

Toward a unified analysis of DP Conjunction¹

Caroline Heycock

Theoretical & Applied Linguistics
University of Edinburgh

Roberto Zamparelli

Facoltà di Lingue
Università di Bergamo

1 Introduction

This paper presents a novel set of data on conjunction inside the noun phrase, and shows how this little-studied domain includes structures with readings which are unexpected under any current theory of the semantics of coordination. Moreover, these readings vary across languages in an interesting and systematic fashion.

In order to fit these facts into a general (and ultimately fully unified) theory of constituent coordination, we propose a new semantics for conjunction, and we deduce the cross-linguistic variation from an independently motivated theory of the syntax-to-semantics mapping, in which a parametric difference exists in the way natural languages obtain the semantics of *number*.

Our theory assumes an analysis of noun phrases as ‘DPs’ (Abney 1987) embedding the lexical projection of the noun, NP, plus various intermediate *functional projections* (FPs). To the extent the analysis is successful, it supports the existence of a direct mapping between syntactically motivated functional heads and semantic functions, and speaks in favor of a tighter integration between syntactic and semantic approaches to language.

1.1 The semantics of conjunction

A long-standing issue in the analysis of conjunction is the problem of a unified semantic interpretation for *and*. The conjunction of DP arguments denoting individuals, as in (1a), seems on the face of it to suggest a treatment in terms of set union, or *i-sums* (Link 1983; Link 1987).

- (1) a. [John and Mary] danced.
b. [John and Mary] met.

The conjunction of predicates, as illustrated in (2a–b), on the other hand, is straightforwardly handled as intersection.

- (2) a. My uncle is [short and fat].
b. My ancestors were [short and fat].

This apparent contrast between arguments and predicates can to some extent be dissolved by interpreting DP arguments as generalised quantifiers, in which case (1a) can also be interpreted as involving property intersection. This leaves open the problem of non-Boolean cases like (1b), for which various solutions have been put forward (Hoeksema 1983,1988; Krifka 1990; Lasnik 1995; Winter 1996).

1.2 Conjunction within the DP

Typically, semanticists working on coordination have concentrated on the conjunction of maximal (extended) projections (in the case of noun phrases, the entire DP). In this paper, we want to focus on the relatively little-studied case of nominal conjunction within the DP, illustrated in (3).

- (3) [My [friend and colleague]] always sang too loud.

¹In Paul Dekker (ed): Proceedings of the Twelfth Amsterdam Colloquium, 1999. Pp. 127–132

A typical assumption about the internal syntax and semantics of argument nominals is that the NP embedded in the DP is interpreted as a predicate (e.g. Higginbotham 1987; Longobardi 1994), which restricts a variable contributed by the determiner, at the DP layer.

- (4) [DP the [NP/predicate doctor]]

If the conjunction in (3) is at the level of the NP predicate, we expect it to be interpreted as intersection. This reading, which we will call the *joint* reading, is indeed available:

- (5) a. [My [friend and colleague]] was late.
b. [That [liar and cheat]] is not to be trusted.

There is however another, unexpected reading, in which such a conjunction is interpreted as denoting distinct individuals with distinct properties. We call this the *split* reading: some examples are given in (6). Note that the agreement on the main verb may disambiguate the two readings.

- (6) a. [My [father and grandfather]] were both sailors.
b. [That [man and woman]] were still shouting at each other.

Searches on the British National Corpus have shown that this reading, far from being an idiomatic usage, is productive, and possible with all singular determiners. Moreover, the split reading (like the joint reading) is also possible in the *plural*:

- (7) a. [My [parents and grandparents]] were all from Rome.
b. [Those [men and women]] were advancing on the barricades.

Here, the noun phrases denote pluralities of people, each of whom (in the most natural interpretation) has only one of the properties in the conjunction. Moreover, each property must be represented in the plurality, unlike the corresponding “or” cases (“*Those men or women*”).

While there are other languages (including Dutch) which pattern with English in allowing both a split and a joint interpretation for the conjunction of singular count nouns, in a number of languages, including French, Spanish, German, and Italian, conjunction of singular count NPs within DP yields only the joint interpretation, the singular split interpretation being excluded (here and throughout this paper we exemplify with Italian):

- (8) a. [L' [amico e collaboratore] di Gianni] è stato qui.
the friend and collaborator of Gianni is been here
Gianni's friend and collaborator was here.
b. *[Questo [soldato e marinaio]] sono buoni amici.
this soldier and sailor are good friends
This soldier and sailor are good friends.

The impossibility of the split reading for the conjunction of singular count nouns in a number of languages was noted already in Dowty 1988, but there is a further important piece of the puzzle: this contrast between English and e.g. Italian holds only in the singular. In Italian, as in English, conjunction of plural NPs within DP can have a split reading (modulo matching genders).

- (9) [Questi [soldati e marinai]] sono buoni amici.
these soldiers and sailors are good friends

We thus have at least the following questions to answer:

1. What semantics for conjunction can capture the full range of DP-internal cases (both the joint and the split readings)?
2. What is the difference between English and Italian that gives rise to the contrast in the singular alone?

2 Conjunction as “set product”

Assuming that common nouns (and NPs) denote (intensional) properties, if conjunction was always intersection we would expect *man and woman* to behave just like *short and fat* in (2): that is, we would expect only a *joint* reading to be generally available. Allowing a union semantics for DP-internal *and* does not resolve the problem, as this would give instead the meaning of *this man or woman* (one person). The idea that D is a plural syntactically disguised as a singular leaves as a mystery the fact that a normal plural D is unacceptable:

- (10) a. that man and woman
 b. *those man and woman

The proposal that the construction is really coordination of full DPs with ellipsis of the second D fails in various ways: among others, it cannot explain why in this case (in contrast to e.g. gapping) ellipsis occurs with *and* but not with *or* (witness the ungrammaticality of the ellipsis in *I didn't like the concert: the performer or ??(the) piece was not so good*), and it would have to be restricted *ad hoc* to apply only in the plural in Italian. Dowty's (1988) proposal to solve the problem by stipulating a special non-compositional rule for conjunction, peculiar to English, that involves type-lifting the conjuncts, equally gives no way to account for the singular-plural difference found in Italian and, we believe, goes in the wrong direction in locating the cross-linguistic difference in the semantics of *and*.

We propose instead that a successful account of these data must rely on a crosslinguistically invariant semantics for conjunction, and must seek to locate the divergence in an independently motivated difference between the syntax and semantics of the nominals.

In what follows, we will assume that both singular and plural individuals can be rendered as *sets* (type $\langle e, t \rangle$). Properties will be uniformly of type $\langle \langle e, t \rangle, t \rangle$, and GQs of type $\langle \langle \langle e, t \rangle, t \rangle, t \rangle$. Singular Ns and NPs will therefore denote *sets of singletons*, rather than simple sets of atomic entities. To capture the split reading, the denotation of the conjunction of two singular NPs must be a set of two-membered sets, each containing an element from each of the conjoined nominals. This result is produced by the operation of *set product*, which we propose as a candidate for the denotation of “and”.

- (11) **Set Product**

$$\text{SP}(A^1, \dots, A^n) =_{\text{def}} \{ X : X = a^1 \cup \dots \cup a^n, a^1 \in A^1, \dots, a^n \in A^n \}$$

The operation takes a member from each set, and performs union. Given two conjuncts, (NP_i and NP_j in (12a)) with non-overlapping extensions (e.g. *man and woman*), set product returns a set of two-membered sets (12b).

- (12) a. $\|\text{NP}_i\| = \{\{a\}, \{b\}\}, \quad \|\text{NP}_j\| = \{\{c\}, \{d\}\}$
 b. $\|\text{NP}_i \text{ and } \text{NP}_j\| = \text{SP}(\|\text{NP}_i\|, \|\text{NP}_j\|) = \{\{a,c\}\{a,d\}\{b,c\}\{b,d\}\}$

Further, since set product is defined in terms of union, if the two conjuncts do overlap, whether fully or partially (as in e.g. *friend and colleague*), the resultant set will also contain singletons, e.g. $\{c\}$ in (13b), from $\{c\} \cup \{c\}$.

- (13) a. $\|NP_i\| = \{\{a\} \{b\} \{c\}\}, \quad \|NP_j\| = \{\{c\}, \{d\}\}$
 b. $\|NP_i \text{ and } NP_j\| = \text{SP}(\|NP_i\|, \|NP_j\|) = \{\{a,c\} \{a,d\} \{b,c\} \{b,d\} \{c,d\} \{c\}\}$

The set of such singletons is the *intersection* of the two conjuncts, needed for the *joint* reading.

The problem of excluding the split reading for conjunctions such as (8b) in Italian now boils down to the problem of filtering out of a denotation like (13b) all the non-singleton elements, whenever the conjuncts are singular. Evidence independent of coordination shows that this is indeed the result of two different strategies for obtaining the denotation of singular and plural in Italian and in English.

3 The Syntax/Semantics interface

3.1 The internal structure of the noun phrase

We assume the following syntactic structure for noun phrases (see Cinque 1993, Longobardi 1994, Zamparelli 1995), and adopt a principle which maps functional heads (here, *D*, *Num* and *Pl*) onto semantic operators (15):

- (14) a. $[_{DP} \textit{Det} [_{NumP} \textit{Num} [_{PIP} (\textit{Modifier}) [_{NP} \textit{Noun} (\textit{Compl})]]]]]$
 b. $[_{DP} \textit{Those} [_{NumP} \textit{few/three} [_{PIP} \textit{interesting} [_{NP} \textit{papers}]]]]]$

(15) **Semantic Composition of Functional Heads:**

Each functional projection *F* denotes a function over the meaning of its syntactic arguments.

First, all count nouns (and NPs based on them), whether singular or plural, denote sets of singularities. The difference between singular and plural is expressed by the feature $[\pm\text{PLUR}]$ on *N*; this feature raises to some higher functional head, and triggers a particular semantic operation at that point.

Second, at *PIP* pluralities are constructed from the base denotation of the *NP*, where “constructing a plurality” means building the closure under Generalised Union of the set denoted by the *NP* (the **-operation*)

(16) **Generalised Union:**

$$\bigcup(X) =_{def} \begin{cases} \iota y, y \in X & \text{if } X \text{ is a singleton set} \\ y^1 \cup \dots \cup y^n & \text{if } X = \{y^1 \dots y^n\}; \text{ undefined otherwise} \end{cases}$$

- (17) $\|[_{Pl} NP]\| = * \|NP\| = \{X : \exists Y \subseteq \|NP\| \ X = \bigcup(Y)\}$

Finally, *Num* regulates the cardinality of the *PIP* denotation, filtering from it all the elements with the wrong number of atoms.

- (18) $\|[_{NumP} n \textit{PIP}]\| = \{X : X \in \|PIP\| \text{ and } |X| = n\}$

3.2 Two routes to number

If we now consider how the difference between singular and plural DPs can be obtained in our system, two possibilities present themselves. It is our contention that both are available to natural languages.

The first possibility is that a $+\text{PLUR}$ feature value on the *NP* triggers the application of the **-operator* at *PIP*, while a $-\text{PLUR}$ does not; in the latter case *Pl* is inactive and the *NP* denotation (a set of singularities) is passed up to *NumP* unaltered. $\pm\text{PLUR}$ doesn’t play any semantic role higher than *PIP*. In the absence of an overt numeral in *Num*, no semantic filtering takes place at *NumP* (the projection is possibly absent). We call this the *PIP strategy*; the strategy exemplified by English.

The second possibility is that singular and plural are ways to partition the denotation delivered by the $*$ -operator at PIP. In this case, $\pm\text{PLUR}$ raises up to Num; a Num head reached by a $-\text{PLUR}$ value *preserves* only elements of cardinality 1; a Num head reached by a $+\text{PLUR}$ value *removes* all elements of cardinality 1. We call this the *NumP strategy*; this is the strategy exemplified by Italian.

This divergence is responsible for various syntactic differences in the two languages; semantically, it predicts that English should preserve singular individuals in the denotation of plural DPs, a fact normally obscured by pragmatic factors, but which emerges in the possibility, for English but not for Italian, of *plural negation* (“no boys arrived”, false if a single boy arrived) and *dependent plurals*:

- (19) a. Unicorns have horns. (*En: one per animal*)
 b. #Gli unicorni hanno (i) corni. (*It: only >1 per animal*)

3.3 The two strategies for number meet conjunction

Consider now how the two strategies interact with the idea that conjunction denotes set product. In a model with two noun phrases, NP_i and NP_j , as in (13)a, both English and Italian obtain the denotation in (13)b and pass it up to PIP.² In English, PI will leave it unchanged (both Ns have $-\text{PLUR}$ features). NumP is inactive: the denotation, pairs included, reaches D and functions as a restrictor for D, giving rise to the possibility of either joint or split readings in English.

In Italian, on the other hand, the $-\text{PLUR}$ feature on the N heads raised across-the-board to NumP triggers the filtering away of all pairs arising from the conjunction, leaving only $\{c\}$, in our example. Hence, no split interpretation is possible.

As noted above, in the plural the two languages converge: PI will apply the $*$ -operator over the result of set product, but $\text{Num}_{+\text{PLUR}}$ will not filter away any of the resulting pluralities.

4 DP coordination

When applied to FPs which may denote individuals or singular properties (DP and NumP), conjunction displays an additional restriction, the impossibility of ‘collapsing’ multiple pluralities as a result of the application of union. Thus, the DPs in (20) are not felicitous if only 4 people (1 both a friend and a colleague) came.

- (20) a. [$\{\text{the/those}\}$ 3 friends] and [$\{\text{the/those}\}$ 2 colleagues] came.
 b. [$\{\text{the/those}\}$ [3 friends] and [2 colleagues]] came.

However, set product can successfully apply to conjoin DPs built on Ns with non-overlapping extensions. If DPs are taken to denote $\langle e, t \rangle$ individuals, we will assume that the ‘Quine operator’ Q ($\lambda x \lambda y (x = y)$) can lift them to $\langle \langle e, t \rangle, t \rangle$ singular properties to which set product can apply:

$$(21) \quad \|\text{John and Mary}\| = \text{SP}(\text{Q}(\{j'\}), \text{Q}(\{m'\})) = \text{SP}(\{\{j'\}\}\{\{m'\}\}) = \{\{j', m'\}\}$$

The ι operator can then be used to lower the result onto an individual. If on the other hand DPs (are lifted to) denote $\langle \langle \langle e, t \rangle, t \rangle, t \rangle$ GQs, the set product operation performs the union of each $\langle \langle e, t \rangle, t \rangle$ property across the conjuncts. This operation does not introduce into the denotation of the conjunction any property which wasn’t already present in each GQ. For instance, suppose John has property P but not Q, and Mary Q but not P. It follows that both John and Mary have

²We are adopting the assumption that coordination is “as low as possible,” possibly some reflex of a principle of structural economy

the property PVQ. But PVQ is just what set product returns when combining P in ||John|| with Q in ||Mary|| using union.

This approach also predicts that (22a) will have the same meaning as (22b), whereas (22c) will be compatible with the arrival of all the men but very few women.

- (22) a. Most men and women came.
b. Most men and most women came.
c. Most of the men and women came.

This is because there is no way to select most women-containing pairs without selecting man-containing pairs, and vice versa. In (22c), on the other hand, *most* applies to a mixed plurality of men and women, selecting, say, ‘more than half’ of its total content.

5 Conclusion and extensions

A close examination of DP-internal conjunction across languages has led to a semantics for “and” that generalizes also to the case of full DPs. The next step is to develop an account of predicate conjunction. Here, the split interpretation is available in both Italian and English for nominal, but not adjectival predicates:

- (23) Those objects are {stars and planets / # close and far away}

This leads to the hypothesis that the split reading is blocked with adjectives because their subject is raised across-the-board from a predicate-internal position.

References

- Abney, S. P. (1987). *The English Noun Phrase in its Sentential Aspect*. Ph. D. thesis, MIT, Cambridge MA.
- Dowty, D. (1988). Type raising, functional composition, and non-constituent conjunction. In *Categorial Grammars and Natural Language Structures*. Dordrecht: Reidel.
- Higginbotham, J. (1987). Indefiniteness and predication. pp. 43–70. Cambridge, MA: MIT Press.
- Hoeksema, J. (1983). Plurality and conjunction. In A. ter Meulen (Ed.), *Studies in Modeltheoretic Semantics*, GRASS, pp. 63–84. Dordrecht: Foris.
- Hoeksema, J. (1988). The semantics of non-Boolean *and*. *Journal of Semantics* 6, 19–40.
- Krifka, M. (1990). Boolean and non-Boolean ‘and’. In L. Kálmán and L. Pólos (Eds.), *Papers from the Second Symposium on Logic and Language*, Budapest. Akadémiai Kiadó.
- Lasnik, P. (1995). *Plurality, conjunction and events*, Volume 55 of *Studies in Linguistics and Philosophy*. Dordrecht: Kluwer.
- Link, G. (1983). The logical analysis of plurals and mass terms: A lattice-theoretical approach. In R. Bäuerle, et al. (Eds.), *Meaning, Use and Interpretation of Language*, pp. 302–323. Berlin: Walter de Gruyter.
- Link, G. (1987). Generalized quantifiers and plurals. In P. Gaerdenfors (Ed.), *Generalized Quantifiers*, pp. 151–180. Reidel.
- Longobardi, G. (1994). Proper names and the theory of N-movement in syntax and logical form. *Linguistic Inquiry* 25, 609–665.
- Winter, Y. (1996). A unified semantic treatment of singular NP coordination. *Linguistics and Philosophy* 19, 337–391.
- Zamparelli, R. (1995). *Layers in the Determiner Phrase*. Ph. D. thesis, University of Rochester.