Unlike phrase structure category coordination

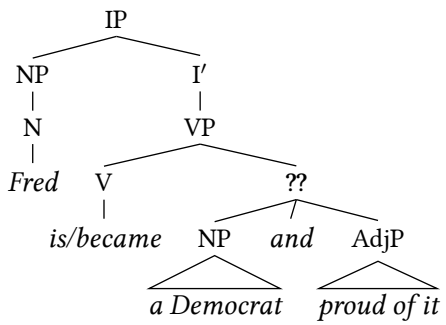
Mary Dalrymple

Abstract. We present a feature-based theory of phrase structure category labels which assigns an appropriate category to unlike category coordinations such as *(Fred is) [[a Democrat] and [proud of it]]*. We propose that unlike category coordinations are specified as including features of the phrase structure categories of each of the conjuncts.

1 Introduction

Often, some syntactic or semantic property of a coordinate structure depends on the corresponding properties of its conjuncts. In this paper we address a particular aspect of that phenomenon: determining the c-structure category label of a coordinate structure in which the conjuncts have different categories. For example, what is the category label of *a Democrat and proud of it* in an example like (1)?

(1)



The c-structure category of a phrase is relevant for category selection requirements imposed by certain predicates and certain phrase structure configurations. These requirements must also be satisfied by coordinate structures, including unlike category coordination. We provide an analysis which assumes that tree nodes are labeled by sets of features, and we propose a means for determining the set of features defining the label of a coordinate structure on the basis of the features labeling the conjunct phrases.

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2 Category selection by predicate or rule

2.1 Predicates selecting c-structure category

There are very few predicates that require a particular c-structure category for their arguments, but a few such predicates are attested. Often, the verbs *wax* and *become* are given as examples.

As discussed in detail by Pollard and Sag (1994), *wax* in its predicative use requires an adjective phrase complement, and disallows nominal, verbal, prepositional, and adverbial phrase complements.

(2) *a.* Fred waxed [poetical]$_{\text{AdjP}}$/[lyrical]$_{\text{AdjP}}$.
b. *Fred waxed [a success]$_{\text{NP}}$.
c. *Fred waxed [in a good mood]$_{\text{PP}}$.
d. *Fred waxed [waving his arms wildly]$_{\text{VP}}$.
e. *Fred waxed [quickly]$_{\text{AdvP}}$.

Pollard and Sag (1994) claim that *become* requires either a nominal or an adjectival complement.

(3) *a.* Fred became [happy]$_{\text{AdjP}}$.
b. Fred became [a professor]$_{\text{NP}}$.
c. *Fred became [in the room]$_{\text{PP}}$.
d. *Fred became [waving his arms wildly]$_{\text{VP}}$.
e. *Fred became [happily]$_{\text{AdvP}}$.

Be can take an adjectival, a nominal, or a prepositional complement.

(4) *a.* Fred is [happy]$_{\text{AdjP}}$.
b. Fred is [a professor]$_{\text{NP}}$.
c. Fred is [in the room]$_{\text{PP}}$.

In coordination, these requirements are preserved. The complement of *wax* can be a coordinate structure composed of adjective phrases, but no other categories. *Become* allows a coordinate structure composed of an adjective phrase and a nominal phrase, but other categories are not allowed. *Be* allows any combination of adjectival, nominal, and prepositional phrase conjuncts. These constraints are exemplified in (5)–(7), including naturally occurring corpus examples from Wikipedia (Davies 2015).

(5) *a.* Fred waxed [poetical]$_{\text{AdjP}}$ and [philosophical]$_{\text{AdjP}}$.

b. *Fred waxed [poetical]$_{\text{AdjP}}$ and [waving his arms wildly]$_{\text{VP}}$.

(6) *a.* Fred became [a professor]$_{\text{NP}}$ and [proud of his work]$_{\text{AdjP}}$.

b. Some Biblical minimalists like Thomas L. Thompson go further, arguing that Jerusalem became [a city]$_{\text{NP}}$ and [capable of being a state capital]$_{\text{AdjP}}$ only in the mid-7th century. (Wikipedia)

c. *Fred became [a professor]$_{\text{NP}}$ and [in line for a promotion]$_{\text{PP}}$.

d. *Fred became [a professor]$_{\text{NP}}$ and [waving his arms wildly]$_{\text{VP}}$.

(7) *a.* Fred is [a professor]$_{\text{NP}}$ and [proud of his work]$_{\text{AdjP}}$.

b. She accepts her status as a Muggle-born witch, and states in Deathly Hallows that she is "[a Mudblood]$_{\text{NP}}$ and [proud of it]$_{\text{AdjP}}$". (Wikipedia)

c. Fred is [a professor]$_{\text{NP}}$ and [in a good mood]$_{\text{PP}}$.

d. Divion is [a commune]$_{\text{NP}}$ and [in the Pas-de-Calais department in the Nord-Pas-de-Calais region of France]$_{\text{PP}}$. (Wikipedia)

e. Fred is [proud of his work]$_{\text{AdjP}}$ and [in a good mood]$_{\text{PP}}$.

f. Cassie discovers weeks later that the doctor who performed her procedure has been influenced by Azazeal, and that the baby is [alive]$_{\text{AdjP}}$ and [in Azazeal's care]$_{\text{PP}}$. (Wikipedia)

2.2 Phrase structure requirements

C-structure category requirements are not imposed only by predicates on their arguments; c-structure positions can also be restricted to phrases of particular types. For example, the complement position of an English PP can be filled by NP or PP, but not CP.[1]

(8) *a.* I removed it from [the box]$_{\text{NP}}$.

b. I removed it from [under the bed]$_{\text{PP}}$.

c. *I didn't care about [that he might be unhappy]$_{\text{CP}}$.

However, the proper generalization governing these examples concerns the permitted categories of phrases appearing in the complement position of PP, and not the category of the f-structure object of a preposition. In fact, a CP can be the f-structure object of a preposition if it is displaced, as discussed by Kaplan and Bresnan (1982), Kaplan and Zaenen (1989), and Dalrymple and Lødrup (2000).

1 Evidence that the PP *under the bed* is the object of *from*, and that *from under* is not a complex preposition, includes the possibility that *under the bed* can be clefted as in (a), and modified as in (b):

(a) It was [under the bed] that I removed it from.
(b) I removed it from [right/directly under the bed].

(9) [That he might be unhappy]$_{CP}$, I didn't care about.

This means that we cannot rule out examples like (8c) by restricting the category of the f-structure object of the preposition, since this would incorrectly rule out examples such as (9), in which a displaced CP is the f-structure object of the preposition *about*. Instead, we must restrict the phrasal category that can appear as the complement of P in the P′ rule.

Notably, a prepositional complement can also be a coordinate structure with one NP conjunct and one PP conjunct; example (10b) is from the NOW corpus (Davies 2013).

(10) *a.* I removed them from [the box]$_{NP}$ and [under the bed]$_{PP}$.

b. Every year, the Canadian Tourism Commission invites travel journalists from [this country]$_{NP}$ and [around the world]$_{PP}$ to a convention called GoMedia to meet tourism representatives from across Canada. (NOW Corpus)

A c-structure rule allowing a disjunction of NP and PP as the complement of P allows either (conjoined) NPs or (conjoined) PPs, but fails to allow unlike category coordination structures such as *[the box]*$_{NP}$ *and [under the bed]*$_{PP}$, with one NP conjunct and one PP conjunct.

(11) P′ rule, version 1 (unsuccessful):

$$P' \longrightarrow P \quad \{NP \mid PP\}$$

In sum, these examples show the need for a theory of phrase structure category labels that provides an appropriate label for a coordinate phrase composed of unlike categories. A coordination of like categories should have that category, and a coordination of unlike categories should have properties of both categories, or be indeterminate between the two categories in some sense.

3 Previous work and alternative analyses

3.1 Ellipsis?

Beavers and Sag (2004) propose that examples like (12) do not exemplify unlike category coordination, but are in fact coordinated verb phrases with elision of the verb in the second conjunct.

(12) Fred [is a professor] and [~~is~~ proud of his work].

On this analysis, *a professor and proud of his work* is not a constituent, since the second conjunct is analyzed as a subpart of an elided larger structure. Although this is a possible analysis of some examples of this type, it does not constitute a general solution to the problem of unlike category coordination. Peterson (2004) provides two arguments

that an unlike category coordination must have an analysis as a single constituent. First, fronting is possible only for single constituents (13a), but an unlike category coordination can be fronted (13b,c).

(13) *a.* *[A book] [to Fred] though Bill gave…

b. [[A plumber] and [making a fortune]] though Bill may be, he's not going to be invited to my party.

c. [[In town] and [itching for a fight]] is the scourge of the West, Zitty Zeke.

However, this argument is not conclusive: as pointed out by Beavers and Sag (2004), there is an alternative analysis of these examples that conforms to their ellipsis-based approach.

(14) A plumber ~~though Bill may be~~ and making a fortune though Bill may be, he's not going to be invited to my party.

Peterson (2004) provides a second argument based on right node raising, which for at least some English speakers is possible only for single constituents (Bresnan 1974). For those speakers, the examples in (15) show that coordinated unlike categories can form a single constituent, and cannot be analyzed in terms of ellipsis.

(15) *a.* Bill is, and John soon will be, [[a master plumber] and [making a fortune]].

b. I can picture Zeke, but cannot imagine John, [[a convicted felon] and [imprisoned for life]].

An additional difficulty comes from the acceptability of modifiers such as *simultaneously* or *alternately*, for which an ellipsis-based analysis does not produce the right reading; under an ellipsis-based analysis, the examples in (16a) and (17a) are elided versions of (16b) and (17b), but the meanings of the (a) and (b) examples are not the same.

(16) *a.* Fred is simultaneously [a professor] and [ashamed of his work].

b. Fred [is simultaneously a professor] and [~~is simultaneously~~ ashamed of his work].

(17) *a.* Fred is alternately [in a good mood] and [suicidal].

b. Fred [is alternately in a good mood] and [~~is alternately~~ suicidal].

3.2 Choose a new category?

Patejuk (2015) proposes that all unlike category coordination structures have the same c-structure category label; she proposes XP (or, alternatively, UP), which is not a variable over category labels, but a special label for unlike category coordinations. In other words, all unlike category coordinations have the category XP.

(18) XP $\longrightarrow$ YP Conj ZP

This proposal requires potentially radical modification of the grammar to allow the special category XP as well as standard categories like NP and PP wherever unlike category coordination structures can appear. Even when this is done, the proposal does not allow the possibility of imposing the category requirements that were shown to be necessary in Section 2, since on this view all unlike category coordinations have the same category. It also makes it difficult to enforce category-function correlations and to control the distribution of phrases of different categories, since there is no relation between the category of the unlike category coordination structure and the categories of the conjuncts.

3.3 Choose one of the categories?

Peterson (2004) proposes that the category of the coordinate structure in unlike category coordination is the category of the first daughter.

(19) X $\longrightarrow$ X Conj Y

This analysis makes the incorrect prediction that the distribution of an unlike category coordination structure matches the distribution of the category of the first conjunct. As shown in examples (20) and (21), both conjuncts must satisfy the requirements, not just the first one.

(20) *a.* Fred waxed [poetical]$_{\text{AdjP}}$ and [philosophical]$_{\text{AdjP}}$.
b. *Fred waxed [poetical]$_{\text{AdjP}}$ and [waving his arms wildly]$_{\text{VP}}$.

(21) *a.* Fred became [a professor]$_{\text{NP}}$ and [happy]$_{\text{AdjP}}$.
b. *Fred became [a professor]$_{\text{NP}}$ and [in line for a promotion]$_{\text{PP}}$.

In fact, the problem is more general: this proposal allows an unlike category coordination structure to appear wherever the category of the initial conjunct is allowed. For example, if the grammar allows the category CP as a verbal complement in V′, this proposal predicts that any unlike category coordination structure whose first conjunct is a CP is also an acceptable verbal complement, no matter what the categories of the non-initial conjuncts are. Like the Patejuk proposal, then, the Peterson proposal does not enforce category-function correlations or allow for control over the distribution of phrases of different categories, since unlike category coordination structures can contain non-initial conjuncts of any category.

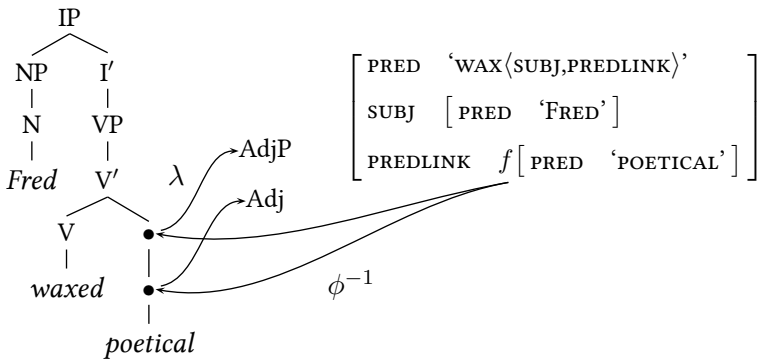
4 Category selection: the CAT predicate

In LFG, category selection by a predicate is treated by appeal to the CAT predicate, which is defined in terms of the node labeling function λ. Nodes in a tree are generally represented by their labels, as in the tree on the left in (22), but this is in fact an abbreviatory convention for the representation on the right, where the λ node labeling function is made explicit.

(22) Standard representation: Making the λ node labeling function explicit:

We can refer to the nodes corresponding to a particular f-structure through the inverse ϕ correspondence: ϕ is a function from c-structure nodes to f-structures, and its inverse ϕ^{-1} is a relation between f-structures and the c-structure nodes that correspond to them.

(23)



This allows us to define the CAT predicate, which relates an f-structure to the labels of the c-structure nodes that correspond to it.

(24) Definition of CAT (Crouch et al. 2008; Kaplan and Maxwell 1996):

CAT(f, C) iff $\exists n \in \phi^{-1}(f) : \lambda(n) \in C$.

"CAT(f, C) is true if and only if there is some node n that corresponds to f via the inverse ϕ correspondence (ϕ^{-1}) whose label (λ) is in the set of categories C."

The CAT predicate allows us to constrain the category of the complement of the verb *wax* by requiring AdjP to be one of the categories of the c-structure nodes correspond-

ing to the PREDLINK of *wax*.[2] The lexical entry for the predicate *wax* using the definition of CAT in (24) is given in (25).

(25) CAT((↑ PREDLINK), {AdjP})

"The label AdjP must be a member of the set of labels of c-structure nodes corresponding to my PREDLINK."

The lexical entry for *become*, which requires AdjP or NP, is given in (26).

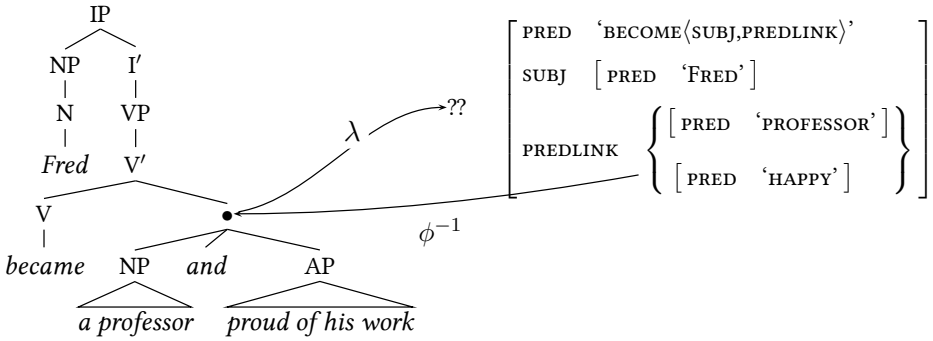
(26) CAT((↑ PREDLINK), {AdjP, NP})

"Either the label AdjP or the label NP must be a member of the set of labels of c-structure nodes corresponding to my PREDLINK."

4.1 CAT in unlike category coordination

What predictions does the CAT predicate make for unlike category coordinations, as in (27)? Notice that the c-structure constituent corresponding to the PREDLINK of *become* is the unlike category coordinate structure *a professor and proud of his work*, as shown in (27), with '??' as the as-yet undefined label for the unlike category coordinate structure.

(27)



This means that we need some additional assumptions to appropriately constrain the categories of the conjuncts in unlike category coordination.

Kaplan and Maxwell (1996) and Crouch et al. (2008) address this problem by proposing that the CAT predicate is *distributive* (Dalrymple and Kaplan 2000): if the CAT predicate is applied to a set of f-structures, it must hold for each member of the set.

2 We analyze the predicative complement of *wax* as the closed grammatical function PREDLINK (Butt et al. 1999; Dalrymple, Dyvik, and King 2004) rather than the open complement XCOMP, but nothing in our analysis hinges on this choice.

(28) For any distributive property P and set s, $P(s)$ iff $\forall f \in s.P(f)$. (Dalrymple and Kaplan 2000, example (73))

Treating CAT as distributive means that each conjunct of a coordinate structure, including unlike category coordinations, must satisfy the constraints imposed by the CAT predicate. If we assume the CAT constraint given in (26) for *become*, the result is as desired for example (27): each conjunct of the coordinated PREDLINK has either the label AdjP or the label NP. Thus, in the analysis of category constraints imposed by predicates such as *wax* and *become* (Section 2.1), treating CAT as distributive yields similar empirical coverage to the solution we propose here.

However, treating CAT as distributive leaves open the issue that is the main focus of this paper: the category label of unlike category coordination structures. Proponents of the distributive CAT definition generally assume the Peterson proposal outlined in Section 3.3, that the category of a nonconstituent coordinate structure is the same as the category of the initial conjunct (Ron Kaplan, p.c.). We must then reevaluate the problem of category selection that arises for the Peterson proposal: recall that the rule in (11) does not adequately constrain the P′ rule, since it allows unlike category coordination structures with an NP or PP initial conjunct and non-initial conjuncts of other categories. This problem can in fact be addressed if the rule is formulated as in (29), with explicit CAT constraints to ensure that all conjuncts in a coordinated prepositional complement are either NP or PP.

(29)
$$\begin{array}{lcl} \text{P}' & \longrightarrow & \begin{array}{ccccc} \text{P} & \{ & \text{NP} & | & \text{PP} \\ \uparrow=\downarrow & & (\uparrow \textsc{obj})=\downarrow & & (\uparrow \textsc{obj})=\downarrow \\ & & \text{CAT}(\downarrow, \{\text{NP PP}\}) & & \text{CAT}(\downarrow, \{\text{NP PP}\}) \end{array} \quad \} \end{array}$$

In fact, such annotations would have to appear throughout the grammar, to prevent the appearance of unlike category coordination structures with conjuncts that are not allowed in particular contexts. For example, to ensure that only phrases of category CP or conjunctions with CP conjuncts can bear the f-structure role of COMP, the CAT annotation in (30) is necessary.

(30)
$$\begin{array}{lcl} \text{V}' & \longrightarrow & \text{V} \quad \begin{array}{c} \text{CP} \\ (\uparrow \textsc{comp})=\downarrow \\ \text{CAT}(\downarrow, \{\text{CP}\}) \end{array} \end{array}$$

We prefer a solution which does not require such a proliferation of additional category constraints. The solution we propose in the following assigns a c-structure category to coordinate structures which reflects the categories of the conjuncts, with an overspecified category reflecting the categories of the conjuncts in unlike category coordination. In this setting, the CAT predicate constrains the category of the coordinate structure as a whole: we advocate a nondistributive definition of CAT which does not distribute to the members of a set.

4.2 Overspecification and indeterminacy

Our analysis is prefigured in work within the GPSG and HPSG frameworks by Gazdar et al. (1985), Sag et al. (1985), and Sag (2002), who propose that there is a systematic relation between the features of a coordinate structure (including features defining the category label as well as other grammatical features) and the features of the conjuncts. Our analysis is also clearly related to work by Bayer (1996), who adopts a deductive approach in a Categorial Grammar setting, and proposes overspecified categories for unlike category coordination.

Gazdar et al. (1985) and Sag et al. (1985) propose that the features of a coordinate structure are the intersection (or, equivalently, the generalization) of the features of the conjuncts, and that a predicate can impose underspecified requirements on its arguments. On their theory, the conjuncts in an example like *[a sick man]*$_{[+\text{N}, -\text{V}, +\text{PRED}]}$ *and [suffering from fever]*$_{[-\text{N}, +\text{V}, +\text{PRED}]}$ have the features indicated. The values of the N and V features clash, but the +PRED feature is common to both conjuncts, and so the coordinate structure has only the feature +PRED. A verb like *is* places no constraints on the N and V features of its complement, requiring only the +PRED feature, and so *a sick man and suffering from fever* is correctly predicted to be an acceptable complement for *is*. Jacobson (1987) and Sag (2002) point out some problems for this proposal when predicates are coordinated: for example, if the predicate *grew* requires a AdjP complement bearing the features [+N, +V] and the predicate *remained* requires an AdjP or NP complement bearing only the feature [+N], Gazdar et al. (1985) and Sag et al. (1985) predict that the coordinated predicates *grew and remained* require only [+N], incorrectly classifying **Kim grew and remained a Republican* as grammatical. Though it does not suffer from these difficulties, our proposal is similar to the Gazdar et al. (1985) and Sag et al. (1985) approaches in that it allows a predicate to place underspecified requirements on the category of its argument: a verb like *become* places indeterminate requirements on its complement, allowing a noun phrase, an adjective phrase, or a coordinate structure with one or more NP conjuncts and one or more AdjP conjuncts.

Sag (2002) proposes a treatment of coordinate structures which allows underspecification in the type lattice, treating only a subset of grammatical features (crucially not including subcategorization requirements) via underspecification in coordination. Bayer (1996) provides an analysis which is similar to Sag's analysis in some respects, according to which unlike category coordinations have a disjunctively specified category label; for example, Bayer proposes the category NP∨S for an unlike coordinate phrase containing an NP conjunct and an S conjunct. Some predicates place fully specified category requirements on their argument; for example, a predicate such as *wax* requires a complement of category AdjP. Other predicates impose a disjunctive category requirement; for example, a predicate such as *become* requires an argument of category NP∨AdjP. A noun phrase such as *a man* is of category NP, but its category can be weakened to NP∨AdjP, allowing it to serve as the complement of *become*. An un-

like category coordination necessarily has a disjunctive category specification, which cannot be strengthened by eliminating one of the disjuncts; for this reason, an unlike NP∨AdjP coordination cannot serve as the complement to a verb like *wax*, which requires the stronger, nondisjunctive category AdjP. Our proposal resembles Sag's and Bayer's in that an unlike category coordination is specified as belonging to each of the categories of the conjuncts, and can appear only with a predicate which places indeterminate category requirements on its argument.

One important difference between these works and our proposal relates to the modular architecture of LFG and the separation of c-structure and f-structure. Our analysis does not assume that f-structure features such as case, person, or number must be treated by the same rules and processes as c-structure features defining category labels. Although our analysis of unlike category coordination bears important similarities to the analysis of f-structure feature indeterminacy, there are also important differences. For example, in the treatment of case indeterminacy (described in the next section) coordinate **predicates** place possibly overspecified requirements on the case features of their shared **arguments**, while arguments can be indeterminately specified, using negative features to rule out unacceptable possibilities. In contrast, in unlike category coordination it is coordinated **arguments** that are potentially overspecified for phrase structure category features, while predicates place potentially indeterminate category requirements on their arguments.

5 Background: F-structure indeterminacy and overspecification

We treat the category of an unlike category coordination as overspecified: that is, an unlike category coordinate structure is specified as belonging to each of the phrase structure categories of its conjuncts. When the categories of all of the conjuncts in a coordinate structure are compatible with the (possibly underspecified) requirements of the governing predicate and the phrasal configuration, an unlike category coordination is acceptable. Our analysis is similar to the Dalrymple, King, et al. (2009) analysis of f-structure indeterminacy, building on the set-based treatment of Dalrymple and Kaplan (2000), which we now describe.

The masculine weak declension plural German noun *Papageien* 'parrots', which shows no case distinctions, can satisfy different case requirements, occurring with verbs that take accusative objects (31) as well as with those that take dative objects (32).

(31) *a.* *Er* *findet* *ihn/*ihm.*
he finds him[ACC]/*him[DAT]
OBJ=ACC
'He finds him.'

b. *Er* *findet* *Papageien.*
he finds parrots[NOM/ACC/DAT/GEN]
OBJ=ACC
'He finds parrots.'

(32) *a.* *Er* *hilft* **ihn/ihm.*
he helps *him[ACC]/him[DAT]
OBJ=DAT
'He helps him.'

b. *Er* *hilft* *Papageien.*
he helps parrots[NOM/ACC/DAT/GEN]
OBJ=DAT
'He helps parrots.'

Groos and Reimsdijk (1979) and Zaenen and Karttunen (1984) were among the first to point out that syncretic forms like *Papageien* can be syntactically **indeterminate** — that is, simultaneously compatible with more than one requirement for a feature such as case.

(33) *Er* *findet* *und* *hilft* *Papageien.*
he finds and helps parrots
OBJ=ACC OBJ=DAT NOM/ACC/DAT/GEN
'He finds and helps parrots.'

In their analysis of indeterminacy, Dalrymple, King, et al. (2009) propose that the value of the CASE attribute is a feature structure which allows specification and differentiation of each (core) case by means of a separate (boolean-valued) attribute: NOM, ACC, DAT, and so forth. A negative value indicates the inability of a form to satisfy the corresponding case requirement, while a positive value indicates that the form can satisfy the requirement. Indeterminate forms can satisfy more case requirements than determinate forms; thus, indeterminate forms contain a smaller number of negative specifications and allow a larger number of positive specifications for case. The value of the CASE feature of the determinately specified German pronouns *ihn* and *ihm* are as given in (34).

(34) Determinate accusative case (*ihn*):

$$\begin{bmatrix} \text{CASE} & \begin{bmatrix} \text{NOM} & - \\ \text{ACC} & + \\ \text{GEN} & - \\ \text{DAT} & - \end{bmatrix} \end{bmatrix}$$

Determinate dative case (*ihm*):

$$\begin{bmatrix} \text{CASE} & \begin{bmatrix} \text{NOM} & - \\ \text{ACC} & - \\ \text{GEN} & - \\ \text{DAT} & + \end{bmatrix} \end{bmatrix}$$

The requirement for the OBJ of *hilft* to bear dative case is imposed by the equation in (35), which requires the value + for the DAT case attribute of *hilft*'s object.

(35) hilft: (↑ OBJ CASE DAT)=+

A dative object like *ihm* can satisfy this case requirement.

(36) *hilft ihm:* DAT

$$\begin{bmatrix} \text{PRED} & \text{'HELP}\langle\text{SUBJ,OBJ}\rangle\text{'} \\ \text{OBJ} & \begin{bmatrix} \text{PRED} & \text{'HIM'} \\ \text{CASE} & \begin{bmatrix} \text{NOM} & - \\ \text{ACC} & - \\ \text{GEN} & - \\ \text{DAT} & + \end{bmatrix} \end{bmatrix} \end{bmatrix}$$

An accusative object like *ihn* fails to satisfy this requirement, since *hilft*'s requirement for DAT + clashes with *ihn*'s requirement for DAT −.

(37) **hilft ihn:* ACC

$$\begin{bmatrix} \text{PRED} & \text{'HELP}\langle\text{SUBJ,OBJ}\rangle\text{'} \\ \text{OBJ} & \begin{bmatrix} \text{PRED} & \text{'HIM'} \\ \text{CASE} & \begin{bmatrix} \text{NOM} & - \\ \text{ACC} & + \\ \text{GEN} & - \\ \text{DAT} & \boxed{+/-} \end{bmatrix} \end{bmatrix} \end{bmatrix}$$

An indeterminate form like *Papageien* is a cased form: it must express some case or other, but there are no restrictions on which case it expresses. This means that it can appear as the object of a verb like *findet* (39) as well as a verb like *hilft* (40), since it can be positively specified for either accusative or dative case. As shown in (41), it can also be **overspecified**, with positive values for both features; that is, it can bear more than one case value at the same time.

(38) Papageien: (↑ CASE {NOM|ACC|DAT|GEN})=+

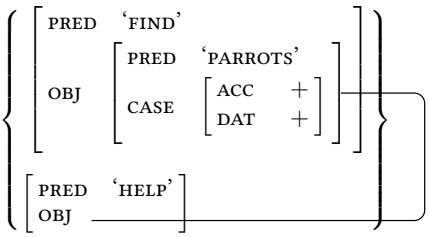
(39) *Er findet Papageien.*
he finds parrots
'He finds parrots.'

$$\begin{bmatrix} \text{OBJ} & \begin{bmatrix} \text{PRED} & \text{'PARROTS'} \\ \text{CASE} & [\,\text{ACC} \quad +\,] \end{bmatrix} \end{bmatrix}$$

(40) *Er hilft Papageien.*
he helps parrots
'He helps parrots.'

$$\begin{bmatrix} \text{OBJ} & \begin{bmatrix} \text{PRED} & \text{'PARROTS'} \\ \text{CASE} & [\,\text{DAT} \quad +\,] \end{bmatrix} \end{bmatrix}$$

(41) *Er findet und hilft Papageien.*
he finds and helps parrots
'He finds and helps parrots.'



6 Feature-based decomposition of c-structure categories

We assume that the features relevant for c-structure category labels encode only c-structure information: phrase structure category, bar level, functional vs. lexical category, and whether the category is projecting (Toivonen 2003). Bresnan et al. (2015, p. 103) provide a discussion of bar-level features, features distinguishing functional from lexical categories, and features distinguishing projecting and nonprojecting categories; since our aim is to encode indeterminate and determinate constraints on c-structure categories and the category of unlike coordinations, we abstract away from those features, and concentrate only on features that encode phrase structure category.

(42) Nouns and noun phrases are: [N +, V −, P −, ADJ −, ADV −]

Verbs and verb phrases are: [N −, V +, P −, ADJ −, ADV −]

Prepositions and prepositional phrases are: [N −, V −, P +, ADJ −, ADV −]

Adjectives and adjective phrases are: [N −, V −, P −, ADJ +, ADV −]

Adverbs and adverb phrases are: [N −, V −, P −, ADJ −, ADV +]

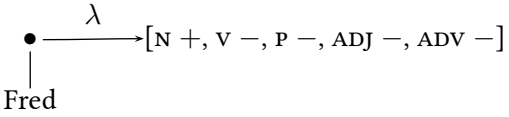
We can now treat N, V, etc. as abbreviations for the corresponding fully instantiated feature matrix:

(43)

Abbreviation	Feature matrix
N	[N +, V −, P −, ADJ −, ADV −]
V	[N −, V +, P −, ADJ −, ADV −]
P	[N −, V −, P +, ADJ −, ADV −]
Adj	[N −, V −, P −, ADJ +, ADV −]
Adv	[N −, V −, P −, ADJ −, ADV +]

And we reinterpret the λ labeling function in (22) as a function from nodes to feature-based node labels.

(44) The node labeling function λ with feature matrices (*Fred* is a noun):



7 Category selection

The following standard notation allows reference to the current node, its mother, and the labels of these nodes.

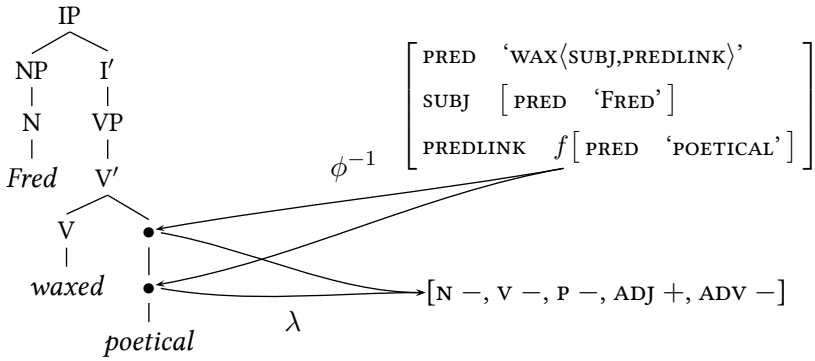
(45) Current node: $*$ Label of current node: $*_\lambda$
Mother node: $\hat{*}$ Label of mother node: $\hat{*}_\lambda$

Lexical entries specify the category of the preterminal node by specifying values for each of the category features. We know of no reason to suppose that the lexicon contains words with overspecified category features, and so we expect all words in the lexicon to have a positive specification for one category feature, and negative specifications for the other category features. Adjectives like *poetical* and *proud* are specified as in (46), with a positive specification for ADJ, and a negative specification for the other category features.

(46) *poetical, proud*
$(\hat{*}_\lambda \text{ N}) = -$
$(\hat{*}_\lambda \text{ V}) = -$
$(\hat{*}_\lambda \text{ P}) = -$
$(\hat{*}_\lambda \text{ ADJ}) = +$
$(\hat{*}_\lambda \text{ ADV}) = -$

On this view, the sentence *Fred waxed poetical* has the following analysis.[3]

(47)



We can now recast our analysis of the requirements of *wax* in feature-based terms: compare (25) with (48). The constraints in (48) use a local variable %C to refer to an arbitrary member of the CAT set of nodes and to specify its required properties. The representation in (47) meets the requirements in (48), as desired.

3 Recall that our focus is on category features, and we ignore features defining bar level. Including a bar level feature would mean that the labels of the two nodes dominating *poetical* would not be the same, since the Adj node would then be distinguished from the AP node by the bar level feature.

(48) Constraints imposed by *wax*:

$\text{CAT}((\uparrow \textsc{predlink}), \%\textsc{c})$

$(\%\textsc{c}\ \textsc{n}) = -$
$(\%\textsc{c}\ \textsc{v}) = -$
$(\%\textsc{c}\ \textsc{p}) = -$
$(\%\textsc{c}\ \textsc{adj}) = +$
$(\%\textsc{c}\ \textsc{adv}) = -$

8 C-structure category of a coordinate phrase

We propose that the category of a coordinate phrase has the value + for a category feature if there is some conjunct with the value + for that feature. On this view, as shown in (49), unlike category coordination involves overspecification: a coordination of unlike categories has the value + for more than one category feature.

(49)

NP:	[N +, V −, P −, ADJ −, ADV −]
AdjP:	[N −, V −, P −, ADJ +, ADV −]
NP and AdjP:	[N +, ADJ +]

Predicates check c-structure category requirements and rule out disallowed options by requiring a negative value for the disallowed feature. For example, an NP or a coordinate phrase containing a NP has the value + for the feature N, and predicates or contexts disallowing NP specify the conflicting value − for the N feature.

9 The coordination rule

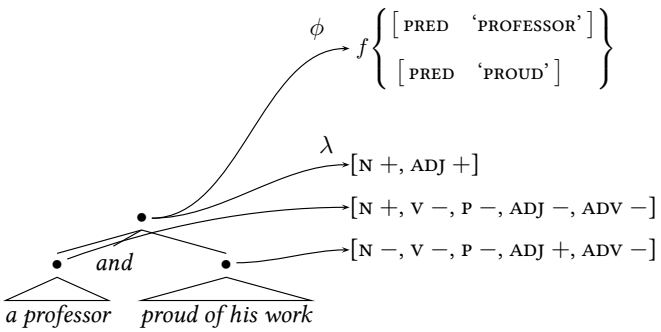
This analysis requires each conjunct daughter to pass up any category feature which has a + value. This is accomplished by annotating each daughter in the coordination rule with the constraints in (50). According to these constraints, if the label (λ) of the daughter node ($*$) has the value + for the feature N, then ($\Rightarrow$) the label of the mother node ($\hat{*}$) is also required to have the value + for the feature N, and similarly for the other category features. If the daughter node has any value other than + for a feature (if it has the value − or is unspecified), nothing is passed up, and the coordinate structure remains unspecified for that feature.

(50) Constraints associated with each daughter node in the coordination rule:

$(*_\lambda\ \textsc{n}) = + \Rightarrow (\hat{*}_\lambda\ \textsc{n}) = +$
$(*_\lambda\ \textsc{v}) = + \Rightarrow (\hat{*}_\lambda\ \textsc{v}) = +$
$(*_\lambda\ \textsc{p}) = + \Rightarrow (\hat{*}_\lambda\ \textsc{p}) = +$
$(*_\lambda\ \textsc{adj}) = + \Rightarrow (\hat{*}_\lambda\ \textsc{adj}) = +$
$(*_\lambda\ \textsc{adv}) = + \Rightarrow (\hat{*}_\lambda\ \textsc{adv}) = +$

These constraints produce the category features [N +, ADJ +] for the unlike category coordination *a professor and proud of his work*, since one of the conjuncts is [N +] and the other is [ADJ +].

(51)



10 Indeterminacy and category selection

10.1 Selection by a predicate

A verb such as *become* places indeterminate requirements on the category of its PREDLINK complement. The category features of the PREDLINK must be compatible with the negative value − for the features V, P, and ADV (they must be unspecified for each of those features, or specified as −), but no constraints on the features N and ADJ are imposed. This means that **either** or **both** of those features can have the value +.

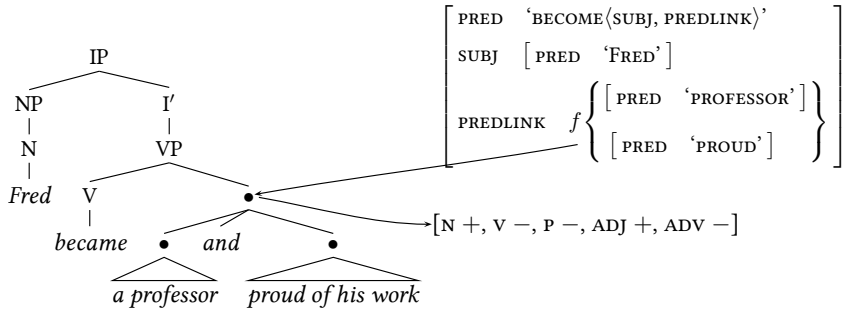
(52) Constraints imposed by *become*:

CAT((↑ PREDLINK), %C)

(%C V) = −
(%C P) = −
(%C ADV) = −

This allows the analysis in (53) of category selection in unlike category coordination. The positive values for the N and ADJ feature come from the coordination rule and the constraints listed in (50), and the CAT constraint in (52) has the effect of negatively instantiating the values of the V, P, and ADV features. In this case, then, the result is that the category of the coordinate structure is fully instantiated, with a value for each category feature.

(53)



10.2 Indeterminate specification in phrase structure rules

As discussed in Section 2.2, a P′ has a head daughter P, and a complement daughter that may be either a nominal phrase or a prepositional phrase. Any of the following are allowed in complement position of a PP:

(54)

NP:	[N +, P −, V −, ADJ −, ADV −]
PP:	[N −, P +, V −, ADJ −, ADV −]
NP and PP:	[N +, P +]

The complement in the P′ rule can have a positive value for the N feature, the P feature, or both, and must be compatible with negative values for the remaining features. The P′ rule can be written as follows, using the abbreviations in (43) for the fully specified categories P′ and P, and an underspecified description for the category of the complement of P.

(55) P′ phrase structure rule, using abbreviations P and P′ for fully instantiated feature matrices:

$$\text{P}' \longrightarrow \text{P} \qquad \begin{array}{c} \bullet \\ (*_\lambda \text{ V}) = - \\ (*_\lambda \text{ ADJ}) = - \\ (*_\lambda \text{ ADV}) = - \end{array}$$

11 Inventory of category features

We have assumed a set of features {N, V, P, ADJ, ADV} that allows maximum differentiation among categories: each feature registers a node as specified for that part of speech. More parsimonious theories of category features have, of course, been proposed; for example, Toivonen (2003) and Bresnan et al. (2015) propose a two-feature system with the features [±PREDICATIVE, ±TRANSITIVE]. The example in (56) is from Bresnan et al. (2015, p. 103).

(56)

	"predicative"	"transitive"
V	+	+
P	−	+
N	−	−
A	+	−

As discussed in detail by Bayer (1996), such decompositions are in general not fine-grained enough to cover all cases of unlike category coordination. In particular, some combinations have no features in common, so it is not possible to use feature underspecification to group together natural classes of all possible combinations. For example, Marcotte (2014) and Bresnan et al. (2015) propose that IP and CP are verbal functional categories, sharing the "predicative" and "transitive" features of verbs but with additional features to mark their status as functional categories. Under their proposal, there is no feature that NPs and CPs have in common.

(57) Pat remembered [the appointment]$_{\text{NP: [PREDICATIVE }-\text{, TRANSITIVE }-]}$ and [that it was important to be on time]$_{\text{CP: [PREDICATIVE }+\text{, TRANSITIVE }+]}$.

The general problem is that the features in (56) are not intended to underpin an analysis of unlike category coordination; the aim is instead to capture a different set of generalizations concerning the relation between functional or lexical categories, or the syntactic combinatory possibilities of the categories (whether they can act predicatively or take an OBJ complement). We use a maximally differentiated feature set in order to be sure that all combinations of categories in unlike category coordinations can be represented and constrained; future work may reveal that a simpler system is possible.

12 Conclusion

This paper addresses one aspect of a general issue that has been the focus of a great deal of attention in the literature. Often, the problem of unlike category coordination is treated as a part of the general problem of syntactic feature resolution and feature indeterminacy, and much of the literature focuses on f-structure features such as case, person, number, and gender; besides the work cited above, relevant work has been done by Pullum and Zwicky (1986), King and Dalrymple (2004), Dalrymple, King, et al. (2006), Dalrymple, Dyvik, and Sadler (2007), and many more. Kaplan (2017) provides an overview discussion of features and underspecification, and proposes a set-based alternative to feature structure-based accounts of indeterminacy which could be explored as an alternative to the account presented here.

In distinguished conjunct agreement, one conjunct in a coordinate structure is syntactically 'distinguished' in that it controls agreement processes (Arnold et al. 2007; Dalrymple and Hristov 2010; Kuhn and Sadler 2007; Sadler 1999, 2003). Sadler (1999)

provides the Welsh examples in (58) to illustrate this pattern: the verb shows first person singular agreement with the first conjunct in example (58a), and third person singular agreement with the first conjunct in example (58b).[4]

(58) *a.* *Roeddwn i a Mair i briodi.*
was.1SG 1SG and Mair to marry
'I and Mair were to marry.'

b. *Roedd Mair a fi i briodi.*
was.3SG Mair and 1SG to marry
'Mair and I were to marry.'

Similar patterns have been claimed to be relevant for c-structure category selection; Sag et al. (1985) discuss examples such as (59), which indicate that the category of the first conjunct can determine the distribution of a coordinate structure (see also Al Khalaf (2015)).

(59) *a.* You can depend on [my assistant] and [that he will be on time].

b. *You can depend on [that he will be on time].

Such examples are actually ruled out by the rule in (55), which constrains all of the categories in a coordinate phrase, and forbids CP arguments in the complement position of a PP; further work is needed to incorporate a treatment of distinguished conjunct category constraints into the overall theory.

Acknowledgments

Helge Dyvik's long-standing interest in the grammar of features in coordination is the inspiration for the proposal presented here, which also builds on our earlier work with Louisa Sadler on gender resolution in coordination (Dalrymple, Dyvik, and Sadler 2007), and I am very happy to dedicate this paper to him. I am also grateful to Miriam Butt, Jamie Findlay, Ron Kaplan, Tracy King, Stephen Jones, Joey Lovestrand, John Lowe, John Maxwell, Adam Przepiórkowski, Louisa Sadler, and two anonymous reviewers for helpful comments.

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4 Thanks to Louisa Sadler for discussion of this point.

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