assurances'

$$pa: \begin{bmatrix} \text{SPEC} & \text{'his'} \\ \left\{ \begin{bmatrix} \text{PRED} & \text{'prayers'} \\ \text{INDEX} & \begin{bmatrix} \text{GEND} & \text{F} \\ \text{NUM} & \text{Pl} \end{bmatrix} \\ \text{CONCORD} & \begin{bmatrix} \text{GEND} & \text{F} \\ \text{NUM} & \text{Pl} \end{bmatrix} \end{bmatrix}, \begin{bmatrix} \text{PRED} & \text{'assurances'} \\ \text{INDEX} & \begin{bmatrix} \text{GEND} & \text{N} \\ \text{NUM} & \text{Pl} \end{bmatrix} \\ \text{CONCORD} & \begin{bmatrix} \text{GEND} & \text{N} \\ \text{NUM} & \text{Pl} \end{bmatrix} \end{bmatrix} \right\} \end{bmatrix}$$

In (33), the determiner agrees with the leftmost conjunct. Here, $\uparrow$ is instantiated to pa, and according to the definition in (28), $\uparrow_C$ must refer to the closest noncoordinate structure in pa, namely the f-structure for *molbe* 'prayers'.

8.2 Single-conjunct INDEX agreement

Sadler (1999) and Kuhn and Sadler (2007) discuss single-conjunct agreement in Welsh, showing that single-conjunct agreement is obligatory with coordinate structures in which the first conjunct is pronominal; we assume that this is obligatory single-conjunct INDEX agreement. The subject noun phrase always appears to the right of the verb, and so the closest conjunct is always the leftmost one (if this were not the case, we would state the definition in terms of the "closest-conjunct" requirement f_C rather than the leftmost conjunct f_L). Kuhn and Sadler (2007) provide example (16), repeated here, for the verb *gwelaist* 'was':

(34) Gwelaist ti a'th frawd eich hunain.
saw.2Sg 2Sg and-2Sg brother 2Pl self
'You and your brother saw yourselves.' (Welsh; Kuhn and Sadler, 2007)

This verb is associated with the following constraints:

(35) gwelaist $((\uparrow \text{SUBJ})_L \text{ INDEX PERS}) = 2$
$((\uparrow \text{SUBJ})_L \text{ INDEX NUM}) = \text{Sg}$

These constraints disallow resolved INDEX agreement in coordinate structures, and require second person singular leftmost-conjunct agreement. The f-structure for example (34) is:

(36)
$$\begin{bmatrix} \text{PRED} & \text{'see'} \\ \text{SUBJ} & yb: \begin{bmatrix} \text{PERS} & 2 \\ \text{NUM} & \text{Pl} \\ \left\{ \begin{array}{l} y: \begin{bmatrix} \text{PRED} & \text{'you'} \\ \text{INDEX} & \begin{bmatrix} \text{PERS} & 2 \\ \text{NUM} & \text{Sg} \end{bmatrix} \\ \text{CONCORD} & \begin{bmatrix} \text{PERS} & 2 \\ \text{NUM} & \text{Sg} \end{bmatrix} \end{bmatrix} \\ \begin{bmatrix} \text{PRED} & \text{'brother'} \\ \text{INDEX} & \begin{bmatrix} \text{PERS} & 3 \\ \text{NUM} & \text{Sg} \end{bmatrix} \\ \text{CONCORD} & \begin{bmatrix} \text{PERS} & 3 \\ \text{NUM} & \text{Sg} \end{bmatrix} \end{bmatrix} \end{array} \right\} \end{bmatrix} \\ \text{OBJ} & [\ldots\text{'self'}\ldots] \end{bmatrix}$$

The expression $(\uparrow \text{SUBJ})_L$ refers to the f-structure labelled yb, if it is not a coordinate phrase, or to the leftmost conjunct in yb. Since yb is a coordinate structure, agreement is with the leftmost conjunct *ti* 'you.Sg', labelled y.

The SCB example in (37) shows that single-conjunct and resolved INDEX agreement patterns can be found in the same sentence:

(37)
[[Deca] i [unučad]] koj-a/koj-i su
children and grandchildren who-N.Pl/who-M.Pl Aux.3Pl
došl-a/došl-i su gladn-a/gladn-i
come-N.Pl/come-M.Pl be.3Pl hungry-N.Pl/hungry-M.Pl
'The children and grandchildren who came are hungry.' (SCB; elicited)

We focus here on the relative pronoun, which, like the Welsh verb, exhibits single-conjunct INDEX agreement. The noun *unučad* 'grandchildren' has neuter plural INDEX, and the coordinate noun phrase *deca i unučad* 'children and grandchildren' has resolved masculine plural INDEX. Either resolved INDEX agreement (masculine plural) or single-conjunct agreement referring to the INDEX features of 'grandchildren' (neuter plural) is possible:[7]

(38)
$$\begin{bmatrix} \text{PRED} & \text{'be.hungry'} \\ \text{SUBJ} \quad cg: & \begin{bmatrix} \text{INDEX} & \begin{bmatrix} \text{GEND} & \text{M} \\ \text{NUM} & \text{Pl} \end{bmatrix} \end{bmatrix} \\ & \left\{ \begin{bmatrix} \text{PRED} & \text{'children'} \\ \text{INDEX} & \begin{bmatrix} \text{GEND} & \text{N} \\ \text{NUM} & \text{Pl} \end{bmatrix} \\ \text{CONCORD} & \begin{bmatrix} \text{GEND} & \text{F} \\ \text{NUM} & \text{Sg} \end{bmatrix} \end{bmatrix} \right. \\ & \left. \begin{bmatrix} \text{PRED} & \text{'grandchildren'} \\ \text{INDEX} & \begin{bmatrix} \text{GEND} & \text{N} \\ \text{NUM} & \text{Pl} \end{bmatrix} \\ \text{CONCORD} & \begin{bmatrix} \text{GEND} & \text{F} \\ \text{NUM} & \text{Sg} \end{bmatrix} \end{bmatrix} \right\} \\ & \text{ADJ} \left\{ \begin{bmatrix} \text{TOPIC} \quad r: \begin{bmatrix} \text{PRED} & \text{'pro'} \\ \text{PRONTYPE} & \text{rel} \end{bmatrix} \\ \text{PRED} \quad \text{'come'} \\ \text{SUBJ} \quad \boxed{} \end{bmatrix} \right\} \end{bmatrix} \end{bmatrix}$$

Agreement requirements for the neuter plural relative pronoun are expressed in (39). In (39), $\uparrow$ refers to the f-structure labelled r in (38), which appears as the TOPIC of the relative clause modifying the coordinate nouns. The expression

[7]Not all combinations of resolved and single-conjunct agreement are possible in this example; the relative clause verb must agree with the relative pronoun, and the predicate *gladn-a/i* 'hungry' is virtually certain to be masculine plural if the relative pronoun is masculine plural. Agreement patterns in such constructions obey Corbett's Agreement and Predicate Hierarchies (Corbett, 2006).

(MOD $\in$ TOPIC $\uparrow$) in (39) refers to the f-structure labelled cg in (38), which corresponds to the head noun which the relative clause modifies:

(39) koja (neuter plural relative pronoun) $((\text{ADJ} \in \text{TOPIC} \uparrow)_R \text{ INDEX GEND}) = \text{N}$
$((\text{ADJ} \in \text{TOPIC} \uparrow)_R \text{ INDEX NUM}) = \text{Pl}$

These constraints require the rightmost conjunct of the coordinated head nouns to be neuter plural; the constraint is satisfied, and example (37) is grammatical.

In (39), we have chosen to characterise the constraints associated with *koja* as involving obligatory rather than optional rightmost conjunct agreement. This is because resolved agreement can never be neuter: as shown by example (13) above, uniformly neuter conjuncts resolve to masculine, not neuter. Thus, neuter plural agreement in coordinate structures must be with a distinguished conjunct, and not with the resolved features.

For the masculine plural relative pronoun, the situation is different: if the rightmost conjunct is masculine plural, the resolved features must also be masculine plural. Therefore, we can treat masculine plural agreement as resolved agreement and not rightmost conjunct agreement in all cases. Finally, feminine plural agreement may be either with the rightmost conjunct (the resolved features may be either feminine plural or masculine plural, depending on the gender of the other conjuncts) or with the resolved feminine plural features of a coordinate phrase (the rightmost conjunct may be either feminine singular or feminine plural).

An alternative analysis is possible according to which all of the relative pronouns specify **optional** rightmost conjunct agreement: the feminine relative pronoun is correctly allowed to agree with either the rightmost conjunct or the resolved features; the neuter relative pronoun is allowed to agree with the resolved features (which, however, will never be neuter plural, due to the resolution rules of SCB); and the masculine relative pronoun is allowed to agree with the rightmost conjunct (though if the rightmost conjunct is masculine plural, the resolved features must also be masculine plural). This would produce uniformity of specification across the relative pronoun paradigm, though it would produce multiple analyses of apparently unambiguous structures; we prefer specifications which do not produce ambiguity.

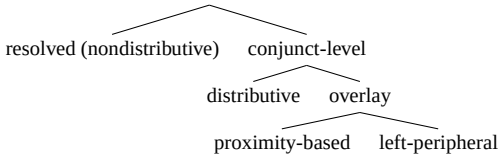
9 An alternative: Kuhn and Sadler 2007

Kuhn and Sadler (2007) provide a thorough discussion of previous proposals for agreement in coordinate structures in LFG, dividing them into **description-based approaches** and **representation-based approaches**. Our approach is description-based, since it works by introducing new functional vocabulary for expressing agreement constraints, rather than enriching the functional structure with additional structure. We are in full agreement with Kuhn and Sadler's criticisms of representation-based approaches, which we do not rehearse here. Kuhn and Sadler criticise existing description-based approaches on the grounds that they require

complex disjunctive statements of constraints, and cannot handle nested coordination. Our approach does not suffer from these difficulties, and so is immune to their criticisms.

Kuhn and Sadler propose the classification of features shown in (40):

(40)



Their approach requires features to be assigned to exactly one classification, and to behave uniformly as that classification requires. The main difficulty with this proposal is the existence of optional single-conjunct agreement. A classification of features entails that a feature will always behave in a certain way: always requiring resolved agreement, for example, or always requiring single-conjunct agreement. However, example (37) shows that the INDEX feature can participate in both single-conjunct agreement and resolved agreement in the same example, which is unexpected on Kuhn and Sadler's view.

10 Conclusion

We have presented an approach to agreement with coordinated structures which allows for the specification of agreement constraints with the entire coordinated phrase or with a single conjunct of the phrase. Our approach allows for the wide variation in agreement patterns exhibited in SCB, and we believe that it will extend unproblematically to agreement patterns in other languages as well. Our research turned up a number of interesting agreement patterns that remain for future work.

First, a basic assumption made by King and Dalrymple (2004) and others is that INDEX features resolve in coordination, but not CONCORD features. However, we have found some examples that seem to exemplify resolved CONCORD:

(41) [[žena] i [deca]] su mu bile u drugoj prostoriji.
wife.F.Sg and children.F.Sg Aux.Pl to.him been.F.Pl in other areas
'His wife and children were in other areas.' (SCB)
http://www.ana.rs/forum/viewtopic.php?t=24328&postdays=0&postorder=asc&start=15
(accessed on 12.06.2010)

The F.Pl agreement on the past participle 'been' above can be neither closest-conjunct nor distributive agreement, as neither conjunct is F.Pl. Therefore, the F.Pl features on 'been' could be analysed as resolved agreement. The resolution rules for SCB produce F.Pl only when both conjuncts are feminine. 'Wife' has F.Sg CONCORD and INDEX, whereas 'children' has F.Sg CONCORD and N.Pl INDEX. Therefore, it seems that it is the CONCORD feature that has resolved, and not the INDEX (a combination of feminine and neuter would resolve to masculine).

However, evidence from Wechsler (1999) suggests that it is the semantics and not the CONCORD that has produced the F.Pl agreement on the target in (41). This would mean that the children in the example above must be semantically feminine (although we currently have no native-speaker grammaticality judgements). The following example is provided in support of this hypothesis:

(42) Ova velika devoja i ovo malo devojče su se
This.F.Sg big.F.Sg girl.F.Sg and this.N.Sg little.N.Sg girl.N.Sg Aux.Pl Refl
lepo igrale/?igrali
well played-F.Pl/played-M.Pl
'This big girl (F) and this little girl (N) played well.' (SCB; Wechsler, 1999, 29)

Here, 'big girl' is unambiguously feminine both grammatically (in CONCORD and INDEX) and semantically. By contrast, 'little girl' has N.Sg INDEX and CONCORD but is semantically feminine. This shows that no feminine grammatical features are needed for this semantic resolution, and so in the absence of conclusive proof to the contrary, we conclude that the same generalisation is relevant for (41).

Second, it seems to be possible (though rare) for a single agreeing target to depend on different functional structure controllers; Arnold et al. (2007) provide examples of Portuguese adjectives which show closest-conjunct agreement for gender but resolved agreement for number, and we have found several similar examples (see also Corbett 1983, van Oirsouw 1987, Camacho 2003). These patterns would pose no problems for our formal model, but their rarity and the constraints on their distribution deserve investigation.

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