Feature Indeterminacy and Feature Resolution

Mary Dalrymple and Ronald M. Kaplan

Xerox Palo Alto Research Center

Palo Alto CA 94304 USA

(650)812-4771 (650)812-4348

{dalrymple,kaplan}@parc.xerox.com

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Syntactic features like CASE, PERSON, and GENDER are often assumed to have simple atomic values that are checked for consistency by the standard predicate of equality. The CASE feature has values such as NOM or ACC, and values like MASC and FEM are assumed for the feature GENDER. However, such a view does not square with some of the complex behavior that these features exhibit. It allows no obvious account of *feature indeterminacy* (how a particular form can satisfy conflicting requirements on a feature like CASE), nor does it give an obvious account of *feature resolution* (how PERSON and GENDER features of a coordinate noun phrase are determined on the basis of the conjuncts). We present a theory of feature representation and feature checking which solves these two problems. It provides a straightforward characterization of feature indeterminacy and feature resolution while sticking to structures and standard interpretations that have independent motivation. Our theory of features is formulated within the LFG framework, but we believe that similar solutions can be developed within other syntactic approaches.*

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Introduction

Well-known examples of *feature indeterminacy*, such as example (1), show that a single phrase can appear to simultaneously fulfill conflicting syntactic requirements (Dyła 1984; Zaenen and Karttunen 1984; Pullum and Zwicky 1986; Zwicky 1991):

(1) (Figure at end.)

In example (1), the pronoun *kogo* is the object of two coordinated verbs; the first verb requires accusative case for its object, while the second requires genitive case. *Kogo* can fill both of these requirements, as the accusative and genitive forms for this particular pronoun are the same. It is not possible to characterize the pronoun in (1) as bearing *either* accusative *or* genitive case, since it must satisfy both requirements simultaneously. Example (2) (Groos and van Reimsdijk 1979; Ingria 1990; Bayer 1996) shows that such examples can also appear in noncoordinate structures:

(2) (Figure at end.)

On the basis of such examples it has been argued (Ingria 1990; Johnson and Bayer 1995) that Boolean combinations of equality constraints over atomic values like those standardly used in constraint-based grammatical theories are not useful for enforcing feature-matching requirements such as these, and even that constraint-based frameworks in general are incapable of handling such phenomena. It is suggested instead that additional devices of various sorts are needed to provide the necessary grammatical characterizations.

We agree with the particular claim that equality constraints over atomic feature values cannot adequately account for these patterns of dependency. But we take issue with the general conclusion that this calls for a wholesale revision to the underlying theory of grammar. Rather, we see these and other recalcitrant patterns of agreement as problems that can be solved within a constraint-based architecture by means of only minor adjustments to representations and mechanisms.

In fact, we can overcome these difficulties by a very simple change of representation: we allow feature values to be *sets* of items as well as individual symbols. The CASE value for an ordinary nominative noun is represented as the singleton set {NOM} instead of the symbol NOM, and an accusative noun has the value {ACC}. A word such as *was* in (2) above, which can satisfy both nominative and accusative requirements, has {NOM,ACC} as its CASE value, where the different elements indicate the different possibilities of realization. Finally, the contextual case-agreement requirements are imposed by set-membership assertions instead of equality conditions. Section 4 presents more examples of feature indeterminacy and our solution for this kind of complex behavior.

The phenomenon of *feature resolution* in coordinate noun phrases raises a different set of challenges for atomic-value-with-equality approaches. The problem is to give a principled account of how certain features of conjoined elements are resolved to determine the agreement features of the coordination as a whole. For example, when one of the conjuncts in a coordinate noun phrase in Slovak is 1, verb agreement shows that the person of the coordinate phrase is also 1:

(3) (Figure at end.)

This problem and the analogous problem for gender have been studied extensively by Corbett (1983a,b, 1991), but many formal accounts of agreement do not address this issue at all, or address it only partially. If the PERSON feature is represented as an atomic value such as 1 or 2, it is not clear how the rules for determining the person of coordinate phrases can be formulated in a non-ad-hoc way for examples like (3), since there is no straightforward way of operating on the features 1 and 2 of the individual conjuncts in (3) to obtain the feature 1 for the coordinate subject noun phrase.

We investigate the feature resolution problem in a range of languages and propose a general and uniform account of feature resolution in coordinate constructions. Here as well we make use of set-valued features. We assign set values to features of the individual conjuncts, {S,H} for first person and {H} for second person. We then take the union of the conjunct sets, in this case {S,H}, to be the feature value for the coordinate structure:

(4) (Figure at end.)

The features required by the verb must be compatible with the features of the coordinate structure as a whole:

(5) (Figure at end.)

Our general approach to coordinate feature resolution is outlined in Section 5. We present our account of resolution of the PERSON feature in Section 6 and of the GENDER feature in Section 7.

1 Background: Lexical Functional Grammar

Our theory of feature indeterminacy and feature resolution is formulated within the framework of Lexical Functional Grammar. Here we provide a brief summary of the general framework. For a more complete explication of the syntactic assumptions of LFG, see Bresnan (1982), Dalrymple et al. (1995), and the references cited there.

LFG postulates two syntactic levels of representation. Constituent structure (*c-structure*) encodes phrasal dominance and precedence relations and is represented as a phrase structure tree. Functional structure (*f-structure*) encodes syntactic predicate-argument structure and is represented as an attribute-value matrix. The c-structure and abbreviated f-structure for sentence (6) are given in (7):

(6) Bill yawns.

(7) (Figure at end.)

An f-structure is a function from attributes such as PRED, SUBJ, and TENSE to values like PRES, semantic forms like 'YAWN' or 'BILL', f-structures, or to sets of such values. Coordinate structures can be represented as sets of f-structures, as proposed by Kaplan and Bresnan (1982), Bresnan et al. (1985) and Kaplan and Maxwell (1988); complex values also can be represented as sets.

The properties of f-structures that correspond to c-structure nodes are specified by annotations on phrase structure rules and lexical entries. The following annotated phrase-structure rule is used in the analysis of sentence (6):

(8) (Figure at end.)

In each rule or lexical entry, the $\uparrow$ metavariable refers to the f-structure corresponding to the mother c-structure node, and the $\downarrow$ metavariable refers to the f-structure corresponding to the nonterminal labeled by the assertion (Kaplan and Bresnan 1982, page 183). The assertions on the rule in (8) indicate that the f-structure for the S ($\uparrow$ in the annotation on the NP node) has a SUBJ attribute whose value is the f-structure for the NP daughter ($\downarrow$ in the annotation on the NP node), and that the S node corresponds to an f-structure which is the same as the f-structure for the VP daughter. When the phrase-structure rule for S is used in the analysis of a given sentence, the metavariables $\uparrow$ and $\downarrow$ are instantiated to particular f-structures placed in correspondence with nodes of the c-structure. The analysis is acceptable if those f-structures satisfy all the requirements that the phrasal annotations specify as well as the assertions associated with lexical entries.

Lexical entries also use the metavariables $\uparrow$ and $\downarrow$ to encode information about the f-structures of the preterminal nodes that immediately dominate them. Lexical entries for the words 'Bill' and 'yawns' are:

(9)	*Bill*	NP	($\uparrow$ PRED) = 'BILL'
	yawns	V	($\uparrow$ PRED) = 'YAWN'
			($\uparrow$ TENSE)=PRES

For example, the assertion ($\uparrow$ PRED) = 'BILL' states that the preterminal node immediately dominating the terminal symbol *Bill* has an f-structure whose value for the attribute PRED is 'BILL'.

The feature assertions in (8) and (9) are satisfied by the f-structure in (7) but also by all larger f-structures that contain other combinations of attributes and values besides the ones shown in (7). These larger structures have properties that are not in any way related to the words or phrases of the sentence, and, as discussed by Kaplan and Bresnan (1982), they are excluded from grammatical consideration. The f-structure assigned to an utterance is the *smallest* f-structure that satisfies all the assertions that come from its words and phrases. This is the *minimal model* for the collection of feature assertions, since it satisfies all lexical and phrasal constraints but contains no additional attributes or values.

The assertions presented above are taken to *define* the minimal model for the f-structure of an utterance. LFG also provides for *constraining equations*, which require the minimal model for the defining equations of an utterance to have certain properties. Constraining equations are distinguished from other assertions by the presence of a subscript c, as in the following:

(10) ($\uparrow$ NUM) $=_c$ PL

We will make use of constraining equations in our analysis of feature resolution in coordination.

2 Traditional approaches to feature representation

It is well-known that some words, such as verbs, can place constraints on features of their arguments, in particular on the person, number, gender, or case values. In the following Hindi example (McGregor 1972), the verb requires its subject to be third person, singular, masculine, and nominative:

(11) (Figure at end.)

We represent the agreement relationship by an arrow: here, the verb *calegaa* agrees with the subject *Ram*. Under traditional LFG assumptions about the form of agreement features, the f-structure for example (11) is:

(12) (Figure at end.)

In LFG the agreement constraints contributed by the lexical entries for *Ram* and *calegaa* are instantiated as:

(13) a. calegaa $(f\ \textsc{subj person}) = 3$
$(f\ \textsc{subj num}) = \textsc{sg}$
$(f\ \textsc{subj gender}) = \textsc{masc}$
$(f\ \textsc{subj case}) = \textsc{nom}$

b. Ram $(g\ \textsc{person}) = 3$
$(g\ \textsc{gender}) = \textsc{masc}$
$(g\ \textsc{num}) = \textsc{sg}$
$(g\ \textsc{case}) = \textsc{nom}$

We can deduce from annotations on the Hindi phrase structure rules that $(f\ \textsc{subj}) = g$, so we conclude that the agreement features in this example are consistent and the sentence is correctly predicted to be well-formed. On the other hand, the lexical entry for *calogii* in the ungrammatical string **Ram calogii* provides the equations

(14) calogii: $(f\ \textsc{subj person}) = 2$
$(f\ \textsc{subj gender}) = \textsc{fem}$

Given the substitution and transitivity axioms of equality, there is a chain of deduction from these premises that leads to the conclusions 2=3 and $\textsc{masc}=\textsc{fem}$, inconsistencies between atomic feature values that account for the unacceptability of this string.

On the face of it, agreement seems to be a problem that has a straightforward solution: two items in a sentence covary systematically, and this covariance is nicely encoded in LFG by means of atomic feature-value assignments and deductions using the standard properties of the equality relation. Essentially equivalent treatments have been provided in other constraint-based syntactic theories, including HPSG (Pollard and Sag 1994).

3 Indeterminacy: A problem for traditional approaches

It is possible for a noun phrase to be ambiguous or vague between two case features. In some instances, it can appear to simultaneously fulfill conflicting syntactic requirements. This phenomenon is sometimes referred to as 'resolution', for example by Pullum and Zwicky (1986); here we use the terms 'feature checking' and 'feature indeterminacy', reserving the term 'resolution' for the process of assigning person and gender features to coordinate phrases,[1] described in Sections 6 and 7 below.

Groos and van Reimsdijk (1979) point out that in German free relatives, the case of the relative pronoun must match the case required by the matrix verb as well as by the verb in the relative clause:[2]

(15) (Figure at end.)

If case requirements conflict, the result is ungrammatical:

(16) (Figure at end.)

These results follow from the traditional atomic-value-and-equality account of agreement. As Groos and van Reimsdijk (1979) note, and as we mentioned above, this simple approach fails in some instances. In the following example, the matrix verb requires an accusative argument and the verb in the relative clause requires a nominative argument. The form *was* can separately satisfy the requirements of both NOM and ACC verbs, and the grammaticality of this example shows that it can appear as the single target of two conflicting demands:

(17) (Figure at end.)

Examples such as these have been widely discussed (Zaenen and Karttunen 1984; Pullum and Zwicky 1986; Ingria 1990; Johnson and Bayer 1995; Bayer 1996; Müller 1999) since they pose a direct challenge for equality-based treatments of agreement. We briefly describe the two most obvious ways of assimilating the treatment of these examples to the traditional approach and show why these proposals are not viable.

3.1 Indeterminacy as disjunction?

It may seem that we can obtain the desired result by assuming that *was* is specified as a Boolean disjunction, so that it is either NOM or ACC:

(18) was: $(\uparrow \text{ CASE}) = \text{NOM} \vee (\uparrow \text{ CASE}) = \text{ACC}$

This approach does not succeed, however, under the usual axioms of Boolean logic that conjunction and disjunction distribute over each other. Any formula can be converted to a disjunctive normal form in which disjunctions have the widest possible scope, so that formally there is no difference between the disjunctive statement in (18) and a list of homophones:

(19) was: $(\uparrow \text{ CASE}) = \text{NOM}$
was: $(\uparrow \text{ CASE}) = \text{ACC}$

Thus, no matter which value of CASE we choose for *was*, it conflicts with the requirements of one of the verbs in the construction:

(20) (Figure at end.)

(21) (Figure at end.)

We see that disjunctively specifying the case of *was* does not predict the grammaticality of (9).

3.2 Indeterminacy as underspecification?

Alternatively, we might assume that *was* is completely unspecified for case:

(22) was: no case at all

But this approach also does not account for the grammaticality of the German free relative. This situation can be diagrammed with a variable x standing for the case of the pronoun rather than the two different values in the illustration above:

(23) (Figure at end.)

The unknown value x for the case of *was* is required by the matrix verb to be ACC, and by the verb of the relative clause to be NOM. Even though no particular value is known, the transitivity of equality still implies the undesired conclusion that NOM=ACC:

(24) $x = \text{NOM} \wedge x = \text{ACC} \Rightarrow \text{NOM} = \text{ACC}$ (!)
(transitivity of equality)

Thus a solution based on feature underspecification fares no better than the disjunction proposal: the agreement requirements of both verbs still are not simultaneously satisfiable. Underspecification has a separate difficulty in that it fails to account for the fact that *was* is not compatible with requirements for cases other than NOM or ACC. For example, *was* cannot appear in contexts requiring dative or genitive case, but such a situation cannot be ruled out if no feature value is specified.

Other approaches to indeterminacy have been proposed and are discussed briefly in Section 4.6. Some researchers (Johnson and Bayer 1995; Müller 1999) have proposed solutions that apply only to the case of German reduced relatives, but do not extend to the coordinate examples discussed in section 4.3. Other researchers (Sag et al. 1985; Shieber 1989) have made proposals to handle feature indeterminacy in coordinate structures, but these solutions do not extend to noncoordinate examples like (23). There have also been proposals to augment the standard constraint-based architecture with additional evaluative operations (Ingria 1990) or to abandon such architectures altogether (Johnson and Bayer 1995). It turns out, however, that a simple and general solution is available within the existing LFG framework. It accounts for all of the examples we have presented and does not require fundamental changes to the architecture of the theory.

4 A set-based theory of indeterminate feature values and requirements

We provide a general solution to the problem of agreement with indeterminate features by representing features as *sets* of atomic values rather than as individual symbols. The elements of a set encode the alternative values that an indeterminate feature can agree with, and agreement requirements are imposed by assertions of set membership:

(25) Sets encode indeterminate feature possibilities.

We illustrate our approach to feature indeterminacy by considering the differing patterns of agreement exemplified by case in German free relatives, case in Polish coordination, and noun class in Xhosa coordination.

4.1 The case of German free relatives

We take the value of the feature CASE for noun phrases always to be a set whose elements are the atomic symbols (NOM, ACC, etc.) of the traditional approach. Often the value is a singleton set, as with the unambiguously nominative German relative pronoun *wer*. For relative pronouns like *was*, which can be used in both nominative and accusative contexts, the set has more than one member:

(26) wer: $(\uparrow \text{ CASE}) = \{\text{NOM}\}$

was: $(\uparrow \text{ CASE}) = \{\text{NOM,ACC}\}$

Case checking by verbs consists in testing for the appropriate members in the CASE set:

(27) gegessen: $\text{ACC} \in (\uparrow \text{ OBJ CASE})$

übrig: $\text{NOM} \in (\uparrow \text{ SUBJ CASE})$

Thus we assign the functional structure in (29) to German free relatives like (28), where a line between feature positions indicates that exactly the same value appears in both places (some details omitted):

(28) (Figure at end.)

(29) (Figure at end.)

The matrix verb *gegessen* 'eaten' requires that ACC be a member of its OBJ's case value, and the embedded predicate *übrig war* 'was left' requires that NOM be a member of its SUBJ's case value. These requirements are embodied in the following assertions:

(30) was: $(o \text{ CASE}) = \{\text{NOM,ACC}\}$

gegessen: $\text{ACC} \in (o \text{ CASE})$

übrig: $\text{NOM} \in (s \text{ CASE})$

In a free relative construction the PRED and CASE values of the relative phrase are shared between the matrix sentence and the relative clause, so for this example we also know that

(31) $(o\ \text{CASE}) = (s\ \text{CASE})$

The conditions in (31) and (30) are mutually consistent: the case requirements for both verbs are satisfied and the sentence is marked as grammatical.

In contrast, the following example is not acceptable:[3]

(32) (Figure at end.)

The relative pronoun *wem* 'who' is unambiguously dative, and so its value for the CASE feature is the singleton set $\{\text{DAT}\}$. The requirements of the verb *vertraust* 'trust' are satisfied, since it requires a dative object. However, the matrix verb *muss* 'must' requires a nominative subject, and this constraint is not met. Letting d and n stand respectively for the f-structures of the dative object and nominative subject, the relevant constraints for this example are:

(33) $(d\ \text{CASE})=(n\ \text{CASE})$

wem:	$(d\ \text{CASE}) = \{\text{DAT}\}$
vertraust:	$\text{DAT} \in (d\ \text{CASE})$
muss:	$\text{NOM} \in (n\ \text{CASE})$ [not satisfied]

4.2 Sets and their descriptions

Our use of set representations as the formal encoding of feature values is a conservative solution to the problem of feature indeterminacy. It is not an extension to LFG's domain of f-structure entities, since sets have been part of the LFG f-structure ontology from the beginning. Kaplan and Bresnan (1982) introduced sets of f-structures to represent collections of adjuncts and modifiers, as for the set of relative clause modifiers RELMODS in example (9), and Bresnan et al. (1985) and Kaplan and Maxwell (1988) used sets to represent the conjoined elements of coordinate constructions. Thus, LFG's functional description language has always included set membership $\in$ as a primitive relation, and this is the relation by which the verbal lexical entries above check that their set-valued argument features meet the appropriate requirements.

The assignment of set values for the pronoun case features does involve a minor extension to the original f-description notation. The CASE value for *was* is defined by the equation

(34) was: $(\uparrow\ \text{CASE}) = \{\text{NOM,ACC}\}$

The expression $\{\text{NOM,ACC}\}$ in this equation is a *set designator*, a notational innovation indicating that the feature value is a set and also providing an *exhaustive enumeration* of the set's elements. This captures some of the disjunctive intuitions of feature indeterminacy: if x stands for some unknown value, we know that

(35) $x \in \{\text{NOM,ACC}\} \Rightarrow \text{NOM} = x \vee \text{ACC} = x$ (implicit disjunction)

$(\text{n.b., GEN} \neq x)$

Whereas explicit disjunction as denoted by the Boolean operator $\vee$ has the undesired wide-scope interpretation, elements in a set are disjunctive only with respect to specific assertions of set membership. In this way, our set representations can be viewed as formally clarifying the intuitions that underlie the disjunctive values of Zaenen and Karttunen (1984). Conversely, we also know that if y is defined by a set designator, then it does in fact contain all of the designated elements:

(36) $y = \{\textsc{nom},\textsc{acc}\} \Rightarrow \textsc{nom} \in y \wedge \textsc{acc} \in y$ (implicit conjunction)
(n.b., $\textsc{gen} \notin y$)

This is why the conjunction of differing verbal requirements is satisfiable with indeterminate pronoun specifications. This combination of disjunctive and conjunctive characteristics is the basis of our analysis of indeterminacy.

The fact that NOM and ACC belong to the set could also be encoded without the use of set designators, by the pair of assertions

(37) was: $\textsc{nom} \in (\uparrow\ \textsc{case})$
$\textsc{acc} \in (\uparrow\ \textsc{case})$

However, this is not only more cumbersome than the single assertion above, it also does not express the important fact that the set contains no other members. Thus, unlike the set designator in (36), the assertions in (37) would have the undesired property of being consistent with a further assertion that $\textsc{gen} \in (\uparrow \textsc{case})$.

4.3 Indeterminacy in coordination

The German free relative example discussed above can be schematically represented as:

(38) (Figure at end.)

Other examples of feature indeterminacy as well as feature determination involve an argument that is shared between two conjuncts. Again, as indicated in the following diagram, the shared argument can appear to satisfy conflicting requirements in the two conjuncts:

(39) (Figure at end.)

Case features in Polish coordinate constructions provide evidence for this type of three-way indeterminate agreement, and our set-based solution also applies to these examples. Dyła (1984, page 701) discusses the following Polish example, in which a noun phrase is shared across a coordinate structure and different requirements are placed on its case feature in each conjunct:

(40) (Figure at end.)

This sentence is grammatical because the pronoun *kogo* 'who' satisfies both agreement requirements, in contrast to the ungrammaticality of example (41) in which *kogo* 'who' is replaced by *co* 'what':

(41) (Figure at end.)

Our use of set-valued features interacts with the LFG theory of coordination to account for this pattern of agreement. As originally proposed by Bresnan et al. (1985) and discussed by Kaplan and Maxwell (1988), the f-structure for a coordinate structure is a set containing the f-structures for the conjuncts.[4] Thus the f-structure for a sentence like *John bought and ate apples* is:

(42) (Figure at end.)

This example of verb coordination is described by the following phrase structure rule:

(43) (Figure at end.)

Given this rule and given the fact that the coordinated V is the head of the VP and S, the f-structure for the whole sentence is a set containing an f-structure corresponding to each conjunct. The NP *John* contributes the subject of this f-structure set by virtue of the simple function-application schema $(\uparrow \text{SUBJ}){=}\downarrow$, and the NP *apples* provides its object. However, the original definition of function application (Kaplan and Bresnan 1982) did not provide a value for such an expression when $\uparrow$ denotes a set of f-structures instead of a single f-structure. Thus, it did not produce the desired effect of distributing the subject and object to each of the conjunct f-structures. Bresnan et al. (1985) outlined a general theory of feature distribution in coordinate constructions by specifying the conditions under which a set can be treated as an f-structure with attributes and values:

(44) For any attribute-value property P and set s: $P(s)$ iff $\forall f \in s.P(f)$

According to this definition, if the NP *John* is the subject of the coordinate structure, it is distributed to be the subject of each of the conjuncts.[5]

For our Polish example (9) the effect of this definition is to distribute *kogo* 'who' so that it becomes the object in each of the conjunct f-structures:

(45) (Figure at end.)

The agreement pattern for examples such as (45) now follows from the same kind of feature markings we used for the noncoordinate German sentences: Polish *kogo* 'who' has a CASE feature whose value is {ACC,GEN}. The verb *lubi* 'likes' requires its object's case to contain ACC, and the verb *nienawidzi* 'hates' requires its object's case to contain GEN. The form *kogo* is the object of both of these verbs and satisfies both of these requirements, and the sentence is well-formed.

(46)	kogo	$(w\ \text{CASE}) = \{\text{ACC},\text{GEN}\}$
	lubi	$\text{ACC} \in (w\ \text{CASE})$
	nienawidzi	$\text{GEN} \in (w\ \text{CASE})$

Examples of indeterminacy can be found with other features besides case. Pullum and Zwicky (1986, page 761) discuss constraints on the form of the verb used in a verb phrase complement. They present examples such as the following and note that they are ill-formed:[6]

(47) (Figure at end.)

(48) (Figure at end.)

The auxiliary *will* requires a bare infinitive complement, while auxiliary *have* requires the past participle form. There is no form of the verb *clarify* that has both of these features, and so the example is ill-formed.

In contrast, example (49) is perfectly acceptable:

(49) (Figure at end.)

This follows if the value of the VFORM feature, like the value of the CASE feature, is a set which may contain more than one element. Since the verb form *set* represents the bare infinitive and the past participle form, the VFORM value of the verb *set* contains both values:

(50) *set* V $(\uparrow \text{PRED}) = \text{`SET'}$
$(\uparrow \text{VFORM}) = \{\text{BASE, PPART}\}$

This form satisfies the requirements of both *will* and *have* and allows for the grammaticality of example (9).

4.4 Indeterminate agreement requirements

The data explored in the previous section show that the case of a noun phrase can be indeterminate and can independently satisfy each of two different case requirements imposed by different verbs. Conversely, a verb may be indeterminate in the requirement it imposes on an argument, and this requirement might be satisfied in two different ways in a conjunction of two differently-specified noun phrases. Such a situation is illustrated by noun class agreement in the Bantu languages as discussed for Xhosa by Voeltz (1971) and Pullum and Zwicky (1986),[7] and for Chicheŵa by Corbett (1991).

In Xhosa, like other Bantu languages, nouns belong to several noun classes. We follow standard practice in referring to these noun classes with numbers. Generally the singular form is a member of one class while the plural form is a member of a second class, and so the noun class of a noun is represented by a pair of numbers such as 1/2, indicating that the singular is in class 1 and the plural is in class 2.

Voeltz (1971) shows that Xhosa verbs agree with their subjects in noun class, and that coordinating subject noun phrases of the same noun class is permissible:

(51) (Figure at end.)

(52) (Figure at end.)

The noun class requirement is met by each conjunct of the coordinate subject noun phrase: each conjunct noun phrase is class 1/2.

It is generally impossible to coordinate subject noun phrases of different noun classes:

(53) (Figure at end.)

When verb agreement is not involved, such coordinate structures are unproblematic; the problem with the examples in (53) is that the subject noun class requirement imposed by the verb is distributed to each conjunct of the coordinate subject phrase but is not satisfied by all of them.

Voeltz notes that an interesting exception to this generalization is provided by verbs that can take subjects in either of two noun classes.[8,9] In such cases, the verb may take a coordinate subject with nouns from these different classes, and each conjunct separately satisfies the requirements imposed by the verb. In the following example, the prefix *zi* is the agreement form for both 7/8 and 9/10 plurals:

(54) (Figure at end.)

We again use set representations to encode an indeterminate pattern of agreement. In this instance, the set appears as a part of the subject noun class requirement of the verb, not as a property of the nouns as in the German and Polish examples. In Xhosa, an indeterminate verb such as *zibomvu* checks the noun class of its subject by checking for membership in a set of possible noun classes. In example (54), the subject's noun class must be either 7/8 or 9/10. This indeterminacy is distributed to the conjuncts of the subject noun phrase, and each conjunct satisfies one of the requirements. Thus, a conjunction of nouns in these classes is permitted:

(55) (Figure at end.)

(56)

izandla	$(h \text{ CLASS}) = 7/8$
neendlebe	$(e \text{ CLASS}) = 9/10$
zibomvu	$(f \text{ SUBJ CLASS}) \in \{7/8, 9/10\}$

The agreement requirements of verbs with determinate subject prefixes, such as *bayagoduka*, are still stated with the equality relation.

Facts similar to the Xhosa data are reported by Corbett (1991, pages 276 ff.) for Chicheŵa, based on work by Corbett and Mtenje (1987), where the verb agreement form for plural nouns of the 1/2 and 5/6 genders are both marked with the prefix *a*-:

(57) (Figure at end.)

(58) (Figure at end.)

Coordinate structures with mixtures of class 2 and 6 nouns are also allowed:

(59) (Figure at end.)

Another example of indeterminate agreement requirements involves the person feature and right-node raising in German. The following observations were originally presented by Eisenberg (1973) and have since been discussed by Ingria (1990) and Pullum and Zwicky (1986, page 757):

(60) (Figure at end.)

(61) (Figure at end.)

Example (9) shows that the German verb *kaufen* 'buy' agrees with both 1 and 3 person subjects. In example (9) the subject of the first conjunct is a 1 person form, the subject of the second conjunct is a 3 person form, and the verb is compatible with both of these. This follows from a simple indeterminate constraint in the lexical entry for this form of *kaufen*:

(62) kaufen $(\uparrow \text{SUBJ PERSON}) \in \{1{,}3\}$

When the verb is right-node raised out of a conjunction of clauses, this constraint is distributed across the elements of the resulting set of conjuncts and thus applied independently to the subject of each conjunct. The sentence is grammatical because each conjunct satisfies the verb's requirement:

(63) (Figure at end.)

Pullum and Zwicky (1986, page 771) and Zaenen and Karttunen (1984) discuss more complicated examples where combinations of more than one feature are involved in the indeterminacy. Example (9) involves both the PERSON and NUM feature:[10]

(64) (Figure at end.)

Our analysis of the more interesting indeterminacy of correlated agreement requirements resembles the treatment we have given for the Xhosa, Chicheŵa, and German examples above. For the verb *kauft* the two combinations of correlated features each contribute to an element of the set representing the indeterminacy:

(65) kauft
$$\begin{aligned}
&(\uparrow \text{SUBJ}) \in \{x, y\}\\
&(x \text{ PERSON}) = 2\\
&(x \text{ NUM}) = \text{PL}\\
&(y \text{ PERSON}) = 3\\
&(y \text{ NUM}) = \text{SG}
\end{aligned}$$

These equations assert that the subject of *kauft* is either a second person plural phrase (the combination of requirements represented by x) or a third person singular phrase (the requirements represented by y). In example (9), these requirements are distributed to, and satisfied separately by, the subject of each conjunct, just as they were in the simpler examples involving only one feature.

Most previous treatments of feature indeterminacy do not properly account for examples involving indeterminacy of correlated features; indeed, besides our own account, only the account of Bayer (1996) successfully handles such cases. The underlying problem for most accounts (Pullum and Zwicky 1986; Johnson and Bayer 1995, as discussed by Bayer 1996) is that they are framed in terms of standard notions of conjunction or disjunction (or analogous operators) that are distributive and associative and thus allow for incorrect combinations of features.

4.5 Speaker variation

As examples such as (9) show, some instances of correlated feature indeterminacy are acceptable for only some speakers. There are also many examples of speaker variation where just a single feature is involved. Zaenen and Karttunen (1984) discuss the following example of case indeterminacy in Icelandic, noting that only some speakers find it acceptable:

(66) (Figure at end.)

The noun phrase *köku* appears as the object of two coordinated verbs, the first of which requires its object to bear dative case and the second of which requires accusative case. Following Zaenen and Karttunen, we assume that such examples are treated as indeterminate by speakers who accept them, that is, that the case of *köku* is analyzed as the set {ACC,DAT}. The single form can then satisfy both requirements. For speakers who find these examples ungrammatical, *köku* must be disjunctively specified for case ($(\uparrow$ CASE$)=\{$ACC$\} \vee (\uparrow$ CASE$)=\{$DAT$\}$). Of course, if the different feature possibilities correlate with some other clearly disjunctive ambiguity, for example an ambiguity of sense, a disjunctive specification is required. From this observation follows what Zaenen and Karttunen (1984) call the *Anti-Pun Ordinance*: a word that has a seemingly indeterminate value for CASE or some other syntactic feature may not be used in two different senses at the same time.

Examples which are analyzed by some speakers as indeterminate and by others as disjunctive are fairly common. Zaenen and Karttunen (1984) also discuss the following sentence, originally considered by Kayne (1975). They note that "some prescriptive grammarians condemn" such examples:

(67) (Figure at end.)

In the same vein, Pullum and Zwicky (1986, page 765) claim that examples like the following are acceptable for all German speakers; however, the speakers we have checked with do not find these examples acceptable:

(68) (Figure at end.)

(69) (Figure at end.)

These examples reinforce the point that different speakers may analyze the same forms either indeterminately or disjunctively.

Pullum and Zwicky (1986) are troubled by the flexibility allowed by approaches such as ours and Zaenen and Karttunen's. They reject the possibility that different speakers may analyze a given form in different ways, and propose instead a more restrictive treatment of idiolectal variation. They claim that the grammar for each speaker can be characterized by a particular integer which specifies the maximum number of features that can be indeterminate in any phonological form. For example, if the number for a speaker is zero, then that speaker will not accept any instances of indeterminacy. If the number is one, then the speaker will accept examples such as (69) but not example (9) above, in which two correlated features are involved. However, some German speakers that we have consulted accept the one-feature indeterminacy in example (9), with the indeterminate verb *kaufen*, but reject example (69), which also has only one indeterminate feature. This is a counterexample to Pullum and Zwicky's particular proposal. We note that their concerns about the range of idiolectal variation may be addressed in other ways. For example, a lexicalist theory such as LFG offers other devices for expressing generalizations across the lexicon, and these may be the basis for a restricted set of possible idiolects.

4.6 Comparison with earlier approaches

To our knowledge, Zaenen and Karttunen (1984) were the first to observe that equality constraints over atomic values are inadequate to characterize case agreement phenomena in their full generality. They identified many of the empirical and formal problems considered in later work, but they presented only a sketch of a coherent treatment of the problem. Subsequent proposals for dealing with case agreement in German free relatives and other examples of indeterminacy have involved more or less radical changes or augmentations to the architecture of constraint-based grammatical theories.

Ingria (1990) proposes handling indeterminate agreement by means of a nondistinctness check rather than either a unification operation or an equality constraint. A relative pronoun such as German *was* is disjunctively marked for case, bearing the case NOM $\vee$ ACC. Verbs check for consistency with this feature without instantiating it to either one of the disjuncts: the nondistinctness check ensures only that the case value required by the verb is consistent with the value of the relative pronoun. Ingria's account resembles ours in that it supplies complex feature values for indeterminate features and checks these features in a special way. However, our account expresses the properties of different features in different constructions in terms of simple, standard, and independently-motivated mathematical relations and structures.

Johnson and Bayer (1995) also discuss the interaction of underspecification with case checking, presenting additional problems for certain approaches to case checking based on unification or equality constraints. They offer an alternative framework based on deduction in Lambek categorial grammar, arguing that 'unification-based' approaches cannot handle the full range of feature indeterminacy and that a deductive approach is therefore to be preferred. Their primary argument against a constraint-based account is aimed at proposals for feature determination in coordination due to Sag et al. (1985) and Shieber (1989). Those analyses assume that the features of a coordinate structure are the generalization of the features of the conjuncts (Sag et al.), or that the features of the coordinate structure must subsume the features of the conjuncts (Shieber). As Johnson and Bayer point out, coordinating two transitive verbs that require different cases for their objects — for example, a verb that requires an accusative object and a verb that requires a dative object — will produce a coordinate structure compatible with an object with either accusative or dative case, the wrong result. Like the original Bresnan et al. (1985) approach, the account we present here does not suffer from such incorrect predictions.

Though our approach and the Johnson/Bayer account are set on very different formal foundations, they have substantial overlap in their empirical coverage, at least for the phenomena that we have examined here.[11] They differ in two main respects. First, as noted in Section 4.4 above, our account handles examples in which multiple correlated features are indeterminate. Bayer (1996) points out that the Johnson/Bayer approach cannot deal with these constructions, for what seem to be fundamental reasons. Second, the solution they offer for indeterminacy in coordination (section 4.3) does not extend to indeterminacy in noncoordinate constructions such as German free relatives (section 4.1). To handle these cases, Johnson and Bayer propose a completely separate mechanism that relies on two separate values for the CASE of the relative pronoun: one of these is checked in the matrix clause, and the other is checked in the relative clause. Müller (1999) offers a similar two-feature analysis for German free relatives, but he does not also offer a solution for coordination. We prefer a solution which treats both types of indeterminacy in the same way, since the phenomena are clearly related.

Müller (1999) and Anette Frank (p.c.) point out that since our set-based account of indeterminacy is designed to eliminate the undesired consequences of transitivity of equality, it would lead to more complicated treatments if any phenomena can be found in which indeterminacies must be resolved in correlated ways. According to Müller, the following sentence exemplifies this situation:

(70) (Figure at end.)

Müller asserts that the adverbial phrase *einen nach dem anderen* 'one after the other' shows CASE agreement with its antecedent, and that this must be consistent with the verb's assignment of CASE to its OBJ. This assumption accounts for the ungrammaticality of the variant in which the adverbial bears NOM case. In fact, though, the correct analysis of these examples is that the CASE value of the adverb is dependent on the antecedent's grammatical function; the adverb must be ACC because its antecedent is an OBJ.[12] Therefore, examples of this sort do not undermine our approach.

To summarize, we agree with Zaenen and Karttunen (1984), Ingria (1990) and Johnson and Bayer (1995) that simple equality constraints with atomic feature values such as NOM or ACC are inappropriate for characterizing feature indeterminacy and feature checking. However, our solution shows that these phenomena do not necessitate the addition of new processes for satisfying special kinds of constraints (as proposed by Ingria) or the abandonment of constraint-based frameworks for linguistic description (as suggested by Johnson and Bayer).

5 Feature resolution with coordinate noun phrases: Distributive and nondistributive properties

Thus far we have examined cases in which features of the individual conjuncts in a coordinate structure are checked separately to determine well-formedness. Section 4.3 discussed examples of wh-fronting in coordinate structures in Polish, where the case of the fronted object is checked independently in each conjunct. Section 4.4 discussed Xhosa examples in which the noun class of each conjunct in a coordinate noun phrase is checked independently by the verb. In these situations, the coordinate structure as a whole does not have its own features distinct from the features of the conjuncts.

However, this is not true for every feature. In example (71) we see that some features of a coordinate noun phrase may be different from the features of the conjuncts. The 1PL form of the verb is appropriate, as shown in (71), even though *José* is a 3SG noun phrase:

(71) (Figure at end.)

Intuitively, a coordinate noun phrase has its own PERSON, NUM, and GENDER features, just as a pronoun does.

To make this intuition explicit, we follow a proposal by John Maxwell (p.c.) to distinguish between different kinds of properties that a coordinate structure can have. Person, number and gender features of a coordinate noun phrase are properties of the coordinate structure as a whole. We refer to these features as *nondistributive* features, since they do not distribute to the individual conjuncts. Instead, they are properties of the *set* of f-structures representing the coordinate phrase. Other syntactic features, such as case or noun class, are *distributive* features. Distributive features are properties of the individual conjunct noun phrases and not of the coordinate phrase. They are checked by inspecting the features of each conjunct, as in the Xhosa examples described above. This proposal was foreshadowed in early work on coordination in LFG by Peterson (1982), who depicts coordinate structures as sets with attributes and values as well as elements. Andrews (1983) also discussed the NUM and GENDER features of coordinate noun phrases within an LFG setting, and considered the problem of determining these features on the basis of the feature values of the individual conjuncts of the phrase.

On this view, f-structures for coordinate structures are *hybrid objects*: they are structures with both elements and nondistributive features. This is shown in the following:

(72) (Figure at end.)

The coordinate structure differs from its conjuncts in its values for the PERSON and NUM features. While the coordinate phrase as a whole is 1PL, neither conjunct has these features; one conjunct is 1SG, and the other is 3SG.

Formally, we refine the definition of function application given in (44) to take into account the distinction between distributive and nondistributive properties of sets:

(73) 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.

If PERSON is a nondistributive feature, a constraint such as ($\uparrow$ SUBJ PERSON)=1 on a verb is satisfied by a first person noun phrase or a coordinate noun phrase with the 1 value for the PERSON feature, even if one or more of its conjuncts bears some other PERSON value.

Coordinate phrases bear nondistributive PERSON, NUM, and GENDER features just as noncoordinate phrases do, and we require a means of determining what these features are. For some features, such as the NUM feature, the determination is primarily semantic: a plural noun phrase is one whose referent includes more than one individual. We have little more to say about the semantically-determined NUM feature. Our analysis focuses on features, in particular PERSON and GENDER, that are related in a systematic way to the corresponding features of the conjuncts by a syntactic process of *feature resolution*. Thus, on our view, agreement features fall into the following classes:

(74) (Figure at end.)

We develop a set-based representation for the values of resolving features that permits a simple formal statement of the way they behave.

Our theory of feature resolution can be tested by observing patterns of agreement with coordinate phrases. However, care must be taken in the use of this diagnostic. Corbett points out that languages often exhibit alternative agreement strategies in which agreement with coordinate phrases depends on the person and gender features of just one of its conjuncts (Corbett 1991; see also Steinberg and Caskey 1988). In the following Swahili examples, the verb shows noun class agreement with the closest conjunct of the coordinate subject phrase (Corbett 1991, page 265):

(75) a. ki-ti na m-guu wa meza u-mevunjika (Swahili)
7-chair and 3-leg of table 3-be.broken
'The chair and the leg of the table are broken.'

b. m-guu wa meza na ki-ti ki-mevunjika
3-leg of table and 7-chair 7-be.broken
'The leg of the table and the chair are broken.'

Peterson (1986) and, more recently, Sadler (1999) provide an extensive discussion of these issues within LFG. The issues raised by these examples are orthogonal to the treatment of resolution, and are therefore not examined further in the present paper.

6 Person resolution

The Spanish example given in (9) shows that a first person plural verb form is used with first person plural coordinate subjects. Slovak (Corbett 1983a, page 178) provides another illustration of the same dependency:

(76) (Figure at end.)

This phenomenon is commonly described in terms of a hierarchy of values for the person feature: if a phrase with first person agreement is coordinated with any other phrase, the coordinate structure bears first person features; if the coordinate structure contains a second person pronoun but no first person pronoun, the coordinate structure bears second person features, and so on.[13] Our goal is to permit person features to be represented so that the person feature of a coordinate structure can be computed systematically on the basis of the person features of its conjuncts. We accomplish this by again using set values for agreement attributes, but not in a way that encodes indeterminacy. For person, gender, and other *resolving* features:

(77) Sets encode complex values, not indeterminacy.

In particular, we refine the representation of values such as 1 for the PERSON feature and take them to be sets whose elements are drawn from the markers S (for Speaker) and H (for Hearer). The advantage of using sets to represent these complex values is that they provide a simple method for resolving the person feature in coordination: the value of the person feature for a coordinate structure is resolved to be the *union* of the person features of the conjuncts. Initially, we can view these sets as reflecting the referent of the coordinate phrase: the union of the person values of the conjuncts represents the membership of the set of individuals referred to. This correlation between reference and syntactic markers breaks down in certain cases, however, as we discuss in Section 6.2.

6.1 Inclusive/exclusive pronouns

Our inventory of markers S and H gives four possible values for the PERSON feature. We assign the following interpretations to these four combinations:[14]

{S}:	first person singular, first person exclusive nonsingular
{S,H}:	first person inclusive nonsingular
{H}:	second person
{}:	third person

Fula (Forchheimer 1953; Arnott 1970) is a language with an inclusive/exclusive distinction in the first person plural pronominal system.[15] We show that Fula exhibits the following pattern of person resolution, where & denotes coordination:

(78)

1.SG & 2	= 1INC.PL
1.SG & 2 & 3	= 1INC.PL
1.SG & 3	= 1EXC.PL
1EXC.PL & 3	= 1EXC.PL
2 & 3	= 2
3 & 3	= 3

In Fula it is possible to front noun phrases, including pronominal forms, thereby putting them in focus. An incorporated pronoun then appears on the verb and shows agreement with the fronted subject. The forms of the verb meaning 'live' with incorporated pronominal subjects are:

(79) (Figure at end.)

In example (80), the first person singular pronoun *min* is fronted, and the incorporated pronoun shows first person singular agreement with it:

(80) (Figure at end.)

This construction provides a way to examine resolution of the PERSON feature, since conjoined phrases can also undergo fronting. Fronted coordinate phrases containing a second person conjunct and a third person conjunct show second person agreement, as is typically found in other languages:

(81) (Figure at end.)

Fronted coordinate phrases containing only third person conjuncts show third person agreement:

(82) (Figure at end.)

More interesting examples involve first person pronouns. Coordinate phrases with a first person singular pronoun and a second person pronoun show first person inclusive plural agreement:

(83) (Figure at end.)

(84) (Figure at end.)

When the coordinate phrase contains a first person pronoun and a third person noun phrase (but no second person phrase), first person exclusive plural agreement is found:

(85) (Figure at end.)

Finally, when a first person exclusive pronoun is coordinated with a third person noun phrase, first person exclusive plural agreement is found:

(86) (Figure at end.)

These facts are predicted by our union analysis if we assign the following sets of person agreement features:[16]

(87) (Figure at end.)

Assuming that the PERSON feature of a coordinate noun phrase is the union of the PERSON features of the conjuncts predicts exactly this pattern; the table in (88) recapitulates the facts given in (78). For example, if a second person pronoun and a third person pronoun are coordinated, the person value for the coordinate noun phrase is the union of the second and third person features. Similarly, if a first person singular pronoun and a second person pronoun are coordinated, the person value for the coordinate noun phrase is again the union of the first and second person features:

(88) (Figure at end.)

The union operation produces f-structures like (89) which satisfy constraints such as the ones given in (90):

(89) (Figure at end.)

(90) $(i\ \textsc{person}) = \{\mathrm{S}\}$

$(y\ \textsc{person}) = \{\mathrm{H}\}$

$(c\ \textsc{person}) = \{\mathrm{S}\} \cup \{\mathrm{H}\} = \{\mathrm{S,H}\}$

6.2 Fewer pronominal distinctions

Many languages, for example English, Spanish, and Slovak, do not make all the distinctions described above in their pronominal systems, but instead have a single 1PL pronominal form that collapses the inclusive/exclusive distinction. This raises a question: do these languages make the full set of syntactic distinctions of Fula, thus preserving the correlation between marker sets and reference? Or is the inclusive/exclusive distinction neutralized in the syntax of language like English, Spanish, and Slovak, with a concomitant weakening of the relation between reference and marker sets?

Consider the first alternative: English, like Fula, has two first-person plural values, {S} for first person exclusive, and {S,H} for first person inclusive. The coordinate phrase *you and I* has the person value {S,H}, while the phrase *Bill and I* has a different person value, {S}. As noted, this preserves the referential values of the person marker sets, but at the cost of introducing a distinction that is unattested by any agreement phenomena in the language.

The second alternative is to collapse the inclusive/exclusive distinction in English, and to assume that coordinate phrases like *Bill and I* and *you and I* have the same value for the person feature. Since the second person introduces the H marker, this common value must be {S,H}. And since third person phrases introduce no marker, the first person singular pronoun must itself be associated with the marker set {S,H}. This alternative does not introduce internally unmotivated syntactic distinctions into the syntax of languages like English and Spanish, at the cost of associating the set {S,H} with the first person singular pronoun and thus breaking the connection between marker sets and pronominal reference.

The choice between these two feature encodings thus depends on the relative importance assigned to two competing principles, the principle that a syntactic distinction is assumed only if it is attested versus the principle that marker sets should uniformly reflect the referent of a phrase. Despite its intuitive appeal, however, other data suggests that the referential principle cannot be strictly maintained. For example, Mark Aronoff (p.c.) has pointed out that the English second person pronominal form can also be used for impersonal third person reference while still requiring second-person agreement, and the French third person singular pronominal form *on* can be used for first person plural colloquial reference. This breakdown in the referential correlation undermines the argument for including unattested distinctions in the English marker system. Thus, we prefer to give up the direct referential correspondence in favor of an encoding that makes only the attested syntactic distinctions.

For English, Spanish, Slovak, and similar languages, then, we suggest that only three of the four possible combinations of markers S and H are realized, with a single set being used for all first person forms:

{S,H}:	first person
{H}:	second person
{}:	third person

Agreement patterns for such languages are shown in the following chart:

(91) English, Spanish, Slovak, . . . :

1 & 2 = 1

1 & 3 = 1

2 & 3 = 2

3 & 3 = 3

The table in (92) represents the same information as in (91), and shows that treating resolution as the union of conjunct sets again makes the correct predictions:

(92) $\{S,H\}\ (1) \cup \{H\}\ (2) = \{S,H\}\ (1)$

$\{S,H\}\ (1) \cup \{\}\ (3) = \{S,H\}\ (1)$

$\{H\}\ (2) \cup \{\}\ (3) = \{H\}\ (2)$

$\{\}\ (3) \cup \{\}\ (3) = \{\}\ (3)$

6.3 More complicated person systems?

Given our inventory of person markers, S and H, no language can make more than four distinctions in its person system for purposes of feature resolution. These four possibilities are fully attested in languages with distinctions between first person inclusive, first person exclusive, second person, and third person. There has been speculation about the existence of more complicated pronominal systems: Boas (1911, page 35) contemplates a system in which one of the first person plural pronouns includes the speaker and hearer or hearers only (the 'limited inclusive'), another includes the speaker and excludes the hearer or hearers (the exclusive), and still another includes the speaker, the hearer, and other persons not present (the 'general inclusive'); the terminology comes from Foster and Foster (1948). Such a system would be more elaborate than the one we have proposed, requiring, for example, a third marker O (for 'other') in addition to S and H to make all the necessary distinctions.

As far as we know, there is in fact no language that makes these additional distinctions. The only apparent support for the necessity of a more complex formal system comes from the affix pronouns of Sierra Popoluca (Foster and Foster 1948; Forchheimer 1953; Elson 1960),[17] which are reported by Foster and Foster (1948) to distinguish limited and general inclusive first person forms. However, this claim has been dismissed by Noyer (1992), who shows convincingly that the form referred to by Foster and Foster as the 'limited inclusive' is actually a first person inclusive *dual* form, referring to the speaker and a single hearer, If reference to multiple hearers is involved, the 'general inclusive'/inclusive plural form is used.

Zwicky (1977) also contemplates the existence of more complicated pronominal systems, but again these systems are not attested. Thus, there is no evidence to justify a more elaborate set of markers than the S, H system we have proposed.

6.4 Formal specification of feature resolution

We have seen that we obtain the appropriate value for the nondistributive PERSON feature of a coordinate phrase if we represent PERSON values as sets and define the PERSON value for a coordinate structure to be the union of the PERSON values of all the conjuncts. LFG allows statements of relations between the f-structures of mother and daughter nodes, via the $\uparrow$ and $\downarrow$ metavariables. We can provide a simple formalization of feature resolution, based on the following proposition:

(93) $x \cup y$ is the smallest set z such that $x \subseteq z \ \wedge \ y \subseteq z$

Thus, the union will result if we take the *smallest* set that satisfies a collection of separately stated *mother-daughter subset* assertions. Both these conditions are easily achieved within the LFG architecture, since, as noted in section 1, LFG f-structures are the minimal models for the functional description of an utterance. Thus, the smallest set is naturally picked out as the mother's PERSON value. The necessary subset relations are established by annotations on the LFG phrase structure rule for coordinate noun phrases:

(94) (Figure at end.)

The annotations on each conjunct use only the $\uparrow$ and $\downarrow$ metavariables to assert that the PERSON markers for the conjunct are contained in the PERSON value for the coordinate structure as a whole.

Example (9) shows that a Spanish coordinate structure with a second person and a third person conjunct takes second person agreement:

(95) (Figure at end.)

The f-structure for this example is:

(96) (Figure at end.)

Rule (9) asserts that the PERSON value for each of the conjuncts is a subset of the PERSON value of the coordinate structure as a whole:

(97) $(j \text{ PERSON}) \quad \{\} \subseteq (c \text{ PERSON})$
$(t \text{ PERSON}) \quad \{\text{H}\} \subseteq (c \text{ PERSON})$

The smallest set that satisfies these conditions is the set {H}, the second person value, as desired; the nonminimal first person set {S,H}, which also satisfies the conditions in (97), is not allowed. Only the smaller set appears in the minimal model for the coordinate NP.

We can now account for patterns of verb agreement. The first person verb *hablamos* has a lexical entry with the following specifications:

(98) hablamos: $(\uparrow \text{ SUBJ NUM}) = \text{PL}$
$(\uparrow \text{ SUBJ PERSON}) =_c \{\text{S,H}\}$

The constraining equation ($=_c$) requires that the PERSON feature in the minimal model be the first person set {S,H}. However, the PERSON set for the coordinate subject is {H}, which does not satisfy this requirement. Therefore, this verb cannot be used if its subject is *José y tu* 'José and you'.

The second person verb in example (9), *habláis*, imposes the following requirements:

(99) habláis: $(f \text{ SUBJ NUM}) = \text{PL}$

$(f \text{ SUBJ PERSON}) =_c \{\text{H}\}$

The constraining equation for this verb asserts that the PERSON of the verb's SUBJ is the set $\{\text{H}\}$. This condition is satisfied for example (9).

6.5 Intersection or union?

Sag et al. (1985) also make use of sets to encode values for the person feature, but they provide a different means for determining the person value for a coordinate structure. They propose that the feature on a coordinate NP is the intersection, not the union, of features on the conjuncts. Sag et al. (1985) specify the following sets of markers:[18]

(100) 1 {}

2 {+XSP}

3 {+XSP,+THP}

This gives the desired results for English, Slovak, and Spanish:

(101)

$$
\begin{aligned}
\{\}\ (1) \cap \{+\text{XSP}\}\ (2) &= \{\}\ (1) \\
\{\}\ (1) \cap \{+\text{XSP},+\text{THP}\}\ (3) &= \{\}\ (1) \\
\{+\text{XSP}\}\ (2) \cap \{+\text{XSP},+\text{THP}\}\ (3) &= \{+\text{XSP}\}\ (2) \\
\{+\text{XSP},+\text{THP}\}\ (3) \cap \{+\text{XSP},+\text{THP}\}\ (3) &= \{+\text{XSP},+\text{THP}\}\ (3)
\end{aligned}
$$

This particular set of values does not work, however, for languages like Fula that have different verb agreement forms for inclusive and exclusive first person plurals. In Fula the coordinate phrase corresponding to *you and I* takes first person plural *inclusive* agreement, while the coordinate phrase corresponding to *Bill and I* takes first person plural *exclusive* agreement. Sag et al.'s analysis fails because its value for the first person number feature is the empty set, and intersecting the empty set with any other set gives the empty set. Thus it is in principle impossible to distinguish different kinds of coordination involving a first person pronoun.

However, it turns out that any analysis in which features are combined by union can be transformed into a corresponding analysis in which features are combined by intersection. This dual analysis is obtained by applying De Morgan's Laws: intersection is used instead of union, and the sets are replaced by their complements. Applying this transformation to our previous account of Fula gives:

(102) (Figure at end.)

These person values seem unintuitive, but it is not difficult to reinterpret them in a more natural way: interpret H as indicating that the hearer is *absent* from the referent set, and S as indicating that the speaker is absent. It is easy to verify that these assignments give the correct results when the PERSON value for the coordinate structure is obtained by intersecting the PERSON values of its conjuncts:

(103) {H} (1SG) $\cap$ {S} (2) = {} (1INC.PL)
{} (1INC.PL) $\cap$ {S,H} (3) = {} (1INC.PL)
{H} (1SG) $\cap$ {S,H} (3) = {H} (1EXC.PL)
{S} (2) $\cap$ {S,H} (3) = {S} (2)
{S,H} (3) $\cap$ {S,H} (3) = {S,H} (3)

Whether union or intersection should be used to combine sets is, then, not an issue of whether an analysis is mathematically possible or impossible: exactly the same range of facts can be covered with either resolution operator. But an intersection analysis is not easy to state within the standard LFG architecture. Expressing this analysis by means of equations appearing on the individual conjunct daughters would require the PERSON value of the coordinate structure to be the *largest/most fully specified subset* of the PERSON values of the individual conjuncts. This is incompatible with the LFG principle of taking the minimal solution to a collection of constraints. In less restrictive theories, such as HPSG, the operations of set union and intersection may already be available as explicit operators on grammatical structures, and schemata may be used to refer directly to the arguments of the union and intersection operations. In those theories, since the operations may be explicitly stated, there may be no formal motivation to choose union over intersection to characterize feature resolution.

7 Gender resolution

As we have noted, there is a near-iconic relation between the sets representing the PERSON value and the referents of the phrases bearing these features: the mnenomic names S and H, for Speaker and Hearer, very nearly represent the semantic contribution of the pronouns bearing these features. In contrast, gender systems vary much more widely across languages than person systems: many languages have no syntactic gender distinctions, or have gender only in certain limited paradigms; other languages have two, three, or more syntactic genders. Languages also vary in their patterns of gender resolution. This variability is related to the fact that syntactic gender systems often do not reflect 'natural' or semantic gender; for instance, the German noun *Mädchen* 'girl' is syntactically neuter, though semantically feminine. Thus, compared to the PERSON feature, the marker sets for the values of the syntactic GENDER feature are less susceptible to an intuitive motivation on the basis of semantic facts.

The complex relationship between syntactic and semantic gender is evident in patterns of gender resolution in many languages. (Corbett 1983b) points out that in many languages, gender agreement with coordinate phrases is semantically based, depending on referential, nonsyntactic properties of the conjuncts such as animacy or humanness rather than syntactic gender. Wechsler (1999) also explores this phenomenon, claiming that although agreement with conjoined inanimates usually depends on syntactic resolution rules, agreement with conjoined animates often depends only on semantic factors:

(104) (Figure at end.)

In this example, the predicate shows MASC agreement with the conjoined phrase *la personne avec la barbe et Marie* based on semantic gender (one conjunct denotes a male), even though each conjunct is syntactically FEM. Such examples do not involve syntactic feature resolution and thus are not relevant to the present discussion.

There are certain common and recurring characteristics of syntactic gender resolution:

(105) a. A coordinate phrase behaves as if it has the same gender as some noncoordinate element in the language. That is, there are no special gender agreement markers that appear only with coordinate phrases.

b. A coordinate structure with same-gender elements behaves as if it has that same gender.

c. A coordinate structure with mixed-gender elements may or may not behave as if it has the gender of one of its conjuncts (but it does behave as if it has a gender that is independently found in the language).

These characteristics follow if we treat the GENDER feature exactly like the PERSON feature: values for the GENDER feature are encoded as sets of markers, and the GENDER of a coordinate structure is the union of the GENDER features of the individual conjuncts. This generalization is expressed in the following annotated rule:

(106) (Figure at end.)

As with the PERSON feature, the GENDER value of the coordinate phrase will be the smallest set containing the GENDER values of the individual conjuncts. To illustrate how this general rule operates, we first examine instances in which the pattern in (105) holds. Then, in section 7.3, we discuss a departure from the pattern in (105b), showing that it can be analyzed as involving a minor variation on the general theme.

7.1 Two genders: Hindi

A simple pattern of gender resolution is found in Hindi (McGregor 1972, page 20), which (like Spanish, French, and many other languages) has two genders, MASC and FEM. When a MASC and a FEM noun phrase are coordinated, the coordinate phrase has MASC gender:

(107) (Figure at end.)

A coordinate phrase has FEM gender only when all of its conjuncts are FEM:

(108) (Figure at end.)

The rules for gender resolution in Hindi can be expressed informally in the following way (Corbett 1983a, 1991):

(109) Hindi:

- If the conjuncts include at least one masculine noun phrase, the masculine form is used.
- Otherwise the feminine form is used.

This observation can be expressed in tabular form, with the symbol & again representing coordination:

(110) Hindi:

$$\begin{array}{rcl} \textsc{masc} \ \& \ \textsc{masc} & = & \textsc{masc} \\ \textsc{masc} \ \& \ \textsc{fem} & = & \textsc{masc} \\ \textsc{fem} \ \& \ \textsc{fem} & = & \textsc{fem} \end{array}$$

We see that, in accordance with the generalization given in (105), coordination of like genders preserves that gender, and coordination of mixed genders behaves as a MASC phrase. The distinctions of this two-way gender system can be represented using a single primitive marker M:

(111) Hindi:

$$\begin{array}{ll} \textsc{masc} & \{\textsc{m}\} \\ \textsc{fem} & \{\} \end{array}$$

Our assumption that the GENDER feature for a coordinate structure is obtained by taking the union of the GENDER features of the conjuncts gives the right result, as the following table shows. The cases it illustrates are parallel to the table given in (110):[19]

(112) Hindi:

$$\begin{array}{rcl} \{\textsc{m}\}\ (\textsc{masc}) \cup \{\textsc{m}\}\ (\textsc{masc}) & = & \{\textsc{m}\}\ (\textsc{masc}) \\ \{\textsc{m}\}\ (\textsc{masc}) \cup \{\}\ (\textsc{fem}) & = & \{\textsc{m}\}\ (\textsc{masc}) \\ \{\}\ (\textsc{fem}) \cup \{\}\ (\textsc{fem}) & = & \{\}\ (\textsc{fem}) \end{array}$$

Our union analysis provides the gender value {M} for the coordinate structure in (9) and the value {} for the coordination in (9). These are compatible with the verbal agreement constraints in (113):

(113) a. rahte: $(\uparrow \textsc{subj gender}) =_c \{\textsc{m}\}$

b. rahtii: $(\uparrow \textsc{subj gender}) =_c \{\}$

7.2 Three genders: Icelandic

Icelandic exhibits a slightly more complicated pattern of gender resolution. It has three genders, and Corbett (1983b) shows that the following generalization holds:

(114) Icelandic:

- If the conjuncts are all masculine, the masculine form is used.
- If the conjuncts are all feminine, the feminine form is used.
- Otherwise the neuter form is used.

Again, like genders are preserved, and any structure involving coordination of mixed genders has NEUT gender:[20]

(115) (Figure at end.)

(116) (Figure at end.)

(117) (Figure at end.)

These results can be restated in tabular form:

(118) Icelandic:

MASC & MASC	=	MASC
FEM & FEM	=	FEM
NEUT & NEUT	=	NEUT
MASC & FEM	=	NEUT
MASC & NEUT	=	NEUT
FEM & NEUT	=	NEUT

We assign the following sets for MASC, FEM, and NEUT gender in Icelandic:

(119) Icelandic:

MASC	{M}
FEM	{F}
NEUT	{M, F}

Example (120) parallels the table in (118) and illustrates that these assignments make the correct predictions:

(120) (Figure at end.)

Given the features in (119) and appropriate agreement constraints, our general rule (9) accounts for this pattern.

7.3 Unexpected agreement with same-gender coordination: Slovene

Some languages exhibit a phenomenon that violates the generalization given in (105b) above: coordinate structures with conjuncts of the same gender unexpectedly require agreement of a different gender. For example, in the South Slavonic language Slovene (Corbett 1983a, 1991), a neuter plural verb form exists, but it is not used for coordinated phrases in which the conjuncts are neuter; instead, the MASC plural verb form is used.[21]

Corbett claims that the following pattern of gender agreement holds for Slovene:

(121) Slovene (Corbett 1983a, page 186):

- If all conjuncts are feminine, then the feminine form is used.

- Otherwise the masculine form is used.

This pattern resembles the Icelandic pattern discussed in Section 7.2 in all but two respects: the MASC form rather than the NEUT form is used for mixed-gender coordination, and, surprisingly, MASC agreement is required when all conjuncts are NEUT. We can begin to account for this pattern by postulating the following sets:

(122) Slovene:

MASC	{F, N}
FEM	{F}
NEUT	{N}

These sets have essentially the same structure as the Icelandic sets, with the MASC set playing a role analogous to the NEUT set of Icelandic. However, the fact that coordination of NEUT conjuncts takes MASC agreement is not yet accounted for:[22]

(123) (Figure at end.)

(124) (Figure at end.)

We present two possible accounts of this phenomenon. The first account assumes that gender resolution takes place in the expected way, given the sets in (122), and that some other property of the coordinate neuter phrase is responsible for its peculiar agreement behavior. That is, a coordinate structure with NEUT conjuncts is in fact NEUT PL. However, coordinate noun phrases must also have some special property unrelated to gender marking which noncoordinate phrases do not share. The NEUT PL verb form forbids its subject to have this property, and as a result, this verb form can appear with a noncoordinate NEUT PL subject but not a coordinate one. On the other hand, MASC PL verbs are marked so as to allow noncoordinate MASC PL phrases as well as coordinate MASC and NEUT phrases. Given this account, we would expect at least some phenomena other than verb agreement to treat coordinated NEUT phrases as NEUT, since they do in fact bear that gender.

On the other hand, it is possible that a coordinate phrase with NEUT conjuncts actually carries the features of a MASC noun phrase. Evidence from Lama (Yu 1988) supports the general possibility that a feature value of a coordinate phrase can be determined independently of conjunct values. Lama noun phrases belong to different classes, as in Xhosa. Yu shows that all coordinate phrases in Lama belong to noun class 2, regardless of the noun class of their conjuncts. Unlike the analysis of Xhosa presented in Section 4.4, we would analyze noun class in Lama as a nondistributive feature. This feature is not resolved (determined on the basis of the features of the conjuncts) but is always set to the value 2 as an additional annotation on the CONJ in the general coordination rule:

(125) CONJ
$(\uparrow \text{CLASS}) = 2$

In Lama, then, the coordinate structure does not just contribute to but completely determines the noun class of the coordinate phrase.

We can provide an analysis of Slovene along similar lines: the conjunction contributes a constraint affecting the gender of the coordinate phrase. We specialize the general coordination rule in (9) so that it adds the element F to the set representing the gender of the coordinate phrase:

(126) CONJ
$\text{F} \in (\uparrow \text{GENDER})$

With this addition to the rule, the pattern in (9) is obtained for Slovene. In this table we have indicated with & the contribution of the coordination:

(127) (Figure at end.)

Unlike our first analysis, this account asserts that coordinated NEUT phrases actually become MASC PL and should behave as MASC phrases in every circumstance. We have not been able to find evidence of other Slovene phenomena which would allow us to determine which of our two accounts is correct.

8 Indeterminacy in gender and number

We now briefly explore the question of whether the kind of indeterminacy discussed in Section 4 can be found with other features. Examples like (128) suggests that the value of the GENDER feature cannot be indeterminate. The Hindi third person pronoun *wah* is ambiguously masculine and feminine, but it cannot be treated as masculine and feminine at the same time:

(128) (Figure at end.)

However, other examples seem to indicate the contrary: that some forms are indeterminately specified for the GENDER feature. Eisenberg (1973) and Pullum and Zwicky (1986) discuss examples like the following:

(129)	der	oder	die	älteste	Abgeordnete (German)
	the.MASC	or	the.FEM	oldest	representative

the oldest representative (masculine) or representative (feminine)

Here, the common gender noun *Abgeordnete* 'representative' is shared between two determiners specified for different genders. This is not possible for unambiguously masculine nouns like *Lehrer* or unambiguously feminine nouns like *Lehrerin*:

(130) *der oder die Lehrer/Leherin (German)
the.MASC or the.FEM teacher.MASC/teacher.FEM
'the teacher or teacher'

Patterns similar to these can also involve the NUM feature. Even where one form can be used sometimes as singular and sometimes as plural, it is not possible for that form to be used as singular and plural at the same time (Zaenen and Karttunen 1984; Pullum and Zwicky 1986):

(131) (Figure at end.)

(132) (Figure at end.)

On the other hand, Eisenberg (1973) and Zaenen and Karttunen (1984) present examples showing that an unmarked noun can be shared between two determiners, one singular and one plural:

(133) der Antrag des oder der Dozenten (German)
the petition of the-SG or the-PL docents
'the petition of the docent or docents'

Analogous examples in English have been judged marginally grammatical by Zaenen and Karttunen (1984), though we do not find these examples acceptable:

(134) %this and these sheep

English examples with coordinated singular and plural nouns and a shared determiner, however, are fully acceptable:

(135) a. *this representatives or representative

b. *these representatives or representative

c. the representatives or representative

To account for these facts, Ingria (1990) and Bayer (1996) draw a distinction between semantically 'potent' features like NUM and semantically 'impotent' features like CASE; we assume that they would also classify GENDER and PERSON as semantically potent like the NUM feature. They claim that phenomena involving feature indeterminacy can only occur with semantically impotent features, thus accounting for the unacceptability of examples (9), (9), and (9). According to their analysis, these examples are ungrammatical because they involve the semantically potent and therefore determinate features NUM and GENDER. To account for the acceptability of examples like (133), they introduce an exception to this general claim. They propose that the NUM feature can in fact be indeterminate, although only in limited circumstances: subconstituents of NP, but not NP itself, can be indeterminately specified for NUM. We suppose that example (129) would lead them to the same conclusion for the GENDER feature.

However, example (136) shows that this proposal is incorrect:[23]

(136) *der Antrag des Dozenten, die gesprochen haben
the petition of the-SG docent that-PL spoken have-PL
'the petition of the docent that have spoken'

Although the agreement involved in this example is NP-internal, the example is still ungrammatical. There are also cases of ungrammaticality involving NP-internal GENDER agreement:[24]

(137) *Dieser Abgeordnete, die sich im Spiegel sah (German)
this.MASC representative that.FEM self in mirror saw
'this (masculine) representative who saw herself in the mirror'

The following Hindi examples show that the same noun cannot be modified by adjectives of different genders:[25]

(138) a. wah saccaa aur acchaa pradhaanmãtrii thaa
(s)he honest.MASC and good.MASC prime minister was.MASC
'He was an honest and good prime minister.'

b. wah saccii aur acchii pradhaanmãtrii thĩĩ
(s)he honest.FEM and good.FEM prime minister was.FEM
'She was an honest and good prime minister.'

c. *wah saccii aur acchaa pradhaanmãtrii thaa/thĩĩ
(s)he honest.FEM and good.MASC prime minister was.MASC/FEM
'He/she was an honest and good prime minister.'

We see that these examples cannot be explained by appealing to a distinction in the way features behave inside and outside NP. Instead, the distinguishing property of the acceptable examples is that they involve either determiner or nominal coordination, as in (129), (133), and (135).

Given these facts, we could simply refine the stipulation that Ingria and Bayer make, proposing that the GENDER and NUM features can be indeterminate only in the more restrictive cases of determiner or noun coordination. However, this begs the question of why they should behave differently in just these constructions. Our framework suggests a different approach, one that assumes that these features are never indeterminate. Rather, the difference in behavior follows from the LFG representation of coordinate structures. The conjuncts in a coordinate structure correspond to different f-structures, and those can take on different values for the GENDER feature in the acceptable coordinate cases (129) and (133):

(139) (Figure at end.)

Though we do not provide an explicit treatment here, we believe that a successful analysis of these examples will emerge from a careful consideration of the interactions between coordination and feature distribution.

In cases not involving determiner or noun coordination, such as examples (9), (136), (137), and (138c), we expect to observe the effects of feature clashes within a single f-structure. For example, we represent the value of the GENDER feature for an ambiguous pronoun like *wah* in example (9) as a (wide-scope) disjunction and not as an indeterminate set:

(140) wah: $(\uparrow \text{GENDER}) = \{\text{M}\}$
$\vee \quad (\uparrow \text{GENDER}) = \{\}$

This accounts for the fact that, as shown in example (9), *wah* cannot be used as a MASC and FEM pronoun at the same time: it is ambiguous, not indeterminate. Both of the following examples are acceptable:

(141) a. wah pahũcaa (Hindi)
he/she arrived.MASC
MASC/FEM SUBJ GENDER=MASC
'He arrived.'

b. wah pahũcii (Hindi)
he/she arrived.FEM
MASC/FEM SUBJ GENDER=FEM
'She arrived.'

Similarly, the determiner *this* in example (136) requires its noun phrase to be singular, while the relative clause is acceptable only as a modifier of a plural phrase.

Thus, examples in which a resolving feature appears to be indeterminate turn out to involve structures with coordinate nouns or coordinate determiners in which the feature is specified in different ways in different conjuncts. We conclude that resolving features like PERSON and GENDER are not indeterminate. This state of affairs is exactly what our theory of feature representation predicts: an indeterminate resolving feature would have to be a set of possible PERSON or GENDER sets, and our union analysis would not operate properly on such a complex value.

Given our conclusion that features like PERSON and GENDER are not indeterminate, it may be worthwhile to recall our treatment of examples such as (9), repeated here for convenience:

(142) (Figure at end.)

This is not a counterexample to our claim that the PERSON of the subject of each conjunct is determinately specified. As noted by Ingria (1990) and discussed in Section 4.4, the verb can place an indeterminate constraint on any of its subject's features, even those that are themselves determinate. This indeterminate constraint is satisfied separately in each conjunct.

9 Conclusion

We have provided a general theory of feature representation which easily accounts for feature indeterminacy and feature resolution within the LFG framework. Our set representations, together with minimal extensions to LFG's description language, enable a simple and intuitive characterization of both these phenomena. We represent indeterminate values by sets containing the alternative possibilities. This approach to indeterminacy makes the right predictions but does not require large-scale formal revisions to avoid the difficulties that previous proposals encountered. We represent resolving features as sets of markers that are combined by union in coordinate structure feature resolution. This provides an explanation for the seemingly complicated behavior of the person and gender features in coordinate structures. Although we have used the conceptual tools and techniques of LFG in formulating our theory, we believe that similar solutions could be framed within other syntactic approaches.

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Notes

[1]Pullum and Zwicky (1986) use the term 'principled resolution' to refer to the process by which the features of a coordinate noun phrase are determined.

[2]In fact, German speakers vary as to whether case agreement in the matrix clause is required. For many speakers, case agreement is required only within the relative clause, while for other speakers, matrix case agreement is not required unless the free relative clause appears in matrix subject position (Arnold Zwicky, p.c.). The following example is grammatical for these speakers:

(a)	%Ich nehme,	[wem	du	vertraust].	(German)
	I take	who	you	trust	
	ACC ∈ OBJ CASE	{DAT}		DAT ∈ OBJ CASE	

'I take who(ever) you trust.'

In the following discussion, we consider only the judgements of speakers of the more restrictive dialect. We are grateful to Arnold Zwicky for discussion of these examples.

[3]We are grateful to Stefan Kaufmann for providing the German example given in (9).

[4]For more discussion of coordination in LFG, in particular of nonconstituent coordination, see Maxwell and Manning (1996).

[5]This definition differs from the later formulation of Kaplan and Maxwell (1988). They proposed that when s is a set, $(s\ a) = v$ iff v is mathematically the generalization of all of the elements of s applied to a. This reformulation, however, makes unwanted predictions involving constraining as opposed to defining properties.

[6]Some speakers allow for alternative agreement strategies in which only the requirements of the nearest conjunct need be satisfied. For those speakers, example (9) is acceptable. See Section 5 for more discussion of alternative agreement strategies involving coordinate phrases.

[7]The noun class system of Bantu is sometimes referred to as a gender system. We use the term 'noun class' here to distinguish this system from the gender systems in languages like French or Hindi, which behave differently in terms of feature resolution.

[8]Roberts and Wolontis (1974) give additional evidence to support Voeltz's claims, and also present a transformationally-based analysis that is similar in some respects to the one presented here: a verb like *zifikile* 'arrived' is marked as both 7/8 and 9/10, and either or both features can be matched by the subject noun phrase.

[9]Interestingly, though DuPlessis and Visser (1992) do not discuss agreement with conjoined subjects in Xhosa, they give rules for Xhosa clitic/object agreement that are different from the generalizations noted by Voeltz: they claim that clitic/object agreement is semantically governed, not determined by the syntactic

processes that Voeltz describes and we have analyzed.

[10]Pullum and Zwicky found that example (9) was ungrammatical for all of the German speakers they consulted, but at least some of our informants find it grammatical, as do some speakers consulted by Zaenen and Karttunen (p.c. to Pullum and Zwicky).

[11]In this work, we confine our analysis to functional features, features that are represented at the level of functional structure. Using the same formal devices as the Johnson/Bayer account, Bayer (1996) provides a detailed analysis of examples in which phrase structure constituents of unlike category are coordinated, assimilating these examples to his account of features such as CASE:

(a) Jermaine is boring and a fool. (AP and NP)

(b) Pat is healthy and of sound mind. (AP and PP)

In LFG, phrase structure category information is represented separately from functional information. This modularity reflects the general architecture of LFG, which assumes that subsystems of grammar, such as phrasal and functional structure, exhibit *near-decomposability*, with major interactions within a module and minor interactions across modules. In most instances, functional information is sufficient to characterize subcategorization requirements. Occasionally, however, the phrase structure category of the subcategorized element is also at issue, and it is these examples which Bayer's analysis treats. We can handle these instances of category indeterminacy within our approach by using the CAT predicate, introduced by Kaplan and Maxwell (1996). This imposes constraints on the category labels of the phrase structure nodes that an f-structure corresponds to. We do not discuss such examples further in this paper.

[12]See Berman (1999) for discussion of the correlation between case and grammatical function in German.

[13]As observed by Corbett (1991, page 263), this hierarchy matches the hierarchy for pronominal reference proposed by Zwicky (1977, page 717) (see also Silverstein 1976):

1. Use the first person (I) pronoun *we* for any reference set with the referential element 1;
2. Otherwise, use the second person (II) pronoun *you* for any reference set with the referential element 2;
3. Otherwise, use the third person (III) pronoun *they*.

[14]The referent of an inclusive first person pronoun includes the hearer, while the referent for an exclusive first person pronoun excludes the hearer.

[15]The variety of Fula described here is spoken in Guinea. We are grateful to Aicha Kone for providing the data, and to Chris Culy for help with the analysis.

[16]Nigel Vincent (p.c.) points out that our representation of the third person feature as the empty set {} can be taken to reflect the unmarked status of this value on a markedness hierarchy (for more discussion of markedness and the representation of agreement features, see Blevins 2000).

[17]We are grateful to María-Eugenia Niño for assistance with the Sierra Popoluca data.

[18]Karttunen (1984) suggests a variant of the Sag et al. approach which makes the same predictions and also suffers from the same problems, outlined below, with languages that distinguish inclusive and exclusive forms of the first person plural pronoun, such as Fula. Farkas and Ojeda (1983) also provide a discussion of number and gender resolution in coordination, noting issues that arise within the GPSG framework, but they do not make a specific proposal for handling person or gender resolution.

[19]As noted in footnote 16, the marker sets for the PERSON feature seem to reflect an independently-motivated markedness hierarchy, with the unmarked third person value represented as the empty set {}. It is tempting to speculate that GENDER values might also be assigned to correlate with a markedness hierarchy. However, Corbett (1991) observes that there is no consistent relationship across languages between markedness and gender resolution: a mixed-gender coordinate phrase does not always resolve to the unmarked gender.

[20]We are grateful to Kristjan Arnason for discussion of these examples.

[21]Corbett (1983a, 1991) provides an extensive discussion of gender resolution in Slavic, pointing out that West Slavic languages exhibit interestingly different patterns of gender resolution with neuter conjuncts as compared to South Slavonic languages like Slovene. The West Slavic language Czech is particularly well-studied in this regard; see, for example, Sgall et al. (1986).

[22]Corbett points out that there is actually some degree of controversy over resolution patterns for gender in Slovene. According to work by Bajec, cited by Corbett (1983a, page 212), coordination of neuter forms requires NEUT rather than MASC agreement, a pattern that is directly captured by the sets given in (122) and raises no further issues.

[23]We are grateful to Thomas Breuel for providing the German example given in (136).

[24]We are grateful to Christian Rohrer for providing the German example given in (137).

[25]We are grateful to Vineet Gupta for providing the Hindi examples given in (138).

(1)	Kogo	Janek	lubi	a Jerzy	nienawidzi (Polish)
	who	Janek	likes	and Jerzy	hates
	?		OBJ CASE = ACC		OBJ CASE = GEN

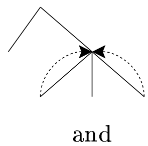
'Who does Janek like and Jerzy hate?'

(2)	Ich	habe gegessen	was	übrig war (German)
	I	have eaten	what	was left
		OBJ CASE=ACC	?	SUBJ CASE=NOM

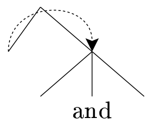
‘I ate what was left.’

(3) $\boxed{\text{Ja a ty}}$ sme bratia (Slovak)
I and you are.1PL brothers
'You and I are brothers.'

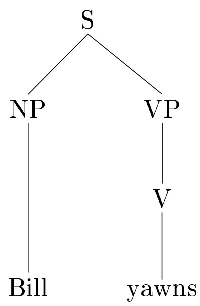
(4)



Feature resolution (Person, gender)

(5)  Feature checking in coordination

(7) C-structure: F-structure:



$$\begin{bmatrix} \textsc{pred} & \text{‘}\textsc{yawn}\text{’} \\ \textsc{tense} & \textsc{pres} \\ \textsc{subj} & \begin{bmatrix} \textsc{pred} & \text{‘Bill’} \end{bmatrix} \end{bmatrix}$$

(8) $$\begin{array}{lccc} \mathrm{S} & \longrightarrow & \mathrm{NP} & \mathrm{VP} \\ & & (\uparrow \textsc{subj}) = \downarrow & \uparrow = \downarrow \end{array}$$

(11) Ram calegaa (Hindi)

Ram.MASC will.go.MASC.3SG

'Ram will go.'

(12)
$$f: \begin{bmatrix} \textsc{pred} & \text{`}\textsc{go}\text{'} \\ \textsc{tense} & \textsc{pres} \\ \textsc{subj} & g: \begin{bmatrix} \textsc{pred} & \text{`R}\textsc{am}\text{'} \\ \textsc{person} & 3 \\ \textsc{num} & \textsc{sg} \\ \textsc{gender} & \textsc{masc} \\ \textsc{case} & \textsc{nom} \end{bmatrix} \end{bmatrix}$$

(15)	Wer	nicht	gefördert wird,	muss klug sein. (German)
	Who	not	supported is	must clever be
	NOM		SUBJ CASE=NOM	SUBJ CASE=NOM

‘Who isn’t supported must be clever.’

(16)	*Wer	nicht	geholfen wird,	muss klug sein. (German)
	Who	not	helped is	must clever be
	NOM		SUBJ CASE=DAT	SUBJ CASE=NOM

'Who isn't helped must be clever.'

(17)

Ich	habe gegessen	was	übrig war
I	have eaten	what	was left
	OBJ CASE=ACC	?	SUBJ CASE=NOM

'I ate what was left.'

(20)	Ich	habe gegessen	was	übrig war
	I	have eaten	what	was left
		OBJ CASE=ACC	ACC	SUBJ CASE=NOM

'I ate what was left.'

(21)	Ich	habe gegessen	was	übrig war
	I	have eaten	what	was left
		OBJ CASE=ACC	NOM	SUBJ CASE=NOM

'I ate what was left.'

(23)

Ich	habe gegessen	was	übrig war
I	have eaten	what	was left
	OBJ CASE=ACC	x	SUBJ CASE=NOM

'I ate what was left.'

(28)	Ich	habe gegessen	was	übrig war
	I	have eaten	what	was left
		ACC $\in$ OBJ CASE	$\{$NOM,ACC$\}$	NOM $\in$ SUBJ CASE

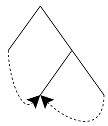
‘I ate what was left.’

(29)

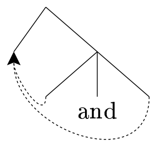
$$
\left[\begin{array}{ll}
\text{PRED} & \text{`EAT'} \\
\text{TENSE} & \text{PAST} \\
\text{SUBJ} & \left[\begin{array}{ll} \text{PRED} & \text{`PRO'} \\ \text{NUM} & \text{SG} \\ \text{PERSON} & 1 \end{array}\right] \\
\text{OBJ} & o: \left[\begin{array}{ll}
\text{PRED} & \text{`WHAT'} \\
\text{CASE} & \{\text{NOM,ACC}\} \\
\text{RELMODS} & \left\{ \left[\begin{array}{ll} \text{PRED} & \text{`LEFT'} \\ \text{SUBJ} & s: \left[\begin{array}{l} \text{PRED} \\ \text{CASE} \end{array}\right] \end{array}\right] \right\}
\end{array}\right]
\end{array}\right]
$$

(32)	*Wem	du	vertraust	muss klug sein. (German)
	who	you	trust	must be clever
	{DAT}		DAT ∈ OBJ CASE	NOM ∈ SUBJ CASE

‘Who(ever) you trust must be clever.’

(38)  Shared values (German CASE)

(39)



(40)	Kogo	Janek	lubi	a Jerzy	nienawidzi (Polish)
	who	Janek	likes	and Jerzy	hates
	{ACC,GEN}		ACC ∈ OBJ CASE		GEN ∈ OBJ CASE

'Who does Janek like and Jerzy hate?'

(41)	*Co	Janek	lubi	a Jerzy	nienawidzi (Polish)
	what	Janek	likes	and Jerzy	hates
	{NOM,ACC}		ACC $\in$ OBJ CASE		GEN $\in$ OBJ CASE

'What does Janek like and Jerzy hate?'

(42) John bought and ate apples.

$$\left\{\begin{array}{l}
\begin{bmatrix}
\textsc{pred} & \text{`}\textsc{buy}\text{'} \\
\textsc{tense} & \textsc{past} \\
\textsc{subj} & \begin{bmatrix} \textsc{pred} & \text{`}\textsc{John}\text{'} \\ \textsc{num} & \textsc{sg} \end{bmatrix} \\
\textsc{obj} & \begin{bmatrix} \textsc{pred} & \text{`}\textsc{apple}\text{'} \\ \textsc{num} & \textsc{pl} \end{bmatrix}
\end{bmatrix} \\
\\
\begin{bmatrix}
\textsc{pred} & \text{`}\textsc{eat}\text{'} \\
\textsc{tense} & \textsc{past} \\
\textsc{subj} & \\
\textsc{obj} &
\end{bmatrix}
\end{array}\right\}$$

(43) $$\begin{array}{ccccc} V & \longrightarrow & V & \text{CONJ} & V \\ & & \downarrow\in\uparrow & & \downarrow\in\uparrow \end{array}$$

(45) Kogo Janek lubi a Jerzy nienawidzi (Polish)
who Janek likes and Jerzy hates
'Who does Janek like and Jerzy hate?'

$$\left\{\begin{array}{l}
\left[\begin{array}{ll}
\text{FOCUS} & w:\left[\begin{array}{ll}\text{PRED} & \text{‘WHO’}\\ \text{CASE} & \{\text{ACC},\text{GEN}\}\end{array}\right]\\
\text{PRED} & \text{‘LIKE’}\\
\text{SUBJ} & \left[\begin{array}{ll}\text{PRED} & \text{‘JANEK’}\end{array}\right]\\
\text{OBJ} &
\end{array}\right]\\
\left[\begin{array}{ll}
\text{FOCUS} & \\
\text{PRED} & \text{‘HATE’}\\
\text{SUBJ} & \left[\begin{array}{ll}\text{PRED} & \text{‘JERZY’}\end{array}\right]\\
\text{OBJ} &
\end{array}\right]
\end{array}\right\}$$

(47) *I certainly will, and you already have, clarify the situation with respect to the budget.

(48) *I certainly will, and you already have, clarified the situation with respect to the budget.

(49) I certainly will, and you already have, set the record straight with respect to the budget.

(51)	umfana	nomfazi	bayagoduka (Xhosa)
	young.man	and.young.woman	go.home
	1/2	1/2	SUBJ CLASS = 1/2

'The young man and the young woman are going home.'

(52)

$$\left[\begin{array}{ll} \textsc{pred} & \text{`}\textsc{go.home}\text{'} \\ \textsc{subj} & \left\{ \begin{array}{l} \left[\begin{array}{ll}\textsc{pred} & \text{`}\textsc{young.man}\text{'}\\ \textsc{class} & 1/2\end{array}\right] \\ \left[\begin{array}{ll}\textsc{pred} & \text{`}\textsc{young.woman}\text{'}\\ \textsc{class} & 1/2\end{array}\right]\end{array}\right\}\end{array}\right]$$

(53)

*Igqira	nesanuse	ayagoduka (Xhosa)
doctor	and.diviner	go.home
5/6	7/8	SUBJ CLASS = 5/6

*Igqira	nesanuse	ziyagoduka (Xhosa)
doctor	and.diviner	go.home
5/6	7/8	SUBJ CLASS = 7/8

'The doctor and diviner are going home.'

(54)	Izandla	neendlebe	zibomvu (Xhosa)
	hands	and.ears	are.red
	7/8	9/10	SUBJ CLASS $\in \{7/8, 9/10\}$

'The hands and the ears are red.'

(55)
$$f:\left[\begin{array}{ll}\textsc{pred} & \text{`}\textsc{are.red}\text{'}\\ \textsc{subj} & \left\{\begin{array}{l} h:\left[\begin{array}{ll}\textsc{pred} & \text{`}\textsc{hands}\text{'}\\ \textsc{class} & 7/8\end{array}\right] \\ \\ e:\left[\begin{array}{ll}\textsc{pred} & \text{`}\textsc{ears}\text{'}\\ \textsc{class} & 9/10\end{array}\right]\end{array}\right\}\end{array}\right]$$

(57) ma-lalanje ndi ma-samba a-kubvunda (Chicheŵa)

orange.and leaf are.rotting

6 6 SUBJ CLASS $\in \{2, 6\}$

'The oranges and the leaves are rotting.'

(58)	a-mphaka ndi	a-galu	a-kuthamanga (Chichewâ)
	cat.and	dog	are.running
	2	2	SUBJ CLASS $\in \{2, 6\}$

‘The cats and the dogs are running.’

(59)	a-mphaka ndi	ma-lalanje	a-li uko (Chicheŵa)
	cat.and	orange	be there
	2	6	SUBJ CLASS $\in \{2, 6\}$

'The cats and the oranges are there.'

(60)	weil	[wir das Haus kaufen]	und	[die Müllers den Garten kaufen]	(German)
	because	we the house buy	and	the Müllers the garden buy	
		1		3	

‘because we buy the house and the Müllers buy the garden’

(61)	weil	[wir das Haus]	und	[die Müllers den Garten]	kaufen
	because	we the house	and	the Müllers the garden	buy
		1		3	SUBJ= 1/3

‘because we [buy] the house and the Müllers buy the garden’

(63)
$$\left\{\begin{matrix}\begin{bmatrix}\textsc{pred} & \text{‘}\textsc{buy}\text{’}\\ \textsc{subj} & \begin{bmatrix}\textsc{pred} & \text{‘}\textsc{pro}\text{’}\\ \textsc{person} & 1\\ \textsc{num} & \textsc{pl}\end{bmatrix}\\ \textsc{obj} & \begin{bmatrix}\textsc{pred} & \text{‘}\textsc{house}\text{’}\end{bmatrix}\end{bmatrix}\\ \begin{bmatrix}\textsc{pred} & \\ \textsc{subj} & \begin{bmatrix}\textsc{pred} & \text{‘M}\textsc{üllers}\text{’}\\ \textsc{person} & 3\\ \textsc{num} & \textsc{pl}\end{bmatrix}\\ \textsc{obj} & \begin{bmatrix}\textsc{pred} & \text{‘}\textsc{garden}\text{’}\end{bmatrix}\end{bmatrix}\end{matrix}\right\}$$

(64)	weil	[Ihr das Haus]	und	[Franz den Garten]	kauft (German)
	because	you the house	and	Franz the garden	buy
		2PL		3SG	SUBJ= 2PL/3SG

‘because you buy the house and Franz buys the garden’

(66) %Hann stal og borðaði köku (Icelandic)

(66)	%Hann	stal	og	borðaði	köku (Icelandic)
	he	stole	and	ate	cookie
		OBJ CASE=DAT		OBJ CASE=ACC	{ACC,DAT}

‘He stole and ate the cookie.’

(67)	%Il	m'a	frappé	et	donné des coups de pied (French)
	he	me	hit	and	gave kicks
		{ACC,DAT}	ACC∈OBJ CASE		DAT∈OBJ CASE

'He hit and kicked me.'

(68)	%Sie hat	Karl	gefunden	und	geholfen (German)
	she has	Karl	found	and	helped
		{ACC,DAT}	ACC$\in$OBJ CASE		DAT$\in$OBJ CASE

‘She has found and helped Karl.’

(69)	%Er	findet	und	hilft	Frauen (German)
	he	finds	and	helps	women
		ACC∈OBJ CASE		DAT∈OBJ CASE	{ACC,DAT}

‘He finds and helps women.’

(70)

weil	Kasparov	[seine Gegner]	[einen nach dem anderen]	geschlegen	hat (German)
because	Kasparov	his opponents	one after the other	beaten	has
		{NOM,ACC}	{ACC}	ACC∈OBJ CASE	
			*[einer nach dem anderen]		
			{NOM}		

'because Kasparov beat his opponents one after the other'

(71) $\boxed{\text{José y yo}}$ hablamos/*habláis/*hablan (Spanish)
José and I speak-1PL/*speak-2PL/*speak-3PL

(72) 'José y yo':

$$\begin{bmatrix} \left\{ \begin{matrix} \begin{bmatrix} \textsc{pred} & \text{`}\textsc{José}\text{'} \\ \textsc{person} & 3 \\ \textsc{num} & \textsc{sg} \end{bmatrix} \\ \begin{bmatrix} \textsc{pred} & \text{`}\textsc{pro}\text{'} \\ \textsc{person} & 1 \\ \textsc{num} & \textsc{sg} \end{bmatrix} \end{matrix} \right\} \\ \textsc{person} \quad 1 \\ \textsc{num} \quad \textsc{pl} \end{bmatrix}$$

(74)

Distributive:	Nondistributive:	
	Syntactic resolution:	Semantically determined:
CASE, Bantu noun class	PERSON, GENDER	NUM

(76) $\boxed{\text{Ja a ty}}$ sme bratia (Slovak)
I and you are.1PL brothers
'You and I are brothers.'

(79)

	singular		plural
1:	mi-djodi	inclusive:	djodu-dèn
		exclusive:	mèn-djodi
2:	djodu-da		djodu-don
3:	wo-djodi		bè-djodi

(80)	min	kö Afriki	mi-djodi	(Fula)
	I	in Africa	live	
	1		1	

'Me, I live in Africa.'

(81)	an	e	Bill	kö Afriki	djodu-don	(Fula)
	you	and	Bill	in Africa	live	
	2		3		2	

‘You and Bill, you live in Africa.’

(82)	Bill	e	George	kö Afriki	bè-djodi	(Fula)
	Bill	and	George	in Africa	live	
	3		3		3	

'Bill and George, they live in Africa.'

(83)

an	e	min	kö Afriki	djodu-dèn	(Fula)
you	and	I	in Africa	live	
2		1		1INCL	

‘You and I, we live in Africa.’

(84)	an	e	Bill	e	min	kö Afriki	djodu-dèn	(Fula)
	you	and	Bill	and	I	in Africa	live	
	2		3		1		1INCL	

'You and Bill and I, we live in Africa.'

(85)

Bill	e	min	kö Afriki	mèn-djodi	(Fula)
Bill	and	I	in Africa	live	
3		1		1EXCL	

'Bill and I, we live in Africa.'

(86)	Bill	e	mènèn	kö Afriki	mèn-djodi	(Fula)
	Bill	and	we-Excl	in Africa	live	
	3		1EXCL		1EXCL	

‘Bill and us, we live in Africa.’

(87)

	singular		plural
1:	min: {S}	inclusive:	enèn: {S,H}
		exclusive:	mènèn: {S}
2:	an: {H}		onön: {H}
3:	ö: {}		kombè:{}

(88) Fula:

$$
\begin{aligned}
\{S\}\ (1\textsc{sg}) \cup \{H\}\ (2) &= \{S,H\}\ (1\textsc{inc.pl}) \\
\{S\}\ (1\textsc{sg}) \cup \{H\}\ (2) \cup \{\}\ (3) &= \{S,H\}\ (1\textsc{inc.pl}) \\
\{S\}\ (1\textsc{sg}) \cup \{\}\ (3) &= \{S\}\ (1\textsc{exc.pl}) \\
\{S\}\ (1\textsc{exc.pl}) \cup \{\}\ (3) &= \{S\}\ (1\textsc{exc.pl}) \\
\{H\}\ (2) \cup \{\}\ (3) &= \{H\}\ (2) \\
\{\}\ (3) \cup \{\}\ (3) &= \{\}\ (3)
\end{aligned}
$$

(89)
$$c : \left[\begin{array}{ll} \left\{\begin{array}{l} i : \left[\begin{array}{ll} \textsc{pred} & \text{‘}\textsc{pro}\text{’} \\ \textsc{num} & \textsc{sg} \\ \textsc{person} & \{\mathrm{S}\} \end{array}\right] \\ \\ y : \left[\begin{array}{ll} \textsc{pred} & \text{‘}\textsc{pro}\text{’} \\ \textsc{num} & \textsc{sg} \\ \textsc{person} & \{\mathrm{H}\} \end{array}\right] \end{array}\right\} & \\ \textsc{num} & \textsc{pl} \\ \textsc{person} & \{\mathrm{S,H}\} \end{array}\right]$$

(94) $\text{NP} \longrightarrow \underset{(\downarrow \textsc{person}) \subseteq (\uparrow \textsc{person})}{\underset{\downarrow \in \uparrow}{\text{NP}}} \quad \text{CONJ} \quad \underset{(\downarrow \textsc{person}) \subseteq (\uparrow \textsc{person})}{\underset{\downarrow \in \uparrow}{\text{NP}}}$

(95) $\boxed{\text{José y tu}}$ habláis (Spanish)

José and you speak.2PL

(96) José y tu habláis

$$
f:\left[\begin{array}{ll}
\textsc{pred} & \text{‘}\textsc{speak}\text{’} \\
\textsc{subj} & c:\left[\begin{array}{ll}
\multicolumn{2}{l}{\left\{\begin{array}{l}
j:\left[\begin{array}{ll}
\textsc{pred} & \text{‘}\textsc{Jose}\text{’} \\
\textsc{num} & \textsc{sg} \\
\textsc{person} & \{\}
\end{array}\right] \\
\\
t:\left[\begin{array}{ll}
\textsc{pred} & \text{‘}\textsc{pro}\text{’} \\
\textsc{num} & \textsc{sg} \\
\textsc{person} & \{\mathrm{H}\}
\end{array}\right]
\end{array}\right\}} \\
\textsc{num} & \textsc{pl} \\
\textsc{person} & \{\mathrm{H}\}
\end{array}\right]
\end{array}\right]
$$

(102) Fula, alternative analysis involving complement sets:

	singular		plural
1:	min: {H}	inclusive:	enèn: {}
		exclusive:	mènèn: {H}
2:	an: {S}		onön: {S}
3:	ö: {S,H}		kombè:{S,H}

(104)	[La personne avec la barbe] et Marie	sont idiots/?*idiotes	(French)
	[the person with the beard]-FEM and Marie-FEM	are idiots-MASC/?*FEM	

'The person with the beard and Marie are idiots.'

(106)

$$\mathrm{NP} \longrightarrow \begin{array}{ccc} \mathrm{NP} & \mathrm{CONJ} & \mathrm{NP} \\ \downarrow\in\uparrow & & \downarrow\in\uparrow \\ (\downarrow \textsc{person}) \subseteq (\uparrow \textsc{person}) & & (\downarrow \textsc{person}) \subseteq (\uparrow \textsc{person}) \\ (\downarrow \textsc{gender}) \subseteq (\uparrow \textsc{gender}) & & (\downarrow \textsc{gender}) \subseteq (\uparrow \textsc{gender}) \end{array}$$

(107)	meraa kuttaa	aur	merii billii	mere saath	g^har mẽ	rahte hãĩ (Hindi)
	my dog	and	my cat	with me	house LOC	live
	MASC		FEM			SUBJ GENDER=MASC

‘My dog and my cat live with me in the house.’

(108)

yah laṛki	aur	uski mãã	dilli mẽ	rahtii hãĩ (Hindi)
this girl	and	her mother	Delhi LOC	live
FEM		FEM		SUBJ GENDER=FEM

'This girl and her mother live in Delhi.'

(115)

drengurinn	og	telpan	eru	þreytt (Icelandic)
the.boy	and	the.girl	are	tired
MASC		FEM		SUBJ GENDER=NEUT

'The boy and the girl are tired.'

(116)

maðurinn	og	barnið	eru	þreytt (Icelandic)
the.man	and	the.baby	are	tired
MASC		NEUT		SUBJ GENDER=NEUT

'The man and the baby are tired.'

(117)	ég sá	á	og	lamb,	bæði	svört (Icelandic)
	I saw	a.ewe	and	a.lamb	both	black
		FEM		NEUT		SUBJ GENDER=NEUT

'I saw a ewe and a lamb, both black.'

(120) Icelandic:

$$\begin{aligned}
\{\textsc{m}\}\ (\textsc{masc}) \cup \{\textsc{m}\}\ (\textsc{masc}) &= \{\textsc{m}\}\ (\textsc{masc})\\
\{\textsc{f}\}\ (\textsc{fem}) \cup \{\textsc{f}\}\ (\textsc{fem}) &= \{\textsc{f}\}\ (\textsc{fem})\\
\{\textsc{m},\ \textsc{f}\}\ (\textsc{neut}) \cup \{\textsc{m},\ \textsc{f}\}\ (\textsc{neut}) &= \{\textsc{m},\ \textsc{f}\}\ (\textsc{neut})\\
\{\textsc{m}\}\ (\textsc{masc}) \cup \{\textsc{f}\}\ (\textsc{fem}) &= \{\textsc{m},\ \textsc{f}\}\ (\textsc{neut})\\
\{\textsc{m}\}\ (\textsc{masc}) \cup \{\textsc{m},\ \textsc{f}\}\ (\textsc{neut}) &= \{\textsc{m},\ \textsc{f}\}\ (\textsc{neut})\\
\{\textsc{f}\}\ (\textsc{fem}) \cup \{\textsc{m},\ \textsc{f}\}\ (\textsc{neut}) &= \{\textsc{m},\ \textsc{f}\}\ (\textsc{neut})
\end{aligned}$$

(123)

To drevo	in	gnezdo	na njem mi bosta	ostala	v spominu (Slovene)
that.tree	and	the.nest	on.it to.me will	remain	in memory
NEUT		NEUT		SUBJ GENDER=MASC	

'That tree and the nest on it will remain in my memory.'

(124) Slovene

MASC & MASC	=	MASC
MASC & FEM	=	MASC
MASC & NEUT	=	MASC
MASC & FEM & NEUT	=	MASC
FEM & NEUT	=	MASC
FEM & FEM	=	FEM
NEUT & NEUT	=	MASC

(127) Slovene

$$
\begin{aligned}
\{\textsc{f,n}\}\ (\textsc{masc}) \cup \{\textsc{f,n}\}\ (\textsc{masc}) \cup \{\textsc{f}\}\ (\&) &= \{\textsc{f,n}\}\ (\textsc{masc})\\
\{\textsc{f,n}\}\ (\textsc{masc}) \cup \{\textsc{f}\}\ (\textsc{fem}) \cup \{\textsc{f}\}\ (\&) &= \{\textsc{f,n}\}\ (\textsc{masc})\\
\{\textsc{f,n}\}\ (\textsc{masc}) \cup \{\textsc{n}\}\ (\textsc{neut}) \cup \{\textsc{f}\}\ (\&) &= \{\textsc{f,n}\}\ (\textsc{masc})\\
\{\textsc{f,n}\}\ (\textsc{masc}) \cup \{\textsc{f}\}\ (\textsc{fem}) \cup \{\textsc{n}\}\ (\textsc{neut}) \cup \{\textsc{f}\}\ (\&) &= \{\textsc{f,n}\}\ (\textsc{masc})\\
\{\textsc{f}\}\ (\textsc{fem}) \cup \{\textsc{n}\}\ (\textsc{neut}) \cup \{\textsc{f}\}\ (\&) &= \{\textsc{f,n}\}\ (\textsc{masc})\\
\{\textsc{n}\}\ (\textsc{neut}) \cup \{\textsc{n}\}\ (\textsc{neut}) \cup \{\textsc{f}\}\ (\&) &= \{\textsc{f,n}\}\ (\textsc{masc})\\
\{\textsc{f}\}\ (\textsc{fem}) \cup \{\textsc{f}\}\ (\textsc{fem}) \cup \{\textsc{f}\}\ (\&) &= \{\textsc{f}\}\ (\textsc{fem})
\end{aligned}
$$

(128) *wah pahũcaa aur pahũcii (Hindi)

*wah	pahũcaa aur	pahũcii (Hindi)
he/she	arrived.MASC and	arrived.FEM
MASC/FEM	SUBJ GENDER=MASC	SUBJ GENDER=FEM

'He/she arrived (masculine) and arrived (feminine).'

(131)	*Ich habe	den Dozenten	gesehen und	geholfen (German)
	I have	the docent	seen and	helped
		ACC SG/DAT PL	SUBJ CASE=ACC	SUBJ CASE=DAT

'I have seen and helped the docent/docents.'

(132)	*Sie	singt und	singen (German)
	he/they	sings and	sings
	3SG/3PL	SUBJ=3SG	SUBJ=3PL

‘He/they sings and sing.’

(139) der oder die Abgeordnete (German)

the.MASC or the.FEM representative

'the representative (masculine) or representative (feminine)

$$\left\{\begin{array}{l}\left[\begin{array}{ll}\textsc{spec} & \textsc{the}\\ \textsc{gender} & \{\textsc{m}\}\\ \textsc{pred} & \text{`}\textsc{representative}\text{'}\end{array}\right]\\ \left[\begin{array}{ll}\textsc{spec} & \textsc{the}\\ \textsc{gender} & \{\}\\ \textsc{pred} & \text{`}\textsc{representative}\text{'}\end{array}\right]\end{array}\right\}$$

(142) (=(9))

weil	[wir das Haus]	und	[die Müllers den Garten]	kaufen (German)
because	we the house	and	the Müllers the garden	buy
	1		3	SUBJ= 1/3

'because we buy the house and the Müllers buy the garden'