NUMBER MISMATCHES IN COORDINATION
AN LFG ANALYSIS

Oleg Belyaev
Lomonosov Moscow State University

Mary Dalrymple
University of Oxford

John J. Lowe
University of Oxford

Proceedings of the LFG15 Conference

Miriam Butt and Tracy Holloway King (Editors)

2015

CSLI Publications

http://csli-publications.stanford.edu/

Abstract

In some languages, including Russian and Italian, it is possible for a plural noun to be modified by two or more coordinated singular adjectives. At the same time, it is possible for a singular noun to be modified by two or more coordinated singular adjectives, but for the reference of the noun phrase to be plural, rather than singular. We provide a formal analysis of these problematic agreement phenomena, making use of the distinction between INDEX and CONCORD agreement features, and the distinction between distributive and non-distributive features. We propose that the distributivity or non-distributivity of a feature may vary not only between different languages, but even on a construction-by-construction basis within a language. Specifically, CONCORD is a non-distributive feature in certain constructions in languages like Russian and Italian.

1 Introduction

Agreement is usually understood as the covariance of a formal property of one element with a semantic or formal property of another element (Steele 1978: 610; Corbett 2006: 4). On this view, standard patterns of agreement between attributive adjective and modified noun, i.e. where adjective and noun show the same features, are very simply dealt with. However, this is challenged by certain patterns in adjective coordination. In Russian and Italian, among other languages, it is possible for a plural noun to be modified by two or more coordinated singular adjectives. In such cases, the conventional approach to agreement does not seem to work: not only do the features on the controller and target differ, but it is the "target" (the adjectives) that seems to determine the number features of the "controller" (the noun), and not vice versa. This possibility exists alongside the possibility of using one or more coordinated plural adjectives to modify a plural noun. In other languages, such as Hindi, number agreement between adjective and head is obligatory, so it is not possible to use coordinated singular adjectives to modify a plural noun.

Although such patterns have been described in the literature, no explicit theoretical analysis has been proposed which can capture either the language-specific patterns, or the broader typological variation. In this paper, we will show how the approach to agreement adopted in LFG can be modified to handle all of the problematic cases. Our analysis makes use of the distinction between CONCORD and INDEX agreement features (Wechsler and Zlatić 2003), and the distinction between distributive and non-distributive features (Dalrymple and Kaplan 2000). Typically,

[†]We are very grateful to Miriam Butt and Farhat Jabeen for the Hindi data, to Martin Maiden, Alessandro Carlucci, Silvio Cruschina, Stella Merlin Defanti, Norma Schifano, and Sandra Paoli for their help with the Italian data, and to Bozhil Hristov for helpful discussion. We thank the audiences at the 4th conference on Constructional & Lexical Semantic Approaches to Russian, St Petersburg, and at LFG15, Tokyo, for the attention and comments, in particular Maria Kholodilova, Ron Kaplan, Agnieszka Patejuk, and Miriam Butt. John Lowe acknowledges the financial support of the Leverhulme Trust. Oleg Belyaev acknowledges the support of the Russian Science Foundation, project no. 14-18-03270.

CONCORD is analyzed as a distributive feature while INDEX is treated as a non-distributive feature (King and Dalrymple 2004), but we propose that CONCORD may, in certain cases, be non-distributive. We propose that the distributivity or non-distributivity of a feature is not only subject to variation between different languages, but even between different syntactic constructions/patterns within a single language. Our proposal has been implemented in XLE and demonstrated to work for all the data under discussion here.

In the following section, we discuss the data from the languages in question. In §3, we introduce the theoretical and formal assumptions underlying our analyses, which we present in §4. In §5 we discuss further issues, and in §6 we draw our conclusions.

2 The data

2.1 Italian

In Italian, attributive adjectives generally show agreement in number and gender with the noun they modify. So in (1), two coordinated singular adjectives agree with the singular head noun, while in (2) two coordinated plural adjectives agree with the plural head noun.

(1) *la* *vecchia* *e* *piccola* *stazione*
the.SG old.SG and small.SG station.SG
'the old and small station' (Italian)

(2) *le* *vecchie* *e* *piccole* *stazioni*
the.PL old.PL and small.PL station.PL
'the old and small stations' (Italian)

On its most prominent reading, example (1) involves a 'joint' reading of coordinated modification (Heycock and Zamparelli 2005): there is one single station, described as both old and small.[1] A joint reading is also available in (2), which may be understood as denoting several stations, each of which is both old and small. Under the joint reading of coordinated modification, it is not possible for two or more singular coordinated adjectives to modify a plural noun (3), and under no circumstances is it possible for two or more coordinated plural adjectives to modify a singular noun (4).

(3) **la/*le* *vecchia* *e* *piccola* *stazioni*
the.SG/the.PL old.SG and small.SG station.PL
Intended: 'the old and small stations' [each station is both old and small]
(Italian)

[1] We note the existence of another reading, the 'split' reading, in Section 2.1.2: (1) can also refer to two stations, one old and one small.

(4) **le/*la* *vecchie* *e* *piccole* *stazione*
the.PL/the.SG old.PL and small.PL station.SG
Intended: 'the old and small station(s)' (Italian)

2.1.1 Resolving agreement

However, there is another reading available for coordinated modification: the 'split' reading (Heycock and Zamparelli 2005). So, example (2) is in fact ambiguous: the reference may be to a single set of stations which are both old and small (the joint reading), or to two separate sets of stations, one set old, the other set small (the split reading).

Under this reading, it is possible for a plural noun to be modified by two or more coordinated singular postnominal adjectives (5). In (5), the phrase *le bandiere rossa e bianca* refers to two flags, with the attributes 'red' and 'white' each holding of a different flag. There is no direct number agreement between each adjective and the noun, but on a more abstract level there is a correlation between the total number indicated by the coordinate adjective set and the number marking on the noun.[2]

(5) *Alla* *partenza* *saranno* *ammainate* ***le*** ***bandiere*** ***rossa*** ***e***
to departure will.be.PL lowered.PL the.PL flag.PL red.SG and
bianca *accompagnate* *possibilmente* *da* *segnale* *acustico.*
white.SG accompanied.PL possibly by signal acoustic
'At the departure **the red and white flags** will be lowered, possibly accompanied by an acoustic signal.' [2 flags total: one red, one white] (Italian[3])

In semantic terms, this pattern is notable: the number marking on the adjectives makes a very clear semantic contribution to the interpretation of the phrase. It is only the number marking on each adjective that determines the absolute cardinality of each conjunct, and thus determines the cardinality of the whole noun phrase. We refer to this pattern as **resolving** agreement.

2.1.2 Non-resolving agreement

In Italian, this is not the only agreement possibility. With prenominal adjectives, the resolving pattern is unavailable; instead, all coordinate adjectives, as well as the head noun, have the same number features. The function of the number marking on the adjectives remains the same, but the number marking on the noun does not

[2]There is no dual in Italian, i.e. PLURAL indicates any number greater than 1. In Sanskrit, a language which has a dual and licenses this pattern of agreement, two singular coordinated adjectives modify a noun in the dual, not the plural, and we expect that similar patterns should hold also in other languages with more complex number systems and resolving agreement.

[3]http://www.primazona.org/Avviso_VeleggiataSanGiovanni_2015.htm

reflect the cardinality of the whole noun phrase. That the noun phrase as a whole has a plural number feature is clear from the plural verb agreement.

(6) *Prima del 1991, un giocatore non poteva giocare per la sua*
before of a player not could play for the his
nuova squadra finché ***la vecchia e nuova società*** *non*
new team until the.SG old.SG and new.SG club.SG not
si fossero accordate sulla cifra del trasferimento.
REFL were.PL agreed.PL on.the number of transfer
'Before 1991, a player could not start playing for a new team before **the old and the new club** had agreed on the amount (paid) for the transfer.' [2 teams total: one old, one new] (Italian[4])

(7) *La novità era nel senso che essa cambiava la natura*
the novelty was in.the sense that it changed the nature
della liquidazione, cosicché ***vecchio e nuovo regime***
of.the liquidation so.that old.SG and new.SG regime.SG
diventavano non più comparabili …
became.PL not anymore comparable
'The novelty was in the sense that it changed the nature of liquidation, so that the **old and new regimes** became no longer comparable …' [2 regimes: one old, one new] (Italian, La Repubblica corpus)

We refer to this pattern as **non-resolving** agreement.

As long as the adjectives concerned are not semantically incompatible, it is of course possible that all-singular agreement can give rise to a joint reading referring to a single individual, in which case the number of the noun phrase is determined by the head noun, and the number marking on each adjective is not counted cumulatively in determining the number of the whole. In the examples of all singular agreement given above, (6) and (7), the adjectives involved are semantically incompatible, so such a reading is impossible. Both readings are in fact available in (1), which may refer either to a single station that is both old and small, or to two different stations, one of which is old and one of which is small. The noun phrase-internal agreement pattern seen in these all singular examples is essentially the same as in the all plural example in (2) which, like (1), has both joint and split readings; as shown in examples (6) and (7), the verb shows plural agreement in the split reading, while in the joint reading the verb shows singular agreement.

It should be noted that mixed singular and plural conjuncts in the non-resolving pattern are not allowed, thus the description of this type as involving agreement between all elements is valid:

(8) **la vecchia e nuove biblioteca*
the.SG old.SG and new.PL library.SG
Intended: 'one old and several new libraries' (Italian)

[4] http://europa.eu/rapid/press-release_IP-95-1411_it.htm

2.1.3 Summary

A summary of the agreement types that are available in Italian is provided in the following table:

(9)

position	A1	A2	N	split	joint
prenominal	SG	SG	SG	+	+
	PL	PL	PL	+	+
	(SG	SG	PL	−	−)
postnominal	SG	SG	SG	−	+
	PL	PL	PL	+	+
	SG	SG	PL	+	−

The generalization regarding adjective position is fairly robust for Italian. Among 1,000 examples of "ADJ *e* ('and') ADJ NOUN" sequences randomly selected from the La Repubblica corpus (Baroni et al. 2004), we have found 18 clear cases of non-resolving agreement and no cases of resolving agreement. Inversely, for 1,000 random examples of "NOUN ADJ *e* ('and') ADJ" sequences, there are 13 cases of resolving agreement and no cases of non-resolving agreement. Therefore, while individual variation is possible (as suggested by reviewers), the distribution in question seems to be a feature of core Italian grammar.

2.2 Russian

Italian is not the only language that displays the two patterns. Russian largely shows the same agreement rules as Italian:

(10) *vysokij i xudoj mužčina*
tall.SG and thin.SG man.SG
'(A/the) tall and thin man' [joint reading, 1 man total]
'(A/the) tall man and (a/the) thin man' [split reading, 2 men total] (Russian)

(11) *vysokie i xudye mužčiny*
tall.PL and thin.PL man.PL
'(The) tall and thin men' [joint/split reading, 2 or more men total] (Russian)

(12) *vysokij i xudoj mužčiny*
tall.SG and thin.SG man.PL
*'(The) tall and thin men' [joint reading]
OK: '(The) tall and thin men' [split reading, 2 men total] (Russian)

(13) **vysokie i xudye mužčina*
tall.PL and thin.PL man.SG
Intended: '(The) tall and thin man/men' (Russian)

Like Italian, Russian displays both the resolving and non-resolving agreement types in adjective coordination with a split reading. But since all adjectives in Russian are prenominal (except for a few special cases), the patterns are (in general) freely interchangeable, not being structurally restricted as is the case in Italian.

2.2.1 Resolving agreement

Resolving agreement in Russian is illustrated by the split reading of (12), and the following noun phrase:

(14) *krasnyj* *i* *belyj* *flagi*
red.SG and white.SG flag.PL
'(the) red and (the) white flag' [2 flags total: one red, one white] (Russian)

Note that, as in Italian, the absolute cardinality of the noun phrase is determined on the basis of the cardinality of the adjectives: each singular adjective can refer to only one flag, so the cardinality of the phrase must be 2. In the following example too, it is the number marking on each adjective that indicates the cardinality (2+) of each conjunct, and it is only on the basis of that that the 4+ cardinality of the whole phrase can be inferred (since the plural marking on the noun indicates only a total cardinality of 2+).[5]

(15) *krasnye* *i* *belye* *flagi*
red.PL and white.PL flag.PL
'(the) red and (the) white flags' [4+ flags total: 2+ red, 2+ white] (Russian)

The resolving agreement type involves a kind of natural coordination effect in Russian (Wälchli 2005, Dalrymple and Nikolaeva 2006):

(16) *dobryj* *i* *zloj* *policejskie*
good.SG and evil.SG policeman.PL
'good cop and bad cop' [referring to an interrogation technique] (Russian)

(17) *??dobryj* *i* *zloj* *sosedi*
good.SG and evil.SG neighbour.PL
intended: 'good neighbour and evil neighbour' (Russian)

2.2.2 Non-resolving agreement

Non-resolving agreement in Russian is generally freely interchangeable with the resolving pattern. The following examples illustrate the non-resolving pattern:

[5]The split reading is the only possibility for the plural equivalent of example (15), because coordinated colour adjectives cannot have a joint reading in Russian. For the joint reading, a compound modifier would be used, e.g. *krasno-bel-yj* (red-white-M.SG.NOM) 'red and white'.

(18) *staryj i novyj stil' budut uravneny*
old.SG and new.SG style.SG become.FUT.PL equal.PL
'The old and new styles will become equal.' [2 styles: one old, one new] (Russian, Russian National Corpus (RNC))

(19) *staryj i novyj obraz stali nakladyvat'sja*
old.SG and new.SG image.SG begin.PST.PL superimpose.INF
'The old and the new image began to superimpose themselves.' [2 images: one old, one new] (Russian, RNC)

If anything, non-resolving agreement is the least marked construction of the two, because the natural coordination effect observed for the resolving pattern does not seem to hold for non-resolving agreement:

(20) *u menja na dače byli dobryj i zloj sosed*
at me in dacha were.PL good.SG and evil.SG neighbour.SG
'At the dacha I had a good neighour and a bad neighbour.' (Russian)

2.2.3 Summary

Since Russian does not distinguish between adjective positions, the summary is simpler than in Italian, but in essence is identical:

(21)

A1	A2	N	split	joint
SG	SG	SG	+	+
PL	PL	PL	+	+
SG	SG	PL	+	−

2.3 Hindi

Agreement mismatches such as these are not possible in all languages. In Hindi, coordinated adjectives agree in number with the head noun; so coordinated adjectives modifying a plural noun must appear in the plural, even if each adjective refers to a set of cardinality one (22). The only way to get the 'exactly one of each' reading is to use a singular noun, with coordinated adjectives in agreement (23).

(22) *ye hare aur piile jhaṇḍe*
this.PL green.PL and yellow.PL flag.PL
'these green and yellow flags' [split reading: 1+ flags of each colour]
'these green and yellow flags' [joint reading: 2+ part green, part yellow, flags] (Hindi)

(23) *yah* *haraa* *aur* *yah* *piilaa* *jhaṇḍaa*
this.SG green.SG and this.SG yellow.SG flag.SG
'this green and this yellow flag' [2 flags total] (Hindi)

The summary for Hindi is thus such that it allows the split reading only in all-plural contexts:

(24)

A1	A2	N	split	joint
SG	SG	SG	−	+
PL	PL	PL	+	+
(SG	SG	PL	−	−)

2.4 Previous analyses

Although such patterns have been described in the literature, no explicit theoretical analysis has ever been proposed to capture either the language-specific patterns or the broader typological variation. The Russian data have been described and discussed in Kodzasov (1987) and Iomdin (1990) in the framework of Meaning-Text Theory. Kodzasov provides an extensive description of the relevant patterns and the semantic restrictions that they involve, but gives only a sketch of a possible syntactic analysis. Iomdin (1990) reviews several potential syntactic analyses in terms of dependency grammar. He concludes that none is satisfactory, and the attested patterns should be relegated to semantics instead (an analysis of which is not explicitly described).

It is noteworthy that Iomdin describes both structures as involving what he terms *sočinitel'noe sokraščenie* ("coordinating reduction") which, in the Russian tradition, is a term roughly analogous to ellipsis. It is certainly appealing to view examples like (18)–(19) (or 6–7 in Italian) as involving ellipsis, i.e. 'the old ~~station~~ and new station'. However, an ellipsis account is not satisfactory for (14) and (16) (or 5 in Italian): the noun is not recoverable, due to the mismatching number. Therefore, an ellipsis account would fail to explain all the data. It is also difficult to see why the availability of ellipsis would depend on the adjectives' position in Italian.

Furthermore, noun agreement seems to be the only property differentiating ellipsis from non-ellipsis on this view. Other properties do not vary with the number of the noun. For example, both constructions allow non-constituents to be coordinated:

(25) *[[graždanskogo* *atomnogo]* *i* *[voennogo*
civil.GEN.SG nuclear.GEN.SG and military.GEN.SG
raketno-jadernogo] *flota]*
rocket-nuclear.GEN.SG fleet.GEN.SG
'of the civil(sg.) nuclear(sg.) and the military(sg.) nuclear-rocket(sg.) fleet(sg.).' (Russian, RNC)

(26) *v* *[[Moskovskom* *sel'skoxozjajstvennom]* *i*
in Moscow.ADJ.PREP.SG agricultural.PREP.SG and
[Kievskom *politexničeskom]* *institutax]*
Kiev.ADJ.PREP.SG polytechnic.PREP.SG institutes.PREP.PL
'at the Moscow Agricultural and the Kiev Polytechnic Institutes' (Russian, RNC)

Thus, a satisfactory analysis must treat the two constructions together.[6]

Bosque (2006) takes a different approach. He discusses Spanish examples like *los embajadores mexicano y argentino* (the.PL ambassadors.PL Mexican.SG and Argentinian.SG), which are analogous to (5) in Italian. His solution is to assume that the coordinate adjectives are in fact DPs with null pronominal heads, i.e.: the.PL ambassadors.PL [*pro* Mexican.SG] and [*pro* Argentinian.SG]. The noun then agrees with the resolved plural feature of the coordinate DP. As we will see, the core idea of this analysis is similar to our approach. But it does not explain why non-resolving examples such as (6) or (18) are possible: if each adjective heads a DP, there should be no singular agreement.

Below, we will show how the data can be accounted for without resorting to null pronouns or relegating the matter to semantics.

3 Agreement

Agreement is sometimes defined as variation in the value of a formal property of one element, e.g. case, number or gender, depending on the value of that property in another element. In other words, the 'target' of agreement merely reflects the formal properties of the 'controller' of the agreement, and does not make a semantic contribution of its own. For example, in the Russian phrase

(27) *ja* *tebja* *vižu*
I you.SG.ACC see.1SG.PRES
'I see you.'

the 1st person and SG features of the verb (the 'target') can be analysed as determined by the inherent 1st person and SG features of the subject pronoun (the 'controller'). This approach can easily deal with standard patterns of agreement, as in the phrase immediately above, but it is more difficult to see how it could deal with the patterns discussed in the previous section, where the number of the adjectives does not reflect the number of the noun head. Indeed, in such examples the number marking on the adjectives has the role of specifying the number of each conjunct. In the case of 'non-resolving' agreement between coordinated singular

[6] A full analysis of non-constituent coordination is beyond the scope of this paper. In the context of LFG, the finite state approach of Maxwell and Manning (1996) can probably provide a solution.

adjectives with a split reading and a singular noun, it would be possible to treat the singular number marking on the adjectives as directly determined by the singular noun, but it then remains to explain why the singular number of the noun does not reflect the plurality of the noun phrase as a whole, as shown by verb agreement.

The standard approach to agreement within LFG (as also in HPSG, and some typological literature, e.g. Kibrik 2011) is to assume a codescriptive approach. Under this approach, the 'target' and 'controller' both contribute to determining the number of the controller. For example, the lexical entry for the Russian pronoun *ja* 'I' contains the specifications in (28), while the lexical entry for *vižu* 'see' includes those in (29).

(28) *ja* (↑ PRED) = 'I'
(↑ PERS) = 1
(↑ NUM) = SG

(29) *vižu* (↑ PRED) = 'see'
(↑ SUBJ PERS) = 1
(↑ SUBJ NUM) = SG

When the pronoun *ja* 'I' functions as subject to the verb *vižu* 'see', both verb and pronoun specify the features of the subject's f-structure. As we will show, this codescriptive approach is able to deal with the complicated agreement patterns discussed in the previous section.

Our analysis also relies on the distinction between INDEX and CONCORD features as two distinct types of agreement features. Wechsler and Zlatić (2003), working within HPSG, show that nouns distinguish two types of agreement features: CONCORD features, which generally control agreement within a noun phrase, e.g. between a noun and any determiners or modifying adjectives; and INDEX features, which generally control noun phrase external agreement, e.g. between a noun phrase and an agreeing verb. Building on this work, King and Dalrymple (2004) explore the INDEX/CONCORD distinction in agreement with coordinated singular nouns:

(30) [This/*these man and woman] are/*is eating sushi.

The coordinate noun phrase in (30) consists of two singular nouns. The determiner is required to appear in the singular, but the verb is constrained to appear in the plural, suggesting that the CONCORD (noun-phrase internal) and INDEX (noun-phrase external) agreement features of the noun phrase have different values.

Finally, our analysis is based on the distinction between distributive and non-distributive features (Dalrymple and Kaplan 2000). Some f-structure features are non-distributive, which means that the feature is associated with the set representing a coordinate structure independent of the features of the individual members of that set. Other f-structure features are distributive, which means that a feature specified for a set representing a coordinate structure can only be associated with the individual members of the set, and not with the set itself; crucially, the value of the feature must be the same for all conjuncts. Dalrymple and Kaplan (2000) show that any requirement made of a set in relation to a distributive feature is satisfied if the requirement holds of every member of that set.

4 Proposal

As mentioned above, CONCORD agreement features are typically analysed as distributive, and as having relevance for noun phrase internal agreement, while INDEX agreement features are typically treated as non-distributive, and as having relevance for noun-phrase external agreement. King and Dalrymple (2004) argue that in some languages, including Russian, INDEX may also have relevance for noun-phrase internal agreement, due to agreement patterns such as the following:

(31) *moi* *brat* *i* *sestra* *prišli*
my.PL brother.SG and sister.SG come.PST.PL
'My brother and sister came.' (Russian)

In this example, both nouns are singular, so must have singular CONCORD, yet the determiner shows plural number. The determiner therefore appears to depend on the plural INDEX feature of the coordinate set, rather than the CONCORD features of the conjuncts. However, this will not suffice to explain the patterns seen in (18)–(20): the plural verb marking shows that the INDEX feature of the coordinate set is plural, yet all elements of the noun phrase are singular. Example (18) is repeated here as (32).

(32) *staryj* *i* *novyj* *stil'* *budut* *uravneny*
old.SG and new.SG style.SG will.be.PL equal.PL
'The old and new styles will become equal.' [2 styles total] (Russian)

We propose that the agreement patterns discussed above can be explained without altering the original assumptions regarding the distinction between INDEX and CONCORD: noun-phrase internal agreement is determined purely by reference to CONCORD, while noun-phrase external agreement is determined purely by reference to INDEX. However, we do require an alternative approach to the distributivity of these features. Specifically, we propose that CONCORD can, in certain circumstances, be non-distributive. While INDEX is universally non-distributive, CONCORD is subject to variation across languages, and even across different constructions within particular languages.

Specifically in relation to the Italian and Russian data, the contrasts of (5) vs. (6) and (14) vs. (18) can be explained by assuming that CONCORD is non-distributive (and resolved as plural) in (5) and (14) but is distributive (and thus forced to be the same for all conjuncts) in (6) and (18). Thus, the distributivity of CONCORD varies in Russian and Italian on a construction-specific basis (in Italian this is linked to word order patterns, but word order is not relevant to the Russian data). For languages like Hindi (22–23) and English, on the other hand, CONCORD features are purely distributive.

It is thus possible to treat typological variation in the status of CONCORD by reference to a 'cline of distributivity', with CONCORD always distributive at one

extreme, and movement along the cline correlated with increasing nondistributivity on a construction-by-construction basis:[7]

(33) Distributivity of CONCORD:

always d.		sometimes d.		often non-d.
English/Hindi	>	Italian	>	Russian

The distributivity or otherwise of a feature is not in principle variable in LFG. There is no way to specify or change the distributivity of a feature in either the lexicon or the syntax (or anywhere else): it is an inherent, pre-established property of a feature.[8] In proposing that CONCORD can be non-distributive in only some constructions in a language, we therefore require some way to simulate this variation without actually changing the status of the feature. We do this by assuming that if in a language CONCORD *can* be non-distributive, then this is its pre-specified status; the effects of distributivity are enforced, in those constructions where CONCORD appears to be distributive, by annotations on phrase-structure rules which require the CONCORD value of the coordinate structure to be the same as the CONCORD value of each conjunct.

We assume that languages may have different coordination rules for adjective phrases, one the normal set-forming coordination rule (giving the joint reading), and the other creating separate f-structures, with each adjective appearing as a modifier within one conjunct (giving the split reading). That is, the variation between the split and joint reading for coordinated adjectives phrases is due to a structural ambiguity. This is accomplished by the phrase-structure rules in (34) and (35), which are the basic templates for all languages (discussed here); as we will see, each language varies these templates slightly.[9]

(34) Phrase-structure rule for adjective coordination, joint reading:

AdjP	→	AdjP^{+}	Cnj	AdjP
		$\downarrow \in \uparrow$	$\uparrow = \downarrow$	$\downarrow \in \uparrow$

Rule (34) for the joint reading is the familiar LFG rule for coordination, creating a set of f-structures: here, a set of AdjP f-structures which will appear in the adjunct (ADJ) set of the modified noun phrase, as shown in (36).

[7] Exceptionless nondistributivity of CONCORD would potentially mean that INDEX and CONCORD were indistinguishable, i.e. in such a language there would effectively be no distinction between these two types of features, except for cases where there are mismatches between CONCORD and INDEX, as found e.g. in Slavic (Wechsler and Zlatić 2003, Hristov 2012). In all of the languages discussed in this paper, CONCORD is distributive in at least some constructions.

[8] Przepiórkowski and Patejuk (2012) have proposed treating distributivity as a property of statements rather than features themselves. However, for our purposes, as we shall see below, there is no need to make any modifications to the LFG formalism.

[9] We use the following abbreviations in phrase-structure rules:

i. CNUM ≡ CONCORD NUM ii. INUM ≡ INDEX NUM

(35) Phrase-structure rule for adjective coordination, split reading:

$$\begin{array}{lccc} \text{AdjP} \rightarrow & \text{AdjP}^{+} & \text{Cnj} & \text{AdjP} \\ & \downarrow \in (\%C\ \textsc{adj}) & \uparrow = \downarrow & \downarrow \in (\%C\ \textsc{adj}) \\ & \%C \in \uparrow & (\uparrow \textsc{inum}) = \textsc{pl} & \%C \in \uparrow \end{array}$$

Rule (35) for the split reading creates a set of "incomplete" (PRED-less) NPs with the adjective occupying the ADJUNCT set. This is accomplished by use of the local name %C, which appears in each daughter category in the rule; recall that the scope of a local name is limited to the annotations on the daughter category in which it appears, so that %C in each daughter category refers to a separate f-structure (Dalrymple 2001, Crouch et al. 2008). The annotations require each daughter AdjP to introduce a member %C of a set representing a coordinate structure of the type expected for coordinated nouns, where each conjunct has an adjunct (ADJ) set containing a modifier, as shown in (37). The PRED feature is a distributive feature, and so in the latter case, the noun's PRED value distributed into this set. This gives us the following f-structures for the two kinds of coordination:

(36) Joint reading (rule 34):

$$\left[\begin{array}{ll} \textit{noun} & \\ \textsc{adj} & \left\{\left[\begin{array}{ll} \textsc{conj} & \textsc{and} \\ \left\{\left[\textit{adj1}\right], \left[\textit{adj2}\right]\right\} & \end{array}\right]\right\} \end{array}\right]$$

(37) Split reading (rule 35):

$$\left[\begin{array}{ll} \textsc{conj} & \textsc{and} \\ \left\{\left[\begin{array}{ll} \textit{noun} & \\ \textsc{adj} & \left\{\left[\textit{adj1}\right]\right\} \end{array}\right], \left[\begin{array}{ll} \textit{noun} & \\ \textsc{adj} & \left\{\left[\textit{adj2}\right]\right\} \end{array}\right]\right\} & \end{array}\right]$$

The split reading for 'red and white flags' (in the 'exactly two' reading) thus involves an f-structure roughly equivalent to 'the red flag and the white flag'. Clearly, the distribution of the PRED value in (37) cannot be achieved using the standard adjunction rule, since the coordinated adjective phrase in the split reading introduces an f-structure resembling the structure for coordinated nouns; hence, unification is required. Hence the AdjP adjunction rule must involve an option for the f-structure for the AdjP to be a co-head:

(38) $$\begin{array}{lcc} \text{N}' \rightarrow & \text{AdjP} & \text{N}' \\ & \{\downarrow \in (\uparrow \textsc{adj}) \mid \uparrow = \downarrow\} & \uparrow = \downarrow \end{array}$$

Note that the co-head possibility for the AdjP can only be used in conjunction with the rule for coordinated AdjPs with a split reading; its use with a simple AdjP is ruled out, since a PRED clash would result.

4.1 Hindi

We assume that CONCORD is a distributive feature in Hindi. For the purposes of this paper, we assume that attributive adjectives head AdjPs in Hindi.[10] Since Hindi does not allow the coordination of singular adjectives to have a split reading, we have to modify the rule in (35) to enforce plural concord:[11]

(39) Phrase-structure rule for adjective coordination, split reading (Hindi):

AdjP	→	AdjP^{+}	Cnj	AdjP
		$\downarrow \in (\%C\ \text{ADJ})$	$\uparrow = \downarrow$	$\downarrow \in (\%C\ \text{ADJ})$
		$\%C \in \uparrow$	$(\uparrow \text{INUM}) = \text{PL}$	$\%C \in \uparrow$
			$(\uparrow \text{CNUM}) = \text{PL}$	

For the joint reading of the Hindi phrase in (22), the resulting f-structure is as in (40), whereas for the same phrase with a split reading the f-structure will be as in (41).

(40) Joint reading (rule 34):

$$\begin{bmatrix} \text{PRED} & \text{'flag'} \\ \text{SPEC} & \left[\text{PRED} \quad \text{'these'}\right] \\ \text{CONCORD} & \left[\text{NUM} \quad \text{PL}\right] \\ \text{INDEX} & \left[\text{NUM} \quad \text{PL}\right] \\ \text{ADJ} & \left\{\left[\begin{array}{ll}\text{CONJ} & \text{AND} \\ & \left\{\left[\text{PRED} \quad \text{'yellow'}\right], \left[\text{PRED} \quad \text{'green'}\right]\right\}\end{array}\right]\right\} \end{bmatrix}$$

(41) Split reading (rule 39):

$$\left[\begin{array}{ll}\text{SPEC} & \left[\text{PRED} \quad \text{'these'}\right] \\ \text{INDEX} & \left[\text{NUM} \quad \text{PL}\right] \\ \text{CONJ} & \text{AND} \\ & \left\{\left[\begin{array}{ll}\text{PRED} & \text{'flag'} \\ \text{CONCORD} & \left[\text{NUM} \quad \text{PL}\right] \\ \text{ADJ} & \left\{\left[\text{PRED} \quad \text{'yellow'}\right]\right\}\end{array}\right], \left[\begin{array}{ll}\text{PRED} & \text{'flag'} \\ \text{CONCORD} & \left[\text{NUM} \quad \text{PL}\right] \\ \text{ADJ} & \left\{\left[\text{PRED} \quad \text{'green'}\right]\right\}\end{array}\right]\right\}\end{array}\right]$$

Here, the coordinated AdjP is either a functional co-head with the noun (as in 35), or specified by the phrase structure rule as appearing in the ADJ set (as in 34).

[10] The English facts are equivalent to the Hindi, except for two differences: English adjectives lack number marking, and attributive adjectives in English are non-projecting (Sadler and Arnold 1994, Toivonen 2003, Arnold and Sadler 2013). The only differences required for English therefore relate to the categories involved: (34) and (35) will involve coordination of the non-projecting category $\widehat{\text{Adj}}$, not AdjP, and (38) will involve adjunction of $\widehat{\text{Adj}}$ to N^0. In other respects, in particular the annotations, the rules will be identical.

[11] In this and following rules, the language-specific annotations are given in plain face, the common annotations (those in 34 or 35) are given in grey.

4.2 Italian

For Italian, the rule for the joint reading (34) is unchanged. For the phrase in (1) with the joint reading, the resulting f-structure will be as in (42).

(42) Joint reading (rule 34):

$$\begin{bmatrix} \text{PRED} & \text{'station'} \\ \text{CONCORD} & \begin{bmatrix} \text{NUM} & \text{SG} \end{bmatrix} \\ \text{INDEX} & \begin{bmatrix} \text{NUM} & \text{SG} \end{bmatrix} \\ \text{ADJ} & \left\{ \begin{bmatrix} \text{CONJ} & \text{AND} \\ \left\{ \begin{bmatrix} \text{PRED} & \text{'old'} \end{bmatrix} \right. \\ \left. \begin{bmatrix} \text{PRED} & \text{'small'} \end{bmatrix} \right\} \end{bmatrix} \right\} \end{bmatrix}$$

Since Italian allows 'resolving' agreement, the crucial difference between Italian and Hindi is that CONCORD is nondistributive in Italian when AdjPs are coordinated. This means that agreement is not enforced between the noun and each adjective conjunct; rather, the plural CONCORD and INDEX features of the noun match the resolved plural CONCORD and INDEX features of the coordinated AdjP. With this proviso, the Hindi variant of the rule for the split reading (39) can be used without modification for the pattern illustrated in (5) with singular coordinated adjectives and a plural noun. Since the resolving pattern in Italian only occurs with postnominal AdjPs, we need separate coordination and adjunction rules for them:

(43) Phrase-structure rule for Italian AdjP adjunction:

$$\begin{array}{lcll} \text{N}' & \rightarrow & \text{N}' & \text{AdjP} \\ & & \uparrow{=}\downarrow & \{\downarrow \in (\uparrow \text{ADJ}) \mid \uparrow{=}\downarrow\} \end{array}$$

(44) Phrase-structure rule for Italian AdjP coordination, split reading (same as 39):

$$\begin{array}{lcccc} \text{AdjP} & \rightarrow & \text{AdjP}^{+} & \text{Cnj} & \text{AdjP} \\ & & \downarrow \in (\%C \text{ ADJ}) & \uparrow{=}\downarrow & \downarrow \in (\%C \text{ ADJ}) \\ & & \%C \in \uparrow & (\uparrow \text{INUM}) = \text{PL} & \%C \in \uparrow \\ & & & (\uparrow \text{CNUM}) = \text{PL} & \end{array}$$

This rule allows the coordinate adjectives in the "resolving" pattern to have different number features, which is indeed allowed in Italian:

(45) *tulipani* *rosso* *e* *bianchi*
tulips.PL red.SG and white.PL
'red and white tulips' (Italian, caption of a picture showing one red tulip and two white tulips[12])

[12] https://www.flickr.com/photos/orsorama/8704984416/

For the phrase in (5), which has only a split reading, the resulting f-structure will be as in (46).

(46) Split reading (rule 35):

$$\left[\begin{array}{ll}
\textsc{concord} & \left[\textsc{num} \quad \textsc{pl}\right] \\
\textsc{index} & \left[\textsc{num} \quad \textsc{pl}\right] \\
\textsc{conj} & \textsc{and} \\
\left\{\begin{array}{l}
\left[\begin{array}{ll}
\textsc{pred} & \text{`flag'} \\
\textsc{concord} & \left[\textsc{num} \quad \textsc{sg}\right] \\
\textsc{adj} & \left\{\left[\textsc{pred} \quad \text{`red'}\right]\right\}
\end{array}\right] \\
\left[\begin{array}{ll}
\textsc{pred} & \text{`flag'} \\
\textsc{concord} & \left[\textsc{num} \quad \textsc{sg}\right] \\
\textsc{adj} & \left\{\left[\textsc{pred} \quad \text{`white'}\right]\right\}
\end{array}\right]
\end{array}\right\}
\end{array}\right]$$

For the non-resolving agreement pattern in Italian (6–7), in which the noun as well as the adjectives are singular, we require a different adjunction rule (for prenominal $\widehat{\text{Adj}}$s) as well as a special coordination rule for $\widehat{\text{Adj}}$s:

(47) Phrase-structure rule for Italian $\widehat{\text{Adj}}$ adjunction:

$$\begin{array}{lccc}
\text{N}^0 & \rightarrow & \widehat{\text{Adj}} & \text{N}^0 \\
 & & \{\downarrow\in(\uparrow \textsc{adj}) \mid \uparrow=\downarrow\} & \uparrow=\downarrow
\end{array}$$

(48) Phrase-structure rule for Italian $\widehat{\text{Adj}}$ coordination, joint reading:

$$\begin{array}{lccccc}
\widehat{\text{Adj}} & \rightarrow & \widehat{\text{Adj}}^{+} & \text{Cnj} & \widehat{\text{Adj}} \\
 & & \downarrow\in\uparrow & \uparrow=\downarrow & \downarrow\in\uparrow
\end{array}$$

(49) Phrase-structure rule for Italian $\widehat{\text{Adj}}$ coordination, split reading:

$$\begin{array}{lccccc}
\widehat{\text{Adj}} & \rightarrow & \widehat{\text{Adj}}^{+} & \text{Cnj} & \widehat{\text{Adj}} \\
 & & \downarrow\in(\%C\ \textsc{adj}) & \uparrow=\downarrow & \downarrow\in(\%C\ \textsc{adj}) \\
 & & \%C\in\uparrow & (\uparrow \textsc{inum}) = \textsc{pl} & \%C\in\uparrow \\
 & & (\uparrow \textsc{cnum}) = (\downarrow \textsc{cnum}) & & (\uparrow \textsc{cnum}) = (\downarrow \textsc{cnum})
\end{array}$$

The annotations under the coordinated phrases in (49) differ from the rule in (35) in two respects. First, the Cnj node is not annotated with a value for the CNUM feature; this allows either singular or plural adjectives to participate in this construction, since the CNUM value of the coordinate adjective phrase is not constrained. Second, each AdjP conjunct is annotated with the requirement for its CNUM value to match the nondistributive CNUM value of the coordinated AdjP as a whole. This enforces the requirement for the conjuncts to have uniform number, either singular (as in example 6) or plural (as in example 11).

We also require that the lexical entries of singular nouns in Italian contain the following specifications:

(50) biblioteca N
$(\uparrow \text{PRED}) = \text{`library'}$
$(\uparrow \text{CNUM}) = \text{SG}$
$\{\ (\uparrow \text{INUM}) = \text{SG} \mid (\uparrow \text{INUM}) =_{c} \text{PL}\ \}$

The constraining equation in the last line permits a singular noun to function as the head of a phrase with INDEX NUM = PL, only if this feature is specified elsewhere, i.e. if it is specified in the phrase structure rules.[13] We will therefore get the f-structure in (51) for the noun phrase in (6).

(51) Split reading (rule 49):

$$\left[\begin{array}{ll}
\text{CONCORD} & \left[\text{NUM} \quad \text{SG}\right] \\
\text{INDEX} & \left[\text{NUM} \quad \text{PL}\right] \\
\left\{\left[\begin{array}{ll}
\text{PRED} & \text{`library'} \\
\text{CONCORD} & \left[\text{NUM} \quad \text{SG}\right] \\
\text{ADJ} & \left\{\left[\text{PRED} \quad \text{`old'}\right]\right\}
\end{array}\right]\right. & \\
\left.\left[\begin{array}{ll}
\text{PRED} & \text{`library'} \\
\text{CONCORD} & \left[\text{NUM} \quad \text{SG}\right] \\
\text{ADJ} & \left\{\left[\text{PRED} \quad \text{`new'}\right]\right\}
\end{array}\right]\right\} &
\end{array}\right]$$

4.3 Russian

The only difference between Russian and Italian is that Russian allows both the resolving and non-resolving patterns with any adjective regardless of its lexical class or syntactic position. This may be modeled by including two rules for AdjP coordination in Russian grammar: the one in (44) and one analogous to (49), but for AdjPs. We may also generalize over these readings by introducing a unified rule like the following:

[13] In this way, singular number in Italian is in some sense an unmarked number: it reflects SG by default, but can reflect PL if externally specified.

(52) Phrase-structure rule for Russian AdjP coordination, split reading:

AdjP	→	AdjP^{+}	Cnj	AdjP
		$\downarrow \in (\%C$ ADJ)	$\uparrow = \downarrow$	$\downarrow \in (\%C$ ADJ)
		$\%C \in \uparrow$	(↑ INUM) = PL	$\%C \in \uparrow$
		{(↑ CNUM) = PL |		{(↑ CNUM) = PL |
		(↑ CNUM) = (↓ CNUM)}		(↑ CNUM) = (↓ CNUM)}

5 Further issues

In this paper, we have addressed only adjective coordination, but in Russian the same, or similar, effects are observed with other NP subconstituents:

(53) *Pasportistka 12-go otdelenija milicii dvaždy*
passport.officer of.twelfth station of.police twice
podyšav na štamp «Propisan postojanno», ottisnula ego
having.breathed on stamp registered permanently imprinted it
*na **pasportax moëm i ženy***
on passport.PL my.M.PREP.SG and wife.GEN.SG
'The passport officer, having breathed twice on the stamp "Permanently registered", imprinted it on **me and my wife's passports**.' (Russian, RNC: Vladimir Vojnovič. Ivan'kiada, ili rasskaz o vselenii pisatelja Vojnoviča v novuju kvariru, 1976)

In (53), a plural noun is modifed by an 'unlike' coordination of a singular possessive adjective and a genitive case noun. Thus the analysis must be extended to cover at least case-marked NPs, and possibly also other phrase types, such as PPs. This would also require a theory of coordination of unlikes. The situation is especially complicated by the fact that in (53) we are dealing with a so-called possessive adjective 'my', an element which is syntactically and morphologically an adjective, but which is functionally equivalent to a genitive dependent, i.e. to a POSS or COMP, but not an ADJ.

A potential problem with the present account is that the stipulation of two different coordination rules and two different adjunction rules significantly increases grammatical complexity. While such a solution seems to be unavoidable in the current LFG architecture, it remains to be seen whether this kind of ambiguity of coordinating constructions is necessary elsewhere in the grammar.

6 Conclusion

In this paper, we have provided an analysis that adequately describes the observed effects of agreement resolution in adjective coordination. While resolving agreement is a problem for theories of agreement which predict that an adjective should not be able to show different agreement features from its controller, the analysis

faces few difficulties in a symmetric theory of agreement, such as is standard in LFG. The LFG formalization that we proposed is based on the distinction between CONCORD and INDEX features to differentiate between NP-internal and clause-level agreement. Mismatches within NPs (i.e. plural marking of the head noun combined with coordinated singular adjectives) are described by assuming that the "resolving" agreement type involves a special, "unificational", rule of coordination, where it is not adjectives themselves that are coordinated, but f-structures lacking PRED features which contain the adjectives as their adjuncts. This requires the introduction of an additional rule of adjective coordination in addition to the standard set-membership one, and of an additional annotation on AdjP which allows it to act as a co-head. As noted above, some of the constructions we analyze in this paper have formerly been described in terms of ellipsis. In this light it is interesting to note that our analysis involves ellipsis-like effects at f-structure without involving any deletion *per se*. It remains for future work to establish whether the distinction between two kinds of coordination that we have introduced is useful for other similar constructions.

Another important distinction on which our analysis depends is the distinction between distributive and non-distributive features. We have demonstrated that the availability of the resolving and non-resolving agreement types shows much cross-linguistic variation. In the former type, CONCORD behaves like a non-distributive feature, while in the latter, it behaves like a distributive one. However, simply assuming that CONCORD can be non-distributive does not solve the problem, because this would run counter to other constructions where no such effects are observed. Furthermore, within some languages, like Italian and Russian, both the distributive and the non-distributive agreement types are allowed. We claim that the most adequate solution to this issue is to assume that distributivity can be construction-specific. This can be modeled without modifying the basic LFG architecture by simulating distributivity in given constructions through annotations on individual conjuncts.

References

ARNOLD, DOUG and LOUISA SADLER (2013). 'Displaced Dependent Constructions'. In Miriam Butt and Tracy Holloway King (eds.), *Proceedings of the LFG13 Conference*, Stanford, CA: CSLI Publications, pp. 48–68.

BARONI, MARCO, SILVIA BERNARDINI, FEDERICA COMASTRI, LORENZO PICCIONI, ALESSANDRA VOLPI, GUY ASTON, and MARCO MAZZOLENI (2004). 'Introducing the La Repubblica corpus: A large, annotated, TEI(XML)-compliant corpus of newspaper Italian'. In *Proceedings of LREC 2004*.

BOSQUE, IGNACIO (2006). 'Coordinated adjectives and the interpretation of number features'. In Laura Brugè (ed.), *Studies in Spanish Syntax*, Venice: Libreria Editrice Cafoscarina, pp. 47–60.

CORBETT, GREVILLE G. (2006). *Agreement*. Cambridge University Press.

CROUCH, DICK, MARY DALRYMPLE, RON KAPLAN, TRACY KING, JOHN MAXWELL, and PAULA NEWMAN (2008). *XLE Documentation*. Palo Alto Research Center, Palo Alto, CA.

DALRYMPLE, MARY (2001). *Lexical Functional Grammar*, volume 34 of *Syntax and Semantics*. New York: Academic Press.

DALRYMPLE, MARY and RONALD M. KAPLAN (2000). 'Feature Indeterminacy and Feature Resolution'. *Language 76*(4), pp. 759–798.

DALRYMPLE, MARY and IRINA NIKOLAEVA (2006). 'Syntax of natural and accidental coordination: Evidence from agreement'. *Language 82*(4), pp. 824–849.

HEYCOCK, CAROLINE and ROBERTO ZAMPARELLI (2005). 'Friends and Colleagues: Plurality, Coordination, and the Structure of DP'. *Natural Language Semantics 13*, pp. 201–270.

HRISTOV, BOZHIL (2012). *Agreement, Case Assignment, and Nominal Coordination*. DPhil thesis, University of Oxford.

IOMDIN, LEONID L. (1990). *Avtomatičeskaja obrabotka teksta na estestvennom jazyke: model' soglasovanija [Automatic natural language processing: The model of agreement]*. Moscow: Nauka.

KIBRIK, ANDREJ A. (2011). *Reference in Discourse*. Oxford University Press.

KING, TRACY HOLLOWAY and MARY DALRYMPLE (2004). 'Determiner agreement and noun conjunction'. *Journal of Linguistics 40*, pp. 69–104.

KODZASOV, SANDRO V. (1987). 'Čislo v sočinitel'nyx konstrukcijax [Number in coordinating constructions]'. In Alexander E. Kibrik and Aleksandr S. Narin'jani (eds.), *Modelirovanie jazykovoj dejatel'nosti v intellektual'nyx sistemax*, Moscow: Nauka, pp. 201–219.

MAXWELL, JOHN T., III and CHRISTOPHER D. MANNING (1996). 'A theory of non-constituent coordination based on finite state rules'. In Miriam Butt and Tracy Holloway King (eds.), *Proceedings of the LFG96 Conference*, Stanford, CA: CSLI Publications.

PRZEPIÓRKOWSKI, ADAM and AGNIESZKA PATEJUK (2012). 'On Case Assignment and the Coordination of Unlikes: The Limits of Distributive Features'. In Miriam Butt and Tracy Holloway King (eds.), *Proceedings of the LFG12 Conference*, Stanford, CA: CSLI Publications, pp. 479–489.

SADLER, LOUISA and DOUG ARNOLD (1994). 'Prenominal Adjectives and the Phrasal/Lexical Distinction'. *Journal of Linguistics 30*, pp. 187–226.

STEELE, SUSAN (1978). 'Word order variation: a typological study'. In Joseph H. Greenberg, Charles A. Ferguson, and Edith A. Moravcsik (eds.), *Universals of Human Language IV: Syntax*, Stanford University Press, pp. 585–623.

TOIVONEN, IDA (2003). *Non-Projecting Words: A Case Study of Swedish Verbal Particles*. Dordrecht: Kluwer.

WÄLCHLI, BERNHARD (2005). *Co-Compounds and Natural Coordination*. Oxford: Oxford University Press.

WECHSLER, STEPHEN and LARISA ZLATIĆ (2003). *The many faces of agreement*. Stanford, CA: CSLI Publications.