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# A Unified Semantic Treatment of Singular NP Coordination

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## 1 Introduction

A leading assumption in contemporary theories of coordination concerns the cross-categorial status of coordinator morphemes. According to this assumption the syntactic and semantic information that coordinators like *and* and *or* convey in different category coordinations is determined by one lexical entry. Linguistically, this is of course a plausible view: it can explain quite easily how in numerous languages, as in English, a single morpheme appears as a coordinator of many different categories. This approach allows an economical representation for the lexical information on coordinators and thus also a good starting point for theories of coordination acquisition. Consequently, semanticists have started looking for appropriate definitions of Generalized Conjunction and Disjunction - semantic functions that can describe the meaning of coordinators in the various structures they coordinate. Much progress has been made in this respect in works by Gazdar, Keenan & Faltz, Partee & Rooth and von Stechow.

One important challenge to the cross-categorial approach is the pre-theoretical distinction between the semantic function of *and* in simple predicate conjunctions and in simple NP conjunctions:

(1) Mary is tall *and* thin.

(2) Mary *and* John are tall.

Intuitively, and without any theoretical commitment, one may represent the meanings of (1) and (2) as follows, in standard set notation:

(1') $\{\mathbf{m}'\} \subseteq \mathbf{tall}' \cap \mathbf{thin}'$

(2') $\{\mathbf{m}'\} \cup \{\mathbf{j}'\} \subseteq \mathbf{tall}'$

Therefore, while intuitively the semantic function of *and* in (1) might be viewed as set *intersection*, in (2) *and* may seem to represent set *union*.

On this pre-theoretical confusion, as on many other important puzzles, the work of Montague shed some bright light: following Montague's analysis of proper names as generalized quantifiers (2) can also be treated semantically as a case of set intersection, this time - quantifier intersection. Indeed, the works mentioned above analyze *and* conjunctions as cross-categorially "intersective". This analysis led to significant improvement in the semantic theory of coordination.

However, this is not the end for non-intersective NP conjunction. The analysis of the conjunction in (2) as intersective relies on the distributivity of the predication in the sentence: being tall is implied separately to each conjunct in the subject. We would like to consider also sentences in which the predicate does not distribute over the conjuncts, henceforth "collective" predication. Consider for example the simple sentence:

(3) Mary and John met.

Conceived as a predication, this case too involves the set $\{\mathbf{m}', \mathbf{j}'\}$, the union of $\{\mathbf{m}'\}$ and $\{\mathbf{j}'\}$:

(3') $\{\mathbf{m}', \mathbf{j}'\} \in \mathbf{meet}'$

In words: the union set containing Mary and John is in the collection of "meeting sets". The important intuitive contrast between (2) and (3) is that in the latter the predicate seems to apply to the union set "collectively", without applying to its members. This is a problem for using the intersective strategy.

One can identify two principal trends in the literature to approach this problem:

1. Assuming a systematic ambiguity of *and*: a standard intersective ("Boolean") representation to account for (1) as well as another one ("non-Boolean *and*") to account for (3). Such a strategy is seminally proposed in Keenan & Faltz(1985:p.270) and Partee & Rooth(1983:appendix B). Various developments of it appear in Link(1983,1984), Hoeksema(1983,1988), Roberts-(1987) and Carpenter(1994a), among others.

2. Revising substantially the assumption that the semantics of *and* is cross-categorially intersective. According to this line, taken in Krifka(1990) and Lasersohn(1995), (3) is more telling than (1) for analyzing *and*. One cross-categorial definition of "non-Boolean" conjunction is proposed, intended to cover also seemingly intersective cases like (1).

In this paper I would like to oppose both views. A central technical point to be shown is that in the generalized quantifiers framework, *and* conjunctions can standardly be treated as uniformly "intersective" to account also for the truth conditions of collective predications like in (3). One general conclusion drawn from this fact is that conservative type theoretical semantics should be able to handle the problem of *and* in a natural way. Thus, a comprehensive theory of coordination can eliminate the ambiguity stipulation in the first approach above as well as the massive technical and ontological revisions necessitated by the second.

Following this observation, we extend the semantic theory of coordinations whose "building blocks" are singular NP's. Traditionally, conjunction and disjunction are treated symmetrically using the standard Boolean definitions. The collective interpretation of sentences like (3) is obtained as a result of type shifting in the denotation of the NP. Type transition, following Partee & Rooth's notion of flexibility, is motivated by type mismatch, here between distributive generalized quantifiers and collective predicates. The shifting operator is shown to be a generalization of the existential determiner, being a part of a "natural" hierarchy of type shifting principles, in the sense of Partee(1986) and van Benthem(1986,1991). This reveals a connection between the phenomena of "free" existential quantification and collective predication in natural languages.

The paper is organized as follows. Section 2 presents some background: a brief discussion of previous proposals and a few conceptual and technical preliminaries for the alternative solution developed. Section 3 deals with coordinations of proper names. Section 4 discusses the hierarchy of operators for NP interpretation (the Partee diagram) in the light of the present work. The theory is extended for singular quantified NP's in section 5. Section 6 discusses one of the remaining problems.

## 2 Background

### 2.1 Some general issues

Before getting into the subject matter of this paper, some words about objectives and preassumptions are in place.

With the aim of providing a unified theory of NP coordination, the following hypothesis is adopted as a guideline:

**Hypothesis**: The coordinator *and* in English is lexically unambiguous.

Methodologically, this is the *null* hypothesis concerning *any* expression in natural language. In analyzing the semantics of a morpheme a common practice is to start by assuming that it is lexically unambiguous. Only when sufficient evidence undermines this assumption can it be renounced. With respect to the conjunctive morpheme it seems worthwhile emphasizing this general point. Somehow, terms like "Boolean/non-Boolean *and*", often used *descriptively* in the literature, might make it hard for one to realize that the null hypothesis has been renounced without second thoughts.

From a cross-linguistic perspective there is another point in favour of the analysis of *and* in English as unambiguous. Although no independent cross-linguistic study is carried out in this paper, it should be noted, following Lasersohn(1992:p.403) that the extensive descriptive survey in Payne(1985) does not show any language in which distinct morphemes represent the "intersective" and the "collective" alleged meanings of *and*. This is an unexpected fact if we renounce the hypothesis above. If *and* is coincidentally ambiguous in English why are the parallels to *and* conjunctions also ambiguous in the same way in so many other human languages? However, some languages *do* distinguish between different morphemes for the conjunctive coordinator, but the distinction is between coordinators of different *categories*. Such an example given in Payne(1985) is Fijian: in order to obtain in Fijian the parallel to an *and* conjunction in English, S,VP,AP and PP conjunctions are coordinated using the morpheme *ka* whereas NP conjunctions are coordinated using *kei*. Payne indicates that the morpheme *kei* is used in Fijian also in comitative constructions, parallel to the English *with* (e.g. *I saw the chief with the lady.*). For this reason Payne classifies Fijian as having a "'*with*' strategy" with respect to conjunction. This might seem as a lexical evidence for some kind of "collective" conjunction. But Payne's observation (Payne(1985:p.29)) is enlightening:

> "What is striking about [the '*with*'] strategy is that even in languages which do have the same morpheme for the conjunction and the comitative, it is commonly the case that devices exist for keeping the two constructions apart. What is more, the same morpheme may well be used for *all* cases of NP conjunction (not only those which are closely related to the comitative) and even for conjunction of other categories."

In other words, Payne notes that even comitative morphemes like *kei* in Fijian, adopt also an "intersective" behaviour when they are used as coordinators. This is a surprising clue in favour of a semantic theory that does not distinguish "intersective" from "collective" conjunction. [1]

This concludes the general discussion of the lexical semantics of *and* in this paper. In Winter-(1995) I claim that the picture might be a bit more complex, but from other respects.

[1] In some languages (e.g. Russian, Polish), in addition to "normal" NP coordination, a "coordination like" NP structure can be created using a comitative morpheme (see McNally(1990)). Unlike coordinators, this comitative morpheme does not behave the same in non-nominal constructions and as McNally claims, it yields a foundationally different structure than coordination. These points, probably like the ones implied by Payne, make such comitative constructions not directly related to coordination so they are also irrelevant for the subject matter of this paper.

The main focus in what follows will be NP coordinations where the basic "building blocks" are singular NP's. I choose not to discuss in this paper coordinations with plural NP conjuncts like *three children*, *most cars* etc. The semantics of plurals is an issue on which much controversy exists. I prefer to deal here with the interpretation of coordinations which are composed of singular NP's mainly because the semantics of singular NP's is more developed in the literature (see some remarks on this issue in van der Does(1993)). This state of the art makes it easier to concentrate on the specific problems of coordination and collectivity. The notion of collectivity that emerges from the present treatment of conjunction might contribute to future theories of plurality and consequently also to the treatment of plural NP coordinations.

A technical working assumption adopted is that an extensional version of the typed lambda calculus is powerful enough for a compositional semantics of extensional phenomena in natural language. Thus, a simple fragment of Intensional Logic with the types $e, t$ and their functional compounds is used without further ontology. In this I follow van der Does(1993) and Carpenter(1994a), where the necessity of more complicated semantic formalisms as in most contemporary theories of plurality is substantially challenged. As far as I can see, more conceptual clarity is gained by this minimalistic line.

## 2.2 Previous accounts

The interpretation of *and* in NP coordinations in relation to the cross-categorial status of this morpheme is explicitly discussed in four stimulating works: Link(1984), Hoeksema(1988), Krifka(1990) and Lasersohn(1995). [2]

These works all assume that a "non-Boolean" lexical meaning of *and* is required but they introduce different approaches to the analysis of conjunction. I consider a central aspect to be their different attitudes with respect to the possible ambiguity of *and*:

1. *Ambiguity*: For Link *and* is a highly ambiguous morpheme: one reading for traditional Boolean meet, and two or even three denotations for non-Boolean operators: i-sum, group formation and maybe also n-tuple formation. Hoeksema proposes that there are two readings of *and*: a Boolean reading and a group formation reading. The Boolean reading is basically for sentence, predicate and quantifier conjunction. The group formation reading is for conjoining NP's that represent individuals in the $e$ domain.

2. *One lexical item*: Krifka uses both propositional meet and the i-sum operator as the basis for one cross-categorial partial definition. Lasersohn uses the group formation operator in a cross-categorial definition of *and* within an event based semantics.

Both proposals of Link and Hoeksema are problematic in one general respect mentioned above: they attribute *and* lexical ambiguity which is unmotivated by independent linguistic considerations. Hoeksema's approach has some important advantages over Link's due to the more elaborate account of the cross-categorial status of *and*. For example: in Link's theory it is not clear why *and* as a predicate coordinator is only interpreted as intersective. Reconsider:

(4) Mary is tall *and* thin.

If we assume that *and* is always interpreted as Link's i-sum operator then nothing prevents (4) from having a reading equivalent to: *Mary is tall <u>or</u> thin.* The reason is that the i-sum operator

[2] In addition, an unpublished manuscript by B. Schein, "Conjunction reduction redux", cited in Lasersohn(1995) as Schein(1992), is reported to be dealing also with this problem. Unfortunately, this work was not available to me while writing this paper.

amounts to propositional disjunction in the case of predicates. One can try to prevent such an absurd prediction by using only intersective conjunction for predicate *and* coordinations. This is actually Hoeksema's proposal. Another option, more in the spirit of Link's original proposal, is to attribute predicate conjunction a special semantics, similar to the one Link stipulates for "Hydra" constructions. [3] This is the origin for Krifka's generalization, to be discussed below.

Hoeksema's treatment does not face this problem for the analysis of predicate conjunction because of the clear distinction made between the types for which the intersective reading of *and* is required and the $e$ type, where group formation is required. Predicate conjunction is only intersective according to Hoeksema. However, this seems only as a description of a semantic fact without further explanation why the same morpheme is used for expressing intersection and group formation. Moreover, Hoeksema is forced to blur this distinction in order to account for the semantics of quantified NP conjunctions in collective contexts:

(5) Every girl and every boy played together.

Here the intersective reading Hoeksema assumes for quantifier conjunction cannot work and therefore he tentatively proposes to use a type shifting operator on the group formation conjunction for $e$-type individuals in order to let it apply also in quantifier conjunctions. This yields the correct reading for (5) but at a cost of overgeneration. Hoeksema notes that because of the ambiguity of *and* for type $(et)t$ undesired truth conditions emerge which should be somehow blocked. Actually, the assumption of type shifting for "non-Boolean" conjunction makes Hoeksema's theory closer to Link's analysis of *and* as ambiguous for some of the types.

Krifka's cross-categorial theory of *and* is a comprehensive attempt to analyze conjunctions on the basis of one semantic definition. His account stands on "non-Boolean" grounds and without explicitly assuming any lexical ambiguity as in Link or Hoeksema's accounts. As claimed above, this is a preferable starting point linguistically. Like Hoeksema, Krifka proposes that when the conjuncts are of type $t$ their conjunction is Boolean (intersective) and that conjunctions of $e$ individuals are non-Boolean. In distinction to Hoeksema, Krifka uses the i-sum operator for type $e$ and not the group formation operator. For other types, Krifka proposes a rather complex partial definition which is intended to generalize both "intersective" and "collective" interpretations of *and* without a stipulation of ambiguity. This is a desirable feature of Krifka's account. However, I believe the non-Boolean definition for types other than $e$ is not fully motivated and for this reason there are some hard empirical problems for Krifka's approach. One problem for Krifka's treatment of *and* is the analysis of quantified NP conjunctions with distributive predicates as in (6):

[3] In Link(1983) and Link(1984) the name "Hydra" is assigned to relative clauses with split antecedents, as in Link's example:

(i) The boy and the girl who dated each other are friends of mine.

Link's proposal for (i) is that the sentence is actually somehow interpreted as:

(ii) The *boy and girl* who dated each other are friends of mine.

A special semantics is then stipulated for what is considered as a Common Noun conjunction in (ii), which leads to the desired interpretation.

This solution is not far from being what Link labels as "syntactic adhockery". No argument is given for the syntactic assumption that (i) contains a reconstructed "redundant" determiner. Link's proposed semantics for *and* in the case of CN conjunction is also rather *ad hoc* as it is used by him only for this special construction. Krifka's attempt to generalize it to other categories (see above) faces some hard problems.

I believe that the problem of "Hydra" constructions is far from being solved. The problems to analyze the syntax and semantics of Hydra sentences are a sharp manifestation of the long-standing problem concerning the structure of relative clauses: is it [ D CN ] S or D [ CN S ] ? See different arguments in Chomsky(1975) and Partee(1975), among the massive literature on this problem. Because the "Hydra" puzzle is part of the hard problem of relatives, which is beyond the scope of this paper, I do not try to deal here with this kind of constructions.

(6) Every girl and every boy are sleeping.

This problem is to be extensively discussed in section 5, where some alternative explanations for quantified NP conjunction are considered. Another hard problem is for Krifka's non-Boolean analysis of predicate conjunction. One example for this is that the following sentence is not considered contradictory by Krifka's account, although linguistically, this is the case:

(7) The house is small and big.

This problem occurs because according to the account Krifka proposes for predicate conjunction a predicate $P_1$ *and* $P_2$ can hold of an object $x$ in case $x$ is an i-sum of two parts, $x_1$ and $x_2$, where $P_1(x_1)$ and $P_2(x_2)$ both hold. Therefore, consider a house $\mathbf{h}'$ consisting of two parts, $\mathbf{h}_1$ and $\mathbf{h}_2$, where $\mathbf{h}_1$ is in the extension of **small′** and $\mathbf{h}_2$ is in the extension of **big′**. Krifka's definition makes $\mathbf{h}$ in this situation satisfy (7). In this way, every big house is in the extension of *small and big*, pace the common intuition. The non-intersective analysis of predicate conjunction leads to many similar problems. In general, for most predicates the traditional simple intersective analysis is preferable. [4] A more conceptual, less empirical, problem for Krifka's account is that it actually uses three different definitions for the semantics of *and*: propositional conjunction for type $t$, the i-sum operator for type $e$, and a more complex partial definition for other types. This analysis contains, similarly to Hoeksema's account, an implicit assumption on the ambiguity of *and*. Another foundational point is that the semantics of *and* for the case of the $t$ and $e$ types is fully specified, whereas only a partial definition is proposed for other cases. A motivation for this distinction is not given in Krifka's paper, which does not contain any substantial argument in favour of its partial strategy in general.

Lasersohn(1995) brings an original event semantics to deal with the problem of conjunction as well as with many other complex problems. Positing some specific empirical difficulties for this proposal [5] seems somewhat inappropriate here since the enterprise taken by Lasersohn is to develop a substantially new semantic theory using the notion of event. Such a project deserves a rather different kind of examination beyond the scope of this paper.

One point in which Lasersohn's work is directly related to the present paper has to do with the argumentation given in Lasersohn(1995:pp.64-67). Lasersohn claims that the intersective analysis of NP conjunction à la Partee & Rooth is incompatible with the behaviour of other plural NP's. The present paper shows that this claim is incorrect. Intersective conjunction of proper names will be

[4] However, perhaps not for all predicate conjunctions. One of the main motivations for Krifka's non-Boolean treatment of predicate conjunction is his following example:

(i) The flag is green and white.

(i) seems as a problem for the intersective analysis as it is probably not equivalent to the corresponding sentential conjunction: *The flag is green and it is also white.* Judgements are quite hard in these cases and often lead to ontological puzzles. However, I believe the problem has a strong connection to the fact that color predicates are also mass term nouns, as in: *Green is my favorite color.* Therefore, (i) might involve also the problematic semantics of mass terms and not simply an interpretation with first order logic predicates. A further strong support for this approach to the problem is that the same "non-intersective" effect generally occurs only with other typical mass terms. For example, in the following example by Krifka:

(ii) This is beer and lemonade.

These are reasons to consider (i)-(ii) and other similar effects with mass term conjunction as another motivation for a better study of mass terms, and not only simply as a straightforward evidence for non-Boolean *and*.

Similar conclusions are reached independently in Lasersohn(1995:pp.281-286)

[5] To name one of them: (5) is analyzed in Lasersohn's system as equivalent to something like ?**Every girl played together and every boy played together.* See the analysis of the sentence *Every man and every woman is happy* in Lasersohn(1995:p.280-281) and substantiate Lasersohn's analysis of *played together* instead of *happy*.

used here to get a set representation although they are basically treated as generalized quantifiers. Thus, a Partee & Rooth like analysis of the NP *Mary and John* can be used to represent a set, just like an NP like *the children* represents a set (group/i-sum) of entities in most theories of plurality. This is exactly what Lasersohn claims the intersective approach cannot do.

One general feature of the four works discussed above is the foundational distinction they make between *and* and *or*. The coordinator *or* is standardly treated as Boolean whereas *and* can operate also in the $e$ domain. For this reason, even simple coordinations containing both *and* and *or* must be analyzed in the Boolean $(et)t$ domain. When *or* does not appear this is not required. While this asymmetry is not necessarily a weakness, one may still wonder if the non-Boolean analysis of *and* is essential or is it just an artifact of the formalisms used.

The rest of this section contains a short overview of some standard assumptions on individuals, predicates, type shifting and Boolean operations. Much of this is very familiar. However, the material is included here for explicitness and for the convenience of the reader. The details of the present proposal start on section 3.

### 2.3 A summary of some assumptions

In this subsection I very briefly introduce some general assumptions on three foundational issues: type shifting principles, simple and complex individuals and distributive and collective predicates. This discussion is intended only to spell out the minimal assumptions on these issues which are adopted in this paper, without getting into the many involved related questions.

#### 2.3.1 Type shifting principles

In many contemporary semantic theories it has been stressed that the attribution of only one semantic type to each lexical category, as in traditional Montague semantics is inadequate. Partee(1986) and Hendriks(1993) contain discussions of arguments supporting this claim. Instead of Montague's "strict" assignment of types to categories a more "flexible" approach is often adopted. According to this approach many categories are assigned a basic semantic type which can be shifted to other types as well using general operators. Throughout this paper I will adopt the general conception of type flexibility which is summarized by Partee(1986:p.117) as follows:

1. Each basic expression is lexically assigned the *simplest* type adequate to capture its meaning.
2. There are general type-shifting rules that provide additional higher-type meanings for expressions.
3. There is a general processing strategy of trying lowest types first, using higher types only when they are required in order to combine meanings by available compositional rules.

The third point is intuitive and facilitates the exposition, but as far as I know it does not very often affect the descriptive predictions of the theory. This "last resort" strategy is somewhat close to the notion of "local economy" (Chomsky(1991)).

#### 2.3.2 Simple and complex individuals

Although the ontological-linguistic problem of the distinction between atomic, complex and mass entities is not the central one addressed in this work, it is important to be explicit about the main general assumptions adopted here. "Atomic" entities, like the ones usually taken to represent simple proper names, will be modeled as elementary objects of type $e$. "Complex" entities, as the ones denoted by conjoined noun phrases like *Mary and John* will be (basically) analyzed as sets of type $et$, containing atomic entities. The assumption in the background of this proposal is that all the extensional information required on a conjunction like *Mary and John* is contained in such a set representation. See Landman(1989:p.571) where this point is made in more detail. For the purposes of this paper this is the only assumption required on the nature of individuals in semantic representations.

In general, things are of course much more complicated when we consider also NP's like *the committee*. It has been argued on solid grounds that such "collective" NP's cannot be represented simply by a set of the committee members, for example. One obvious argument for this is that a set of the members of one committee can constitute also another different committee. In Link(1983) it has been proposed that committees and similar plural entities should be represented as distinct individual objects (related to their parts). In Landman(1989:II) it has been argued that a better approach is obtained as one observes the relations between problems concerning "committee descriptions" and the intensionality of descriptions in general. Landman proposes an intensional analysis for both cases. In this paper I do not treat sentences that involve such definite descriptions and therefore no account to this range of problems is proposed. However, it seems that both proposals of Link and Landman can be incorporated into the framework developed here without special difficulties.

### 2.3.3 Distributive and collective predicates

It is uncontroversial that predicates like *to sleep* differ from predicates like *to meet* in their distributivity features. For example: if Mary is a woman, the predicate *to sleep* allows the inference from *The women sleep* to *Mary sleeps*. A similar inference from *The women meet* to ?**Mary meets* is impossible. Predicates of the first kind are traditionally called "distributive" whereas the second kind of predicate is traditionally called "collective". I will follow this terminology. Much disagreement exists on the exact way differences between distributive and collective predicates should be modeled. Here, in accordance with Partee's principle 1 above, I will assume that (intransitive) distributive predicates are basically of type $et$, which is the simplest type for predicates in extensional semantics. Collective predicates will be modeled as basically applying to sets, that is they are of type $(et)t$. In this I follow Bennett(1974), Scha(1981) and many other works.

A further traditional distinction will be made between predicates like *to drink all the milk*, *to carry the piano* and predicates like *to meet*. In one interpretation (the distributive one) the first predicate allows the inference from *The women drank all the milk* to *Mary drank all the milk*. In another interpretation (the collective one) this inference is impossible: the women did it *together*. Predicates like that are sometimes called *mixed* predicates, in distinction to predicates like *to meet*, which require "togetherness" and I will call here *completely collective* predicates. This distinction will turn out to be crucial in the analysis of NP coordination and some problems concerning it will be accounted for in subsection 3.2. For a start, like the completely collective predicates, also mixed predicates are given the type $(et)t$: the lowest type for collective predicates.

It was often claimed that coordinations of collective and distributive predicates like *meet and have a beer* are a knockout argument against the strategy adopted above. Landman(1989) shows this is not so [6], proposing a flexibility operator to handle such cases, which nevertheless still require a separate study.

[6]Not only technically speaking. The validity of such "knockout arguments" seems to be similar to the validity of an imaginable argument claiming that proper names cannot be interpreted in the $e$ domain simply because they appear in coordinations with quantifiers. However, typically, theories accepting the first argument would not accept

## 2.4 Some notation

Standard extensional typed $\lambda$-calculus will be used as an intermediate logical language to represent natural language expressions. Basic types are $t$ and $e$. The type of functions with domain of type $\tau$ and range of type $\sigma$ is denoted by $(\tau\sigma)$, parentheses omitted whenever possible. I use the variable symbols as in table 1.

Table 1: Notation for variables

| type | symbols | standing for |
|---|---|---|
| $e$ | $x, y, z$ | individuals |
| $et$ | $P, A, B$ | distributive predicates |
| $(et)t$ | $Q$ | distributive quantifiers |
| $(et)t$ | $\mathcal{P}, \mathcal{A}, \mathcal{B}$ | collective predicates |
| $((et)t)t$ | $\mathcal{Q}$ | collective quantifiers |

For constants of type $e$ I use the notation $\mathbf{m}', \mathbf{j}', \mathbf{s}', \mathbf{b}'$ (for *Mary, John, Sue* and *Bill*), usually assuming that they have an interpretation and are interpreted as different individuals. For convenience, I abbreviate the generalized quantifier corresponding to each individual as M,J,S and B, respectively. For example: M $= \lambda P.P(\mathbf{m}')$. Also for convenience, when this does not create ambiguity I sometimes use set notation instead of the corresponding lambda terms. For example, $\{\mathbf{m}', \mathbf{j}'\}$ instead of $\lambda x.x = \mathbf{m}' \vee x = \mathbf{j}'$ [7]. This is convenient under the assumption mentioned above that different constants represent different individuals.

The semantics used for typed $\lambda$-terms is standard: assuming that for every model $M$ and assignment $f$ of constants to variables, a $\lambda$-term $\varphi_\tau$ has the corresponding semantic object $[\![\varphi]\!]_{M,f}$ in the domain $D_\tau$, usually abbreviated as $[\![\varphi]\!]$, when $M$ and $f$ are implied by the context.

## 2.5 Boolean operations

The cross-categorial behaviour of the connectives *and*, *or* and the negation particle *not* in natural language is often modeled in contemporary semantic theories using a polymorphism on the definitions for the traditional propositional connectives $\wedge$, $\vee$ and $\neg$. I adopt here a definition for this polymorphism that similarly to Gazdar(1980), Keenan & Faltz(1985) or Partee & Rooth(1983) is not generalized for all types. Instead, these operations are defined only for ***t-reducible*** types [8], defined as follows:

**Definition**: $\tau$ is a ***t-reducible*** type iff $\tau = t$ or $\tau = \tau_1\tau_2$, where $\tau_1$ is any type and $\tau_2$ is a $t$-reducible type.

This means that $t$-reducible types are of the form $\tau_1(\tau_2(...((\tau_n)t)...))$, where $\tau_1, \tau_2, ..., \tau_n$ are any (possibly empty) types.

For types which are $t$-reducible the generalized connectives $\sqcap$ and $\sqcup$ are defined recursively as

the second.

[7] How to get the denotation of $\{\mathbf{m}', \mathbf{j}'\}$ from the standard $et$ denotation is straightforward and defined in the following sub-section.

[8] Other names for these types in the literature are "Boolean", "propositional" or "$t$-conjoinable" types, which I consider a bit misleading. Footnote 11 clarifies that this restriction might be actually unnecessary.

follows:

**Definition**: For any $t$-reducible type $\tau$, the operators $\sqcap$ and $\sqcup$ of type $\tau(\tau\tau)$ are defined for all $\lambda$-terms $X, Y$ of type $\tau$ by:

$$X \sqcap Y \overset{def}{=} \begin{cases} X \wedge Y & \tau = t \\ \lambda Z_{\tau_1}.X(Z) \sqcap Y(Z) & \tau = \tau_1\tau_2 \end{cases}$$

$$X \sqcup Y \overset{def}{=} \begin{cases} X \vee Y & \tau = t \\ \lambda Z_{\tau_1}.X(Z) \sqcup Y(Z) & \tau = \tau_1\tau_2 \end{cases}$$

The following fact about these definitions, from Partee & Rooth(1983), will be very useful for us in this paper:

**Fact**: For every two terms $\lambda z.X$, $\lambda z.Y$ of a $t$-reducible type:

$$(\lambda z.X) \sqcap (\lambda z.Y) = \lambda z.(X \sqcap Y)$$
$$(\lambda z.X) \sqcup (\lambda z.Y) = \lambda z.(X \sqcup Y)$$

Generalized inclusion for *all* types is defined as in van Benthem(1986:p.62):

**Definition**: For any type $\tau$, the relation $\sqsubseteq$ of type $\tau(\tau t)$ is defined as follows- for all $\lambda$-terms X,Y of type $\tau$:

$$X \sqsubseteq Y \overset{def}{=} \begin{cases} X = Y & \tau = e \\ X \to Y & \tau = t \\ \forall Z_{\sigma_1}(X(Z) \sqsubseteq Y(Z)) & \tau = \sigma_1\sigma_2 \end{cases}$$

Terms of the $t$-reducible types $\tau t$, where $\tau$ is not null, denote functions from type $\tau$ into truth-values, which can be viewed as subsets of the domain $D_\tau$. For a $\lambda$-term $Z_{\tau t}$ we can denote this set by $\Pi(\llbracket Z \rrbracket)$ [9]. Henceforth I use the abbreviation $\llbracket Z \rrbracket$ ambiguously also as this set denotation, when this should not create confusion. For these "set" types the representation in $D_\tau$ of any Boolean term of type $\tau t$ is exactly the one obtained using the traditional set-theoretical operations: $\llbracket X \sqcap Y \rrbracket = \llbracket X \rrbracket \cap \llbracket Y \rrbracket$, $\llbracket X \sqcup Y \rrbracket = \llbracket X \rrbracket \cup \llbracket Y \rrbracket$, $\llbracket X \sqsubseteq Y \rrbracket = \llbracket X \rrbracket \subseteq \llbracket Y \rrbracket$ [10]. For these types it will sometimes be convenient to use the set theoretical $\in$ relation instead of function application: $X_\tau \in Y_{\tau t}$ iff $Y(X) = 1$, where $\tau$ is any type.

Another definition that will be quite useful in this paper is for the minimum operator for types of sets:

**Definition**: For each type $\tau$, $min$ is an operator of type $(\tau t)(\tau t)$ defined as follows:

$$min \overset{def}{=} \lambda X_{\tau t}.\lambda Y_\tau.X(Y) \wedge \forall Z_\tau \sqsubseteq Y(X(Z) \to Z = Y)$$ [11]

We will often use this operator for $\lambda$-terms representing collections of sets, i.e. of type $(\sigma t)t$. For example, for a term $X_{(et)t}$, if $X$'s denotation $\llbracket X \rrbracket$ is $\{\{a,b\},\{a,b,c\},\{d\},\{a,b,c,d\}\}$ we get $\llbracket min(X) \rrbracket = \{\{a,b\},\{d\}\}$.

[9] For any $\lambda$-term $Z_{\tau t}$ we can transform the relation $\llbracket Z \rrbracket \in D_{\tau t}$ into a set $\Pi(\llbracket Z \rrbracket) \subseteq D_\tau$ to which this relation is the characteristic function: $\Pi(\llbracket Z \rrbracket) = \{x \in D_\tau | \langle x, 1\rangle \in \llbracket Z \rrbracket\}$.

[10] Actually, using also product types *each* $t$-reducible type is equivalent in most type calculi to a "flattened" product type which is of a type $\tau t$ ($\tau$ possibly null). This is due to the equivalence $a(bc) \Leftrightarrow (a \bullet b)c$ (see van Benthem (1991:p.38)). Since each $t$-reducible type is of the form $\tau_1(\tau_2(...((\tau_n)t)...))$ this equivalence means that such types can always be viewed as types of sets: $(\tau_1 \bullet (\tau_2 \bullet (... \bullet (\tau_{(n-1)} \bullet \tau_n)...)))t$ and then the semantics of the type theoretical Boolean operations completely reflects the definition of their set theoretical counterparts.

[11] The $max$ operator is defined by: $max_{(\tau t)(\tau t)} \overset{def}{=} \lambda X_{\tau t}.\lambda Y_\tau.X(Y) \wedge \forall Z_\tau \sqsupseteq Y(X(Z) \to Z = Y)$
The operators $\sqcap$ and $\sqcup$ can also be defined in terms of $\sqsubseteq$ by using the abbreviations $min$ and $max$. We can define

# 3 Coordination of proper names

In this section I consider *and/or* coordinations of proper names. This is probably the most elementary case of NP coordination and therefore it is suitable as a test case and as a point of departure for the analysis of more complex cases of coordination.

A foundational problem in the analysis of coordinations of proper names which was the primary motivation for developing "non-Boolean" theories of *and*, is evoked by simple sentences with collective predication:

(8) Mary and John met.

(9) [ Mary or Sue ] and John met.

It will be shown that collective predication as in these sentences can be adequately analyzed although the semantics of *and* is standardly the intersective operator $\sqcap$. Thus, only a careful inspection of the way to derive the collective interpretation is required, without any other major revisions. In the proposed solution one type shifting operator on the generalized quantifier representing the NP is hold responsible for the collective interpretation. The application of this operator is motivated by type mismatch in functional application between distributive quantifiers and collective predicates. Distributive interpretations of sentences with conjoined NP's are analyzed using standard generalized quantifiers and predicates, where no type mismatch appears.

After presenting this main idea we discuss the origins of the unacceptability of sentences like (10) or (11):

(10) ?* Mary or John met.

(11) ?* Mary met.

This question is not directly related to the interpretation of coordination, but answering it is important in order to achieve a better analysis of various sentences with conjoined NP's. It is claimed that very simple common assumptions on world knowledge and the implicatures of disjunction account for such unacceptabilities. These intuitive but informal notions are given a precise definition for the range of cases in focus.

Having done that, we move to more complex cases of proper name coordinations and to the relations between their structure and their semantic interpretation.

## 3.1 Application - the general details

First let us consider briefly the way Montagovian theories handle coordination of proper names with distributive predicates. Then an extension of this treatment is introduced to handle the same constructions in collective predications.

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for *any* type $\tau$ (not necessarily a $t$-reducible one) with $\iota$ the *iota* operator (see section 4):

$$\mathrm{X}_\tau \sqcap \mathrm{Y}_\tau = \iota(max(\lambda \mathrm{Z}_\tau.Z \sqsubseteq X \wedge Z \sqsubseteq Y)) \qquad \mathrm{X}_\tau \sqcup \mathrm{Y}_\tau = \iota(min(\lambda \mathrm{Z}_\tau.Z \sqsupseteq X \wedge Z \sqsupseteq Y))$$

It is not hard to see that for $t$-reducible types these definitions agree with the definitions above. However, as $\sqsubseteq$ is defined for all types, so are the revised definitions for $\sqcap$ and $\sqcup$. For example, for type $e$ we get:

$$x_e \sqcap y_e = x_e \sqcup y_e = \begin{cases} x & y = x \\ \text{undefined} & \text{otherwise} \end{cases}$$

Because I do know of any linguistic motivation for these extended definitions, I use in this paper the more restricted traditional ones. However, formally, there is no reason not to define $\sqcap$ and $\sqcup$ for all extensional types, if we are willing to accept partial definitions for non-$t$-reducible types.

If we adopt a popular assumption on the nature of proper names (see Partee & Rooth(1983), Partee(1986)) these NP's are basically of type $e$ and their type is lifted whenever needed, i.e. when there is a type mismatch, into type $(et)t$. For example, in order to analyze the sentence *Mary slept* no type lifting should be used because the denotation of *Mary* is of type $e$ and the denotation of *sleep* is of type $et$. We get: $\mathbf{m}'(\lambda x.\mathbf{sleep}'(x)) \Leftrightarrow \mathbf{sleep}'(\mathbf{m}')$. However, the fact that proper names can appear in coordinations with quantificational NP's, as in *Mary or some man*, *Mary and every other woman* leads most treatments of proper names to assume that they are to be analyzed also as quantifiers, of type $(et)t$. In the above coordinations, for example, the constant $\mathbf{m}'$ of type $e$ standing for *Mary* is lifted using the type lifting operator known as "Montague Raising" into the quantifier $\lambda P.P(\mathbf{m}')$ =M. The first coordination, for example, is analyzed as:

$$[\![\text{Mary or some man}]\!] = [\![\text{Mary}]\!] \sqcup [\![\text{some man}]\!] = [\lambda P.P(\mathbf{m}')] \sqcup [\lambda P.\mathbf{man}' \cap P \neq \emptyset] = \lambda P.(P(\mathbf{m}') \lor (\mathbf{man}' \cap P \neq \emptyset))$$

More generally, assuming that *and/or* are analyzed as Boolean operators, proper names always have to be type lifted in NP coordinations because type $e$ is not $t$-reducible. We get distributive sentences like (12) analyzed as in (12a):

(12) Mary and John slept.
a. $(\mathrm{M} \sqcap \mathrm{J})\mathbf{sleep}' \Leftrightarrow (\lambda P.P(\mathbf{m}') \land P(\mathbf{j}'))\mathbf{sleep}' \Leftrightarrow \mathbf{sleep}'(\mathbf{m}') \land \mathbf{sleep}'(\mathbf{j}')$

Consider now the simple collective sentence (8), restated here:

(13) Mary and John met.

If we follow the intersective treatment of NP conjunctions in distributive sentences, the subject of this sentence is analyzed as in (12a) above:

$$[\![\text{Mary and John}]\!] = \lambda P.P(\mathbf{m}') \land P(\mathbf{j}')$$

That is, the denotation of the subject in (13) is basically of type $(et)t$, similarly to (12). However, the collective predicate *to meet* is also of type $(et)t$ and therefore it requires an argument of another type: $et$ or $((et)t)t$. In the present framework, the resolution of this type mismatch is to be achieved using some type shifting operator. This operator, I propose, is exactly the operator that "collectivizes" the distributive quantifier into the appropriate collective quantifier of type $((et)t)t$. [12] It is easier to exemplify the informal idea behind the definition of this operator using a specific model where $D_e = \{\mathbf{m}', \mathbf{s}', \mathbf{j}', \mathbf{b}'\}$. Then we get, in set notation: $[\![\text{Mary and John}]\!] = \{\{\mathbf{m}', \mathbf{j}'\}, \{\mathbf{m}', \mathbf{j}', \mathbf{s}'\}, \{\mathbf{m}', \mathbf{j}', \mathbf{b}'\}, \{\mathbf{m}', \mathbf{j}', \mathbf{s}', \mathbf{b}'\}\}$. The proposed operator, denoted $\mathsf{C}$ (collectivizer), lifts this denotation into type $((et)t)t$ in two stages:

1. Taking only the minimal sets from the denotation of the quantifier. In this example the only minimal set is $\{\mathbf{m}', \mathbf{j}'\}$, so the minimum of the quantifier is $\{\{\mathbf{m}', \mathbf{j}'\}\}$.

2. Lifting the minimum of the quantifier into the set of properties in $D_{((et)t)t}$ which are properties of at least one set in this minimum. [13] In this case we get the following term: $\lambda \mathcal{P}.\exists P(P \in \{\{\mathbf{m}', \mathbf{j}'\}\} \land \mathcal{P}(P))$ or more simply: $\lambda \mathcal{P}.\mathcal{P}(\{\mathbf{m}', \mathbf{j}'\})$ – the properties of the set $\{\mathbf{m}', \mathbf{j}'\}$.

[12] Notice that unlike van der Does(1993) I use here a type shifting operator on a generalized quantifier and not on a determiner. It seems more reasonable for the case of NP coordinations, because the coordination itself does not contain a morphologically overt determiner. However, one can of course give a semantic definition for a null determiner position in NP coordinations and lift it using a similar definition for determiners. This should be no more than a notational variant of the method adopted here.

[13] This is standard existential lifting from $(et)t$ to $((et)t)t$.

Consequently, (13) is analyzed as claiming that the set property *to meet* is a property of the set consisting of Mary and John, which is an intuitive way to model what this sentence means.

Formally, the main new definition introduced in this paper goes as follows:

**Definition**: The collectivity operator $\mathsf{C}_{((et)t)(((et)t)t)}$ is defined by:

$$\mathsf{C} \stackrel{def}{=} \lambda Q_{(et)t}.\lambda \mathcal{P}_{(et)t}.\exists P_{et}(P \in min(Q) \wedge \mathcal{P}(P))$$

According to this definition (13) is analyzed as follows:

(14) Mary and John met.

a. $[\mathsf{C}(\mathrm{M} \sqcap \mathrm{J})]\mathbf{meet}' \Leftrightarrow$
$[\lambda \mathcal{P}.\exists P(P \in min(\mathrm{M} \sqcap \mathrm{J}) \wedge \mathcal{P}(P))]\mathbf{meet}' \Leftrightarrow$
$\exists P(P \in \{\{\mathbf{m}', \mathbf{j}'\}\} \wedge \mathbf{meet}'(P)) \Leftrightarrow$
$\mathbf{meet}'(\{\mathbf{m}', \mathbf{j}'\})$

In words: the set property $\mathbf{meet}'$ is a property of the set $\{\mathbf{m}', \mathbf{j}'\}$.

Let us state the following principle, which is derived from Partee & Rooth(1983)'s and Partee(1986)'s general conception of the way type shifting principles apply to NP denotations in natural language:

**(P)** **The collectivity transition**: The operator $\mathsf{C}$ is freely applicable for lifting NP denotations of type $(et)t$ into type $((et)t)t$.

That this liberal principle should actually be restricted in some situations will become clear in section 5. However, already at this early point it should be emphasized that $\mathsf{C}$ is not proposed as a *general* operator for $(et)t$ quantifiers. Such a general treatment would result in undesired effects with many generalized quantifiers. With this reservation kept in mind, **(P)** is convenient for the objectives of the present section.

From examples like sentence (9), restated below as (15), it is obvious that in the present framework the denotation of the NP coordination must be lifted to type $((et)t)t$ and cannot be just lowered into type $et$ [14]. The reason for this is that in (15) the predicate *to meet* must be analyzed as applying to one of two different sets, and not only to a unique set. This is how it is done using our definition for $\mathsf{C}$ [15]:

(15) [ Mary or Sue ] and John met.

a. $[\mathsf{C}((\mathrm{M} \sqcup \mathrm{S}) \sqcap \mathrm{J})]\mathbf{meet}' \Leftrightarrow$
$[\mathsf{C}(\lambda P.(P(\mathbf{m}') \vee P(\mathbf{s}')) \wedge P(\mathbf{j}'))]\mathbf{meet}' \Leftrightarrow$
$[\lambda \mathcal{P}.\exists A(A \in min(\lambda P.(P(\mathbf{m}') \vee P(\mathbf{s}')) \wedge P(\mathbf{j}')) \wedge \mathcal{P}(A))]\mathbf{meet}' \Leftrightarrow$
$[\lambda \mathcal{P}.\exists A(A \in \{\{\mathbf{m}', \mathbf{j}'\}, \{\mathbf{s}', \mathbf{j}'\}\} \wedge \mathcal{P}(A))]\mathbf{meet}' \Leftrightarrow$
$\mathbf{meet}'(\{\mathbf{m}', \mathbf{j}'\}) \vee \mathbf{meet}'(\{\mathbf{s}', \mathbf{j}'\})$

Since (15) makes a statement not on a unique group of people who met but on two possible meetings, it is impossible to treat such a "collective" NP as representing an object of type $et$ and we must allow type *lifting* of the generalized quantifier into $((et)t)t$.

[14] In (14) we could imagine a more simple type *lowering* operator C' defined as follows: $\mathsf{C}'(Q) = \iota(min(Q))$ For example, $\mathsf{C}'(\mathrm{M} \sqcap \mathrm{J}) = \{\mathbf{m}', \mathbf{j}'\}$ since $min(\mathrm{M} \sqcap \mathrm{J})$ contains only one set. Actually, if required, there is no reason to block application of such a type lowering operator in the cases where it is defined.

[15] At this stage it is not clear from our discussion why this interpretation is *the only* one available. By **(P)**, $\mathsf{C}$ can apply also in other ways to sub-parts of the expression $(\mathrm{M} \sqcup \mathrm{S}) \sqcap \mathrm{J}$. The answer to this question is to become clear as we go along.

For many predicates the *min* operator in the definition of $\mathsf{C}$ is dispensable. For example, a predicate like *to meet* is (probably) downward monotone in that if a set is in its extension then all the plural subsets of this set are in its extension. For instance, if there is a meeting of Mary, Sue and John, it follows that there is also a meeting of Mary and Sue. Due to this property of the predicate we could require only existence of *some* set in the quantifier to which $\mathbf{meet'}$ applies, and not necessarily a minimal set. However, for non-downward monotone predicates like *be numerous*, *have together $1000*, etc. we need a minimal set in the quantifier. For example: from *Mary, Sue and John have together $1000* it does not follow that *Mary and Sue have together $1000.* So the predicate in the second sentence must apply exactly to the set $\{\mathbf{m'}, \mathbf{s'}\}$ and not to any proper super-set of it. Using the *min* operator we get exactly this because $min(\mathrm{M} \sqcap \mathrm{S}) = \{\{\mathbf{m'}, \mathbf{s'}\}\}$. [16]

These are the basics of the proposed account of collective interpretations for coordinations of proper names. The implications will be further studied in the following sections. The underlying assumption in this analysis is that collective interpretations of sentences with *and* conjunctions are not related directly to the semantic definition of the connective, so no stipulation of lexical ambiguity or any other "non-Boolean" operation in the meaning of *and* is required. Instead, the more foundational mechanism by which predicates apply to NP denotations is held responsible for possible collective interpretations of sentences with NP coordinations.

### 3.2 Completely collective predicates and disjunction

Many collective predicates are acceptable only in sentences where they apply to "plural entities", to use an informal notion. For example, compare (16) and (17):

(16) ?* Mary met.

(17) The children met.

I call predicates like *to meet, to gather, to disperse* by the name *completely collective* (*ccl*) predicates, in distinction to other collective-distributive "mixed" predicates like *to weigh*, *to lift*, or *to bring* that can appear also with singular subjects. For example, while (19) can be interpreted collectively similarly to (17), it can also be interpreted distributively "down to the atoms". (17) cannot. Another piece of evidence for the distinction between *to meet* and *to weigh* is that (18) is OK by contrast to (16):

(18) Mary weighs over 100 Kg.

(19) The children weigh over 100 Kg.

This is an important distinction for the analysis of NP coordinations since it governs contrasts as the one between (20) and (21):

(20) Mary and John met.

(21) ?* Mary or John met.

It has been stressed in many previous discussions of this issue that the predicates we labeled as *ccl* do not simply introduce a restriction on the syntactic number of the argument, as (22) exemplifies:

(22) The committee gather*s*. (American English)

[16] I am thankful to Jaap van der Does for his remark on this point.

This sentence is OK although the subject is syntactically singular. On the other hand, (21) is unacceptable although the subject *can* bear plural agreement with the verb. For example: *Mary or John <u>are</u> sleeping in the room.* (see Sag et al.(1985) where this possibility is mentioned).

It might be assumed then that the restriction is semantic or pragmatic in nature. Two trends to analyze it are:

1. *Semantic type mismatch*: In Bennett(1974) it is proposed that sentences like (16) are blocked since the semantic type of "group" predicates like *to meet* do not match the type of the individual subject. Roughly, *Mary* is of type $(et)t$ and *to meet* is also of the same type, which do not match.

2. *Selectional restrictions/ "World knowledge"*: In Roberts(1987:p.124) it is informally proposed (following Scha(1981) and Dowty(1986)) that sentences like (16) are not ungrammatical but only conflict with a selectional restriction of the verb, or (alternatively?) with our world knowledge that individuals by themselves just cannot do things like meeting or gathering. For such actions we need a group, our world knowledge says. According to this view it is the same effect that exists in Chomsky's celebrated example of furiously sleeping colorless green ideas, which is well-recognized as grammatical, although very weird.

Intuitively, the Scha/Dowty/Roberts proposal seems to me preferable. More persuasively, we will see that there are obvious technical reasons not to take Bennett's strategy, especially with the typing he uses (adopted also here). See the discussion of sentences like (31), subsection 3.3.

However, one might like to know more about the world knowledge restriction *ccl* predicates impose. Probably the most simple way to look at this issue (see Dowty(1986)) is as follows. Sentences like (16) are false in any situation most of us can imagine. This is the origin for their oddness. Although this line is very attractive (it actually disclaims the problem as far as semantics is concerned), some other factors should be considered. Especially interesting in our context is the case of sentence (23). This sentence should probably be modeled, similarly to (24), as true in any case Mary and John had a meeting. However, it is not much better than (16).

(23) ?* [ Mary and John ] or Sue met.

(24) ?* Mary and John met or Sue met.

Why is (23) odd? It seems that the answer is still simple if we take into account the pragmatics of disjunctive propositions. [17] Following Grice, if a sentence S uttered by a speaker A conveys the propositional content $\varphi \vee \psi$, this *conversationally* implies that as far as A knows, both $\varphi$ and $\psi$ are contingent. This follows from Grice's conversational maxims: if, for example, A believed $\varphi$ to be true, she could have been more informative and convey a stronger proposition than what S asserts. [18] See Gazdar(1979:p.60) for one of the many explorations of this perspective.

Getting back to (23), if our semantic mechanism assigns this sentence a disjunctive proposition equivalent to (24), its oddness is explained: the propositional disjunct equivalent to ?**Mary met* is false due to our world knowledge. Consequently, a conversational implicature of the sentence

[17] I am grateful to Danny Fox for suggesting this to me.

[18] That this is a conversational and not a conventional implicature related to the morpheme *or* should be evident as one looks at sentences like:

(i) Mary dates every blond or handsome guy.

(i) does not convey any uncertainty with respect to the kind of guys Mary dates: it implies she dates all blond guys *and* all handsome guys. When the disjunction is in a downward monotone environment as in (i), the proposition uttered by the sentence is not necessarily disjunctive.

should be canceled somehow to make the sentence pragmatically informative. For example, it can be understood as a joke coming to imply Mary and John met.

The semantic mechanism proposed for the analysis of coordination does exactly the job hypothesized for it in the paragraph above - it assigns (23) the appropriate disjunctive proposition:

(25) ?* [ Mary and John ] or Sue met.

a. $[\mathsf{C}((\mathrm{M} \sqcap \mathrm{J}) \sqcup \mathrm{S})]\mathbf{meet'} \Leftrightarrow$
$[\mathsf{C}(\lambda P.(P(\mathbf{m'}) \wedge P(\mathbf{j'})) \vee P(\mathbf{s'}))]\mathbf{meet'} \Leftrightarrow$
$\lambda\mathcal{P}.\exists A[A \in min(\lambda P.(P(\mathbf{m'}) \wedge P(\mathbf{j'})) \vee P(\mathbf{s'})) \wedge \mathcal{P}(A)](\mathbf{meet'}) \Leftrightarrow$
$\mathbf{meet'}(\{\mathbf{m'}, \mathbf{j'}\}) \vee \mathbf{meet'}(\{\mathbf{s'}\})$

The disjunct $\mathbf{meet'}(\{\mathbf{s'}\})$ is the one whose truth is impossible according to our common world knowledge.

Theoretically, this kind of account seems to me completely satisfying as it rests on some solid linguistic assumptions without any additional stipulations. Although in the appeal to world knowledge and pragmatics we lose a great deal of rigor, this is probably because questions about the formal nature of these domains might need to wait some time before properly answered. However, in the meantime some comfort for the formally minded can be found in what follows. There seems to be a way to state explicitly the restriction *ccl* predicates impose on their arguments, which mimics the relevant implicatures of disjunction. The question becomes now: what is a proper restriction on the arguments in *ccl* predications that can adequately describe their behaviour?

The answer I propose to this question in the generalized quantifiers approach is rather straightforward. It is proposed that a completely collective predicate requires a "*completely plural*" argument. The notion of completely plural (henceforth *cpl*) objects is projected from the trivial distinction between "plural" *et* sets - sets with two or more members and "non-plural" sets - singletons or the empty set (see also van Eijck(1983) for a relevant discussion). In higher set types of the form $(...((et)t)t...)t$ we define a *cpl* object as an object whose minimum is composed recursively only of *cpl* sets. Formally:

**Definition**: An object $X$ in $D_{\tau t}$ is *completely plural* (*cpl*) iff the following holds:

1. For $\tau = e$: $|X| \geq 2$ ($X$ is a plural set)
2. For $\tau \neq e$: For every object $Y$ in $D_\tau$, if $Y \in min(X)$ then $Y$ is *cpl*.

Examples: $[\![P_{et}]\!]$ is *cpl* iff $|P| \geq 2$ holds
$[\![Q_{(et)t}]\!]$ is *cpl* iff $\forall P \in min(Q)(|P| \geq 2)$ holds (iff $\forall P \in Q(|P| \geq 2)$)
$[\![\mathcal{Q}_{((et)t)t}]\!]$ is *cpl* iff $\forall Q \in min(\mathcal{Q})(\forall P \in Q(|P| \geq 2))$ holds

Notice that for the quantifier type $(et)t$ complete plurality is equivalent to the requirement that all sets in the quantifier are *cpl* (i.e. plural). This is not the case for type $((et)t)t$: here the restriction of the minimum is not a restriction on all the members of the object. The reason we use a restriction only on $min(X)$ is to become clear in the discussion that follows.

The restriction induced by completely collective predicates on their arguments can now be stated as in the following slogan-like generalization:

**(G)** A *ccl* predicate allows only a *cpl* argument. [19]

[19] I refer here, obviously, only to the linguistic notion of argument and predicate, and not to the $\lambda$-theoretical notion: in a sentence like *Every boy sleeps* the NP is still considered as an argument although its denotation might be viewed as a predicate applying to the VP denotation.

To see how this account combines with the proposed type lifting analysis of collective sentences, consider our representation for the collectivized subjects of (20) and (21):

$$\mathsf{C}([\![\text{Mary and John}]\!]) \;=\; \mathsf{C}(\mathrm{M}\sqcap\mathrm{J}) \;=\; \lambda\mathcal{P}.\mathcal{P}(\{\mathbf{m}',\mathbf{j}'\})$$

$$\mathsf{C}([\![\text{Mary or John}]\!]) \;=\; \mathsf{C}(\mathrm{M}\sqcup\mathrm{J}) \;=\; \lambda\mathcal{P}.\exists P(P\in min(\mathrm{M}\sqcup\mathrm{J})\wedge\mathcal{P}(P)) \;=\; \lambda\mathcal{P}.\exists P(P\in\{\{\mathbf{m}'\},\{\mathbf{j}'\}\}\wedge\mathcal{P}(P)) \;=\; \lambda\mathcal{P}.\mathcal{P}(\{\mathbf{m}'\})\vee\mathcal{P}(\{\mathbf{j}'\})$$

It is easy to see that in any model where $\mathbf{m}'\neq\mathbf{j}'$ we get that $\mathsf{C}(\mathrm{M}\sqcap\mathrm{J})$ is *cpl* whereas $\mathsf{C}(\mathrm{M}\sqcup\mathrm{J})$ is not.[20]. This is due to the following equations:

$$min(\mathsf{C}(\mathrm{M}\sqcap\mathrm{J})) \;=\; \{\{\{\mathbf{m}',\mathbf{j}'\}\}\}$$

$$min(\mathsf{C}(\mathrm{M}\sqcup\mathrm{J})) \;=\; \{\{\{\mathbf{m}'\}\},\{\{\mathbf{j}'\}\}\}$$

In the first term the minimum is recursively composed only of plural members (the set $\{\mathbf{m}',\mathbf{j}'\}$) whereas in the second term this is clearly not the case. Therefore, according to the definition above the first is *cpl* whereas the second is not. Consequently, (20) is licensed by **(G)** whereas (21) is ruled out. Notice also the reason why we use the *min* operator in the definition of *cpl* objects. We want a term like $\mathsf{C}(\mathrm{M}\sqcap\mathrm{J}) = \lambda\mathcal{P}.\mathcal{P}(\{\mathbf{m}',\mathbf{j}'\})$ representing the subject of (20) to be defined as a *cpl* argument, as *Mary and John* is an acceptable argument for a *ccl* predicate like *to meet.* However, not *all* the members in a set denotation for $\mathsf{C}(\mathrm{M}\sqcap\mathrm{J})$ have to be *cpl* objects. For example: $\{\{\mathbf{m}',\mathbf{j}'\},\{\mathbf{s}'\}\}\in\mathsf{C}(\mathrm{M}\sqcap\mathrm{J})$ is not such an object (it contains the singleton $\{\mathbf{s}'\}$). However, *the minimum* of $\mathsf{C}(\mathrm{M}\sqcap\mathrm{J})$ contains only the term $\{\{\mathbf{m}',\mathbf{j}'\}\}$, which consists only of non-singletons. Therefore, the correct empirical generalization involves recursively only the members in the minimum of the argument as in the definition above and not all the members in the argument. For capturing the right restriction in **(G)** only the "inherent" sets (so to speak) composing the argument should be considered, that is, only its minimum.

Once again I must emphasize that I do not consider **(G)** as "the real explanation" of the problem, which was claimed to be more pragmatic in nature. It is only a handy empirical generalization and I henceforth use it freely.

### 3.3 Combining the semantic principles with syntactic representations

Now that we have considered the proposed analysis of coordinations with proper names in collective sentences and the restrictions some collective predicates impose on their arguments we may see how these two components combine in the analysis of other simple sentences, and what the role of the syntactic representation of the coordination is in determining its possible interpretations.

Let us start by re-examining the way **(P)** and **(G)** combine in the analysis of a simple NP conjunction like *Mary and John.* According to Partee's principles the representations of the conjuncts must be lifted from type $e$ into type $(et)t$ (by "Montague raising") and only then can the operator $\sqcap$ apply to the generalized quantifiers M and J, to get another generalized quantifier:

(i) $\mathrm{M}\sqcap\mathrm{J} \;=\; \lambda P.P(\mathbf{m}')\wedge P(\mathbf{j}')$

[20] In "anomalous" models where $\mathbf{m}'=\mathbf{j}'$ also $\mathsf{C}(\mathrm{M}\sqcap\mathrm{J})$ is not *cpl* and sentences like (20), with a *ccl* predicate are unacceptable, as predicted by **(G)**. For example:

(i) **?** Dr. Jekyll and Mr. Hyde met in the park.

See in this respect the discussion in section 6.

This is the minimal type required in distributive sentences, where the predicate is of type $et$. A sentence like *Mary and John slept* is analyzed in the standard GQ approach as: $(\mathrm{M} \sqcap \mathrm{J})\mathbf{sleep'} \Leftrightarrow \mathbf{sleep'}(\mathbf{m'}) \wedge \mathbf{sleep'}(\mathbf{j'})$.

With a collective predicate of type $(et)t$ the denotation in (i) must be lifted into type $((et)t)t$ in order to avoid type mismatch. There are two ways to do this using $\mathsf{C}$:

(ii) $\mathsf{C}(\mathrm{M} \sqcap \mathrm{J}) \;=\; \lambda\mathcal{P}.\mathcal{P}(\{\mathbf{m'},\mathbf{j'}\})$

(iii) $\mathsf{C}(\mathrm{M}) \sqcap \mathsf{C}(\mathrm{J}) \;=\; (\lambda\mathcal{P}.\mathcal{P}(\{\mathbf{m'}\})) \sqcap (\lambda\mathcal{P}.\mathcal{P}(\{\mathbf{j'}\})) \;=\; \lambda\mathcal{P}.\mathcal{P}(\{\mathbf{m'}\}) \wedge \mathcal{P}(\{\mathbf{j'}\})$

The other combinations using application of $\mathsf{C}$ only to one conjunct - $\mathsf{C}(\mathrm{M})\sqcap\mathrm{J}$ or $\mathrm{M}\sqcap\mathsf{C}(\mathrm{J})$ - are undefined because $\sqcap$ requires two conjuncts of the same type.

We have then collective sentences like (26) with non-*ccl* predicates analyzed as ambiguous between (26a) and (26b):

(26) Mary and John weigh over 100 Kg.
  a. $[\mathsf{C}(\mathrm{M} \sqcap \mathrm{J})]\mathbf{w100'} \;\Leftrightarrow\; \mathbf{w100'}(\{\mathbf{m'},\mathbf{j'}\})$
  b. $[\mathsf{C}(\mathrm{M}) \sqcap \mathsf{C}(\mathrm{J})]\mathbf{w100'} \;\Leftrightarrow\; \mathbf{w100'}(\{\mathbf{m'}\}) \wedge \mathbf{w100'}(\{\mathbf{j'}\})$

These are of course available interpretations.

In sentences with *ccl* predicates like *to meet* we get only the "together" interpretation for the NP, corresponding to (26a), and not the "each" interpretation in (26b). This is predicted by (**G**): while the representation $\mathsf{C}(\mathrm{M}\sqcap\mathrm{J})$ is *cpl*, as we have shown above, the representation $\mathsf{C}(\mathrm{M})\sqcap\mathsf{C}(\mathrm{J})$ is not because:

$$min(\mathsf{C}(\mathrm{M})\sqcap\mathsf{C}(\mathrm{J})) \;=\; min(\lambda\mathcal{P}.\mathcal{P}(\{\mathbf{m'}\}) \wedge \mathcal{P}(\{\mathbf{j'}\})) \;=\; \{\{\{\mathbf{m'}\},\{\mathbf{j'}\}\}\}$$

The right side of this equation evidently cannot represent a *cpl* object.

Now we may turn to the analysis of NP's with more than two conjuncts. Consider for example the NP *Mary and Sue and John.* Here also syntactic ambiguity gets into the picture- traditionally this NP is analyzed as structurally ambiguous between the left and right bracketing association:

(a) [ Mary and Sue ] and John

(b) Mary and [ Sue and John ]

In a compositional semantic mechanism the application of $\mathsf{C}$ to full NP denotations means that the structure in (a) has the interpretations in ($\mathrm{i_a}$)-($\mathrm{iv_a}$) whereas the structure in (b) has symmetrically the interpretations ($\mathrm{i_b}$)-($\mathrm{iv_b}$):

| | | | |
|---|---|---|---|
| ($\mathrm{i_a}$) | $[\mathrm{M}\sqcap\mathrm{S}]\sqcap\mathrm{J}$ | ($\mathrm{i_b}$) | $\mathrm{M}\sqcap[\mathrm{S}\sqcap\mathrm{J}]$ |
| ($\mathrm{ii_a}$) | $\mathsf{C}([\mathrm{M}\sqcap\mathrm{S}]\sqcap\mathrm{J})$ | ($\mathrm{ii_b}$) | $\mathsf{C}(\mathrm{M}\sqcap[\mathrm{S}\sqcap\mathrm{J}])$ |
| ($\mathrm{iii_a}$) | $\mathsf{C}(\mathrm{M}\sqcap\mathrm{S})\sqcap\mathsf{C}(\mathrm{J})$ | ($\mathrm{iii_b}$) | $\mathsf{C}(\mathrm{M})\sqcap\mathsf{C}(\mathrm{S}\sqcap\mathrm{J})$ |
| ($\mathrm{iv_a}$) | $[\mathsf{C}(\mathrm{M})\sqcap\mathsf{C}(\mathrm{S})]\sqcap\mathsf{C}(\mathrm{J})$ | ($\mathrm{iv_b}$) | $\mathsf{C}(\mathrm{M})\sqcap[\mathsf{C}(\mathrm{S})\sqcap\mathsf{C}(\mathrm{J})]$ |

The (i)'s are the distributive readings of the NP structures, the (ii)'s are *cpl* collective readings, the (iii)'s are non-*cpl* "semi-collective" readings, and the (iv)'s are distributive readings but unlike the (i)'s they are of type $((et)t)t$. Consequently, and similarly to the analysis given for NP's with two conjuncts, the (i)'s are the only interpretations available with the distributive predicate in sentence (27), the (ii)'s are the only ones available in the *ccl* predication of (28) and the non-*ccl* predicate in (29) allows (ii) as well as the non-*cpl* readings (iii)-(iv). The subscript $a$ or $b$ of the interpretation is according to the parsing of the NP. All these predictions are intuitively sound.

(27) Mary and Sue and John slept.

(28) Mary and Sue and John met.

(29) Mary and Sue and John weigh over 100 Kg.

By associativity of $\sqcap$ we get $(i_a)=(i_b)$, $(ii_a)=(ii_b)$ and $(iv_a)=(iv_b)$. On the other hand, $(iii_a)$ and $(iii_b)$ differ. This is a correct prediction. For example, consider the utterance in (30), where the NP is syntactically disambiguated due to the comma intonation. The representations $(iii_a)$ and $(iii_b)$ attribute (30) the interpretations in (30a) and (30b) respectively.

(30) Mary and Sue, and John weigh less than 100 Kg.
a. $[\mathsf{C}(M\sqcap S)\sqcap\mathsf{C}(J)]\mathbf{wl100'} \Leftrightarrow [\lambda\mathcal{P}.\mathcal{P}(\{\mathbf{m'},\mathbf{s'}\})\wedge\mathcal{P}(\{\mathbf{j'}\})]\mathbf{wl100'} \Leftrightarrow \mathbf{wl100'}(\{\mathbf{m'},\mathbf{s'}\})\wedge\mathbf{wl100'}(\{\mathbf{j'}\})$
b. $[\mathsf{C}(M)\sqcap\mathsf{C}(S\sqcap J)]\mathbf{wl100'} \Leftrightarrow [\lambda\mathcal{P}.\mathcal{P}(\{\mathbf{m'}\})\wedge\mathcal{P}(\{\mathbf{s'},\mathbf{j'}\})]\mathbf{wl100'} \Leftrightarrow \mathbf{wl100'}(\{\mathbf{m'}\})\wedge\mathbf{wl100'}(\{\mathbf{s'},\mathbf{j'}\})$

From (30) it cannot be inferred that Sue and John *together* weigh less than 100 Kg., which is what (30b) claims. The interpretation in (30a), by contrast, is quite natural.

Now it is evident, as was mentioned in connection to the proposal in Bennett(1974), that it is useful to let C "collectivize" also denotations of singular NP's like *John*. The reason is that such NP's can appear in coordinations with "collectivized" NP's like *Mary and Sue*, as it happens in the interpretation (30a) for (30). A similar point is also made in Hoeksema(1988), using the following nice example:

(31) Dylan and Simon and Garfunkel wrote many hits in the 60's.

This sentence can easily be interpreted as making a statement on the number of hits the well-known "collective" Simon&Garfunkel wrote in the 60's, without taking into account the number of hits each of the artists in this couple wrote on his own during the same period. Our world knowledge of the pop song writers in the 60's certainly helps in parsing (31) this way (more accurately- it helps to eliminate alternative readings).

The difference between $(iii_a)$ and $(iii_b)$ is only one way in which the syntactic representation of a coordination affects the available interpretations. Another clear prediction of the system is that readings like (32a) are ruled out for both syntactic bracketings of the NP in (32):

(32) Mary and Sue and John have exactly \$1000.
a. * $[\mathsf{C}(M\sqcap J)\sqcap\mathsf{C}(S)]\mathbf{he1000'} \;\Leftrightarrow\; \mathbf{he1000'}(\{\mathbf{m'},\mathbf{j'}\}) \wedge \mathbf{he1000'}(\{\mathbf{s'}\})$

Using the mechanism proposed it cannot be inferred from the sentence in (32) that Mary and John *together* have exactly \$1000 whereas Sue has the same amount of money for herself. This is what (32a) claims, but (32a) is not obtained for (32), no matter what syntactic structure we use for (32), as speakers object to this kind of reading. Therefore, the prediction that (32a) is a non-existent reading for (32) is a desirable one.

The account presented above has another intuitive prediction. Consider the contrast between (32) and (33):

(33) Mary, Sue and John have exactly \$1000.

Semantically, there is an important distinction between the truth conditions of these two sentences: (33) is not true in a situation where Mary and Sue together have exactly \$1000, and John also has the same amount of money for himself. Similarly for Sue and John together and Mary for herself. By contrast, as noticed above, (32) has these interpretations. This contrast has a straightforward account here. For (32) we saw already that the above mentioned interpretations are predicted. However, it is entailed by (**P**) that C applies compositionally only to meanings which are attributed to complete NP's. Therefore, we do not get these interpretations for (33), which is traditionally treated as a trinary coordination. [21] In (33) the only NP denotations to which C can apply are the denotations of the proper names *Mary, Sue, John* separately, or the denotation of the whole subject. Therefore, we get for (33) only the "completely distributive" interpretation (each person has $1000 for herself) and the "completely collective" interpretation (the three persons share the money). In other words: only the denotations $M \sqcap S \sqcap J$, $C(M \sqcap S \sqcap J)$ and $C(M) \sqcap C(S) \sqcap C(J)$ are available for the subject of (33).

Sentences like (33) have been extensively discussed in the literature (see Gillon(1987,1990), Lasersohn(1989,1995:pp.132-141)), especially with the following example:

(34) Rodgers, Hammerstein and Hart wrote musicals.

(34) is certainly true although neither any of the three people mentioned wrote musicals by himself nor the three of them ever cooperated as a 3 members team. Sharp contrasts as the ones between (32) and (33) point in the direction of Lasersohn's approach to the the analysis of (34): its truth might well be due to a vagueness in the property of "collective action" of groups with a predicate like *to write musicals* (the team of three people can be assigned the property although it has never worked as one team). The status of so-called "neutral readings" as *separate* readings for plural sentences seems highly questionable.

The analysis of NP's with mixed *and/or* coordinations is similar to the analyses above. Consider for example the NP *Mary and Sue or John*, which has two syntactic representations:

(a) [ Mary and Sue ] or John

(b) Mary and [ Sue or John ]

Once again we get four possible interpretations for each structure:

| | | | |
|---|---|---|---|
| ($i_a$) | $[M \sqcap S] \sqcup J$ | ($i_b$) | $M \sqcap [S \sqcup J]$ |
| ($ii_a$) | $C([M \sqcap S] \sqcup J)$ | ($ii_b$) | $C(M \sqcap [S \sqcup J])$ |
| ($iii_a$) | $C(M \sqcap S) \sqcup C(J)$ | ($iii_b$) | $C(M) \sqcap C(S \sqcup J)$ |
| ($iv_a$) | $[C(M) \sqcap C(S)] \sqcup C(J)$ | ($iv_b$) | $C(M) \sqcap [C(S) \sqcup C(J)]$ |

All these readings differ from each other. Among the collective readings only ($ii_b$) is *cpl*, which means that only under the structure (b) can the following sentence (35) be acceptable, and its only interpretation is as paraphrased by (35'):

(35) Mary and Sue or John met.

(35') Mary and Sue met or Mary and John met.

This is of course an intuitive result.

One problematic kind of sentences, for which I am not sure if the present account proposes a satisfactory semantics, appears in Hoeksema(1983), as well as Landman(1989) and Schwarzschild-(1992). For example:

[21] See Dik(1968:p.53), for an historical survey of this issue. A more elaborate structure can also be used here (see for example Gazdar(1981)) but the point is that some parallel syntactic difference between the subjects in the two sentences should be reflected in the structural representation.

(36) [ Mary and John ] and [ Sue and Bill ] fought each other.

This sentence can be intuitively interpreted in three ways:

(36') a. Mary and John had a fight and Sue and Bill had a fight.
b. The four people had a fight.
c. The couple Mary and John fought the couple Sue and Bill, and vice versa.

Assuming that the reciprocated transitive predicate in (36) should be denoted by an intransitive *ccl* predicate of type $(et)t$, our treatment attributes the subject in this sentence two *cpl* readings:

(i) $\mathsf{C}(\mathrm{M}\sqcap\mathrm{J})\sqcap\mathsf{C}(\mathrm{S}\sqcap\mathrm{B})$

(ii) $\mathsf{C}(\mathrm{M}\sqcap\mathrm{J}\sqcap\mathrm{S}\sqcap\mathrm{B})$

No special assumptions are required to show that (i) yields a representation corresponding to the (36'a) interpretation and that (ii) corresponds to (36'b). The problematic interpretation for (36) is (36'c). One could argue that this interpretation refers only to one kind of the situations that verify (36'b) and therefore it should not have a distinct semantic representation. Empirically, this line of reasoning predicts that the following sentences should be verified by any situation verifying (36'c), simply because they are equivalent to (36'b):

(37) Mary, John, Sue and Bill fought each other.

(38) The four people fought each other.

This is a subtle judgement on (37) and (38), especially comparing it to (36) above: it is sure that (36) is entailed by (36'c), but it is less evident that this is the case also with (37) and (38).

An alternative way out of this problem is to follow Landman(1989) in developing a richer hierarchical group ontology. This should allow a "two-level" group reading as in (36'c). Arguments against this approach are given in Schwarzschild(1992), where it is proposed to attribute the apparent "group of groups" interpretation to the semantic/pragmatic function of the reciprocal. In this respect the recent systematic analysis of reciprocals in Dalrymple et al.(1994) might be extremely helpful. A comprehensive attempt to decide between the many possible alternatives to solve (or to disclaim) this problem is beyond the scope of the present enterprise.

## 4 Interlude: The Partee Triangle being squared

The leading idea in this paper is that no ambiguity of *and* should be stipulated in order to analyze the semantics of conjunction in collective sentences. The type shifting operator $\mathsf{C}$ is used to obtain collective readings without affecting the intersective semantic definition of *and*. One general question that the reader may find somewhat disturbing is the following: what is the status of the type shifting operator $\mathsf{C}$ among the type shifting operators discussed in semantic theories? Or even: isn't $\mathsf{C}$ only an arbitrary mechanism which cannot be justified on independent grounds? I believe that a simple answer to the first question can be given, which is a (negative) answer also to the second. This will be shown by examining the formal relations between $\mathsf{C}$ and other type shifting mechanisms from Partee(1986).

Partee develops a general conception of some of the main type shifting operators in semantic theory. Her treatment concentrates on the three active types for NP interpretation in popular extensions to Montague semantics and generalized quantifiers theory: $e$, $et$ and $(et)t$. The operators discussed are summarized in a simple diagram (figure 1), which I will follow van Benthem in calling *The Partee Triangle* [22].

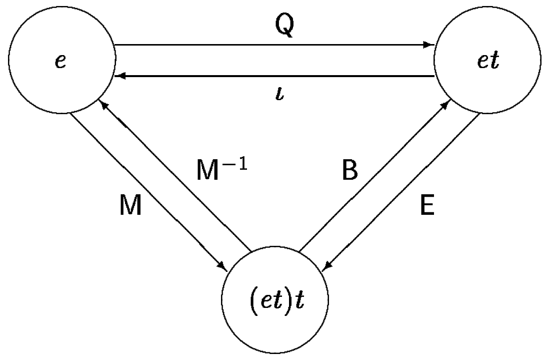


Figure 1: The Partee Triangle

In this diagram $\mathsf{Q}$ stands for Q*uine*, $\iota$ for the *iota* operator, $\mathsf{E}$ for the *e*xistential operator, $\mathsf{B}$ for Montague's semantic definition for the auxiliary verb *to be* and $\mathsf{M}/\mathsf{M}^{-1}$ for Montague raising/lowering. These operators are defined as follows:

$$\mathsf{Q} \overset{def}{=} (\lambda x.\lambda y.y = x) \qquad \iota \overset{def}{=} \lambda P.\begin{cases} a & P = (\lambda y.y = a) \\ \text{undefined} & \text{otherwise} \end{cases}$$

$$\mathsf{E} \overset{def}{=} \lambda A.\lambda P.\exists x(P(x) \wedge A(x)) \qquad \mathsf{B} \overset{def}{=} \lambda Q.\lambda x.Q(\lambda y.y = x)$$

$$\mathsf{M} \overset{def}{=} \lambda x.\lambda P.P(x) \qquad \mathsf{M}^{-1} \overset{def}{=} \lambda Q.\begin{cases} a & Q = \mathsf{M}(a) \\ \text{undefined} & \text{otherwise} \end{cases}$$

A nice property of this diagram is its commutativity features:

$\iota \circ \mathsf{Q} = id$ [23] $\qquad \mathsf{B} \circ \mathsf{E} = id \qquad \mathsf{M}^{-1} \circ \mathsf{M} = id$ [24]

$\mathsf{E} \circ \mathsf{Q} = \mathsf{M} \qquad \mathsf{B} \circ \mathsf{M} = \mathsf{Q} \qquad \mathsf{B} \circ \iota = \mathsf{M}^{-1} \qquad \ldots$

It is well known that the type shifting operators in Partee's diagram can be given polymorphic definitions. For example: the Montague Raising operator $\mathsf{M}$ can be generalized to type $\tau((\tau\sigma)\sigma)$ for any types $\tau, \sigma$: $\lambda X_\tau.\lambda Y_{\tau\sigma}.Y(X)$ (see van Benthem(1991:p.30). This is the semantics for general type lifting which is derivable in the Lambek calculus. The Quine operator $\mathsf{Q}$ can be generalized to type $\tau(\tau t)$, and similarly the other operators. From this point of view, one may like to reduce the number of operators between the different types to a minimal arsenal of polymorphic definitions. Such generalizations might be obtained more easily if we consider more types in addition to the

[22] Figure 1 is not the original triangle introduced by Partee. I choose to ignore the operator THE in Partee's diagram (I only use the more general $\mathsf{E}$) as well as the (extensionalized) intensional operators *pred* and *nom*. I use also some different names for the operators, which might be more convenient here.

[23] For every type $\tau$, $id_{\tau\tau} = \lambda X_\tau.X$

[24] The converses do not hold: $\mathsf{Q} \circ \iota \neq id$, $\mathsf{E} \circ \mathsf{B} \neq id$, and $\mathsf{M} \circ \mathsf{M}^{-1} \neq id$. This is because $\iota$ and $\mathsf{M}^{-1}$ are not total on their domains and the total function $\mathsf{B}$ is not one to one: it attributes the same value to quantifiers with the same singletons.

three vertices of the Partee triangle. The analysis of coordination proposed in this paper suggests that it would be linguistically meaningful to consider in the diagram also the type $((et)t)t$ as a vertex [25] and the operator $\mathsf{C}$ as the arc leading to it from $(et)t$.

Polymorphically $\mathsf{C}$ can be written in full lambda notation as follows:

$$\mathsf{C}_{(\tau t)((\tau t)t)} \;=\; \lambda X_{\tau t}.\lambda Y_{\tau t}.\exists Z_{\tau}(min(X)(Z) \wedge Y(Z))$$

In this notation it is easy to notice the following

**Fact**: $\mathsf{C}_{(et)((et)t)} \;=\; \mathsf{E}$

**Proof**: A more convenient notation for $\mathsf{C}$ on $et$ is:

$$\mathsf{C}_{(et)((et)t)} = \lambda A.\lambda P.\exists x(min(A)(x) \wedge P(x))$$

For $min$ on $et$ we get:

$$\begin{aligned}
&min_{(et)(et)} \;=\\
&\lambda P.\lambda y.P(y) \wedge \forall z \sqsubseteq y(P(y) \rightarrow z = y) \;=\\
&\lambda P.\lambda y.P(y) \wedge \forall z = y(P(y) \rightarrow z = y) \;=\\
&\lambda P.\lambda y.P(y) \;=\; \lambda P.P \;=\; id_{(et)(et)}
\end{aligned}$$

This means that for every predicate $P_{et}$ we get: $min(P) = P$. Then we get:

$$\mathsf{C}_{(et)((et)t)} \;=\; [\lambda A.\lambda P.\exists x(A(x) \wedge P(x))] \;=\; \mathsf{E}$$

The conclusion from this result is that the polymorphic definition for $\mathsf{C}$ reduces to the existential operator $\mathsf{E}$ for $et$. In other words, $\mathsf{C}$ is a generalization of the existential determiner operator $\mathsf{E}$. [26] Is there a way to get also $\mathsf{Q}$ into the picture and to derive it from the same generalized definition for $\mathsf{C}$? I believe there is, but this belief is based on some unorthodox notational variant. See footnote for details. [27]

Whether $\mathsf{C}$ can be easily reduced to $\mathsf{Q}$ or not, the fact shown above means that we can add the type $((et)t)t$ to the Partee diagram at a very low theoretical cost: the additional operator $\mathsf{C}$ in the picture actually reduces to the well-motivated existential operator $\mathsf{E}$. I consider this a somewhat

[25] The idea to look also in this "type theoretical corner" for plurality was proposed in van Benthem(1989:pp.36-37), attributing it to Henk Verkuyl.

[26] One may reasonably wonder why the $min$ operator is the logical possibility chosen to extend $\mathsf{E}$ among the many operators of type $(\tau t)(\tau t)$ that reduce to $id$ on $et$ (e.g. $id$ itself, $max$). Indeed, $min$ should be independently motivated, which deserves a separate explanation that involves extending substantially the current framework for other linguistic domains. I defer presentation of these developments to another occasion.

[27] Let us denote $\mathsf{E}$ in terms of a generalized set membership relation $\sqsubseteq\!\!\!-$ (a generalization of the set theoretic $\in$):

$$\mathsf{E} \overset{def}{=} \lambda A.\lambda P.\exists x(x \,\underline{\in}\, P \wedge x \,\underline{\in}\, A)$$

Where $\underline{\in}$ is defined as follows:

$$X_{\tau_1} \underline{\in} Y_{\tau_2} \overset{def}{=} \begin{cases} Y(X) & \tau_2 = \tau_1 t \\ Y = X & \tau_2 = \tau_1 \end{cases}$$

We get for type $e$:

$$\mathsf{E} = [\lambda x.\lambda y.\exists z(z \,\underline{\in}\, y \wedge z \,\underline{\in}\, x)] = [\lambda x.\lambda y.\exists z(z = y \wedge z = x)] = [(\lambda x.\lambda y.y = x)] = \mathsf{Q}$$

This result shows that under a certain definition for $\underline{\in}$ we get $\mathsf{E}$ reduced to $\mathsf{Q}$ on $e$, so $\mathsf{C}$ is generally the required type lifting operator from $e$, $et$ and $(et)t$. The definition for $\underline{\in}$ is based on the intuition that set membership reduces to equality when both arguments of the relation are of the same type. I am not sure whether this intuition is mathematically solid and therefore it should be further supported by some independent theoretical motivation.

surprising finding: recall that $\mathsf{C}$ is linguistically motivated in order to model coordinations in collective contexts. The operator $\mathsf{E}$ is motivated on entirely independent linguistic grounds. The reduction for type *et* of the former operator to the latter is an unexpected observation on the relations between the "natural" phenomena of existential quantification and collectivization in human languages.

We should not expect a general inverse operator for $\mathsf{C}$ from $((et)t)t$ to $(et)t$ because $\mathsf{C}$ is not a one-to-one function: it produces the same outcome for different quantifiers that have the same minimum. Therefore, in general one may look for the following pattern of polymorphic operators $\alpha, \beta$ for the four extensional types discussed:

$$\begin{tikzcd} e \arrow[r, shift left, "\alpha"] & et \arrow[l, shift left, "\beta"] \arrow[r, shift left, "\alpha"] & (et)t \arrow[l, shift left, "\beta"] \arrow[r, "\alpha"] & ((et)t)t \end{tikzcd}$$

(For the present discussion we can ignore the operators $\mathsf{M}$ and $\mathsf{M}^{-1}$, which are definable using the other operators in the Partee triangle).

In the proposal above I have only shown the following partial pattern:

$$\begin{tikzcd} e \arrow[r, shift left, "\mathsf{C}\,?"] & et \arrow[l, shift left, "\iota"] \arrow[r, shift left, "\mathsf{C}"] & (et)t \arrow[l, shift left, "\mathsf{B}"] \arrow[r, "\mathsf{C}"] & ((et)t)t \end{tikzcd}$$

In the case that a broader perspective is achievable I am not able to point on it at the present. The question whether only two polymorphic type shifting principles can derive the extended diagram above (and therefore also the Partee triangle) is left open at this stage.

To summarize, considering the logical status of $\mathsf{C}$, it was observed that this is one of the natural candidates for extending Partee's diagram also for the type $((et)t)t$. This result gives further motivation to extend also the theory of coordination proposed to additional cases.

## 5 Coordination of singular quantified NP's

A natural range of facts to check the adequacy of the account developed above comes from coordinations of quantified NP's. Sentences like (39) and (40) pose an important challenge to any theory of coordination and plurality.

(39) Every woman and every man met.

(40) Mary and some man or some woman weigh 100 Kg.

In this section I will analyze this challenge in some detail and show a possible way of extending the analysis to treat these cases using common assumptions about QNP "scope" and indefinites.

### 5.1 Universal QNP coordination

#### 5.1.1 Some problems for previous approaches

Consider the following sentences, which contain the same QNP conjunction as a subject:

(41) Every woman and every man slept.

(42) Every woman and every man praised each other. [28]

Empirically there is an important distinction between the ways these two sentences are interpreted. To see this consider first the following rough paraphrases for their prominent readings:

(41') Every woman slept and every man slept.

(42') For every couple that consists of a woman $x$ and a man $y$, $x$ and $y$ praised each other.

Intuitively, (42) is making a statement about certain couples of individuals - the couples of a woman and a man. (41) does not: it expresses a certain statement about each woman and about each man *independently*. To see that this is a true semantic difference consider somewhat more vivid examples:

(43) Every tall girl in class A and every quick boy in class B should join our basketball team.

(44) Every tall girl in class A and every quick boy in class B should praise each other.

Now consider a situation in which class B coincidentally happens to include only slow boys. Sentence (43) is contingent- it requires that every tall girl in class A joins the team. By contrast, (44) becomes automatically true: it does not require anything from boys in class B (there are no quick ones) and it also does not require anything from tall girls in class A (they have no quick boys in class B to praise).

Generally, if $VP_{\mathbf{d}}$ is a distributive predicate and $VP_{\mathbf{c}}$ is a collective predicate then the inference in ($I_1$) is incorrect, whereas the inference in ($I_2$) is valid for any nominals $N'_1$, $N'_2$ (symmetrically also for $N'_2$ in the antecedent):

$$(I_1)\quad \frac{\text{No } N'_1 \text{ exists}}{\#\ \text{Every } N'_1 \text{ and every } N'_2\ VP_{\mathbf{d}}}$$

$$(I_2)\quad \frac{\text{No } N'_1 \text{ exists}}{\text{Every } N'_1 \text{ and every } N'_2\ VP_{\mathbf{c}}}$$

I claim that this central distinction between the inferential status of (41)/(43) and (42)/(44) cannot be reflected in a compositional theory as given in section 3 that simply extends an intersective treatment of conjunction without using some version of Quantifying-in. Neither is it reflected in

[28] I henceforth sometimes use overtly reciprocated predicates as representatives for *ccl* predicates, which is more convenient to exemplify the main point. The same effect exists with "lexically reciprocated" verbs like *to meet* as in (39) but probably with some variations among speakers that obscure the distinction. In Arabic there is an easy way to facilitate the processing of such sentences also with verbs like *to meet*. The following sentence in standard Arabic was informed to have no ambiguity or vagueness whatsoever due to the suffix *ya* which signals couples, not any plural number as in English:

(i) kul walad w kul bint iltaqa-*ya*
every boy and every girl met-PLU(couple)
"Every couple that consists of a boy and a girl had a meeting."

non-Boolean treatments of conjunction. The two kinds of theories have complementary difficulties: while the first kind fails to capture the meaning of the collective predication in (42)/(44), the second is inadequate with respect to the meaning of the distributive (41)/(43).

Consider first the Boolean treatment of a quantificational conjunction:

$$[\![\text{every woman and every man}]\!] = \\ (\lambda P.\mathbf{woman'} \subseteq P) \sqcap (\lambda P.\mathbf{man'} \subseteq P) = \\ \lambda P.\mathbf{woman'} \subseteq P \wedge \mathbf{man'} \subseteq P$$

In this representation the conjunction denotes the set of properties shared by all women and all men. It is well-known that this works fine for (41):

$$[\lambda P.\mathbf{woman'} \subseteq P \wedge \mathbf{man'} \subseteq P]\mathbf{sleep'} \Leftrightarrow \\ \mathbf{woman'} \subseteq \mathbf{sleep'} \wedge \mathbf{man'} \subseteq \mathbf{sleep'} \Leftrightarrow \\ \forall x(\mathbf{woman'}(x) \rightarrow \mathbf{sleep'}(x)) \wedge \forall x(\mathbf{man'}(x) \rightarrow \mathbf{sleep'}(x))$$

This is exactly the meaning of (41) as paraphrased in (41'). However, when we get to (42) we face a serious problem: in the Boolean representation for the conjunction we lose important information - the "coupling" of women and men required for modeling the meaning of the sentence. In other words: how can a procedure on this representation reconstruct such couples from a set in the conjoined quantifier, which contains women and men together (as well as other things, possibly)? It must use information on the internal components of the coordination - a sad conflict with compositionality.

The non-Boolean view on conjunction, following Link, involves the i-sum or group formation operators in the interpretation of such NP's. I choose to exemplify the difficulty for this approach using Hoeksema's account of quantifier conjunction. Similar problems appear for other non-Boolean approaches. Hoeksema uses the following definition for conjunction of $(et)t$ quantifier types [29]:

$$\lambda Q_1.\lambda Q_2.\lambda P.Q_1(\lambda x.Q_2(\lambda y.P(\{x,y\}_g)))$$

where $\{\}_g$ is the group formation operator on the $e$ domain.

This definition is successful when used for modeling the collective predication in (42). It derives the following formula:

$$\forall x(\mathbf{man'}(x) \rightarrow \forall y(\mathbf{woman'}(y) \rightarrow \mathbf{meet'}(\{x,y\}_g)))$$

In accordance with our intuitions concerning (42), this formula is trivially true when there are no women or no men (cf. ($I_2$)). However, we get a similar formula for representing (41):

(45) $\forall x(\mathbf{man'}(x) \rightarrow \forall y(\mathbf{woman'}(y) \rightarrow \mathbf{sleep'}(\{x,y\}_g)))$

This formula is automatically true in situations with no women or no men, unlike (41). This is counter intuitive. It is important to emphasize that distributivity mechanisms proposed in the literature do not save this undesired result. If we use a distributivity operator on the predicate as commonly done in the Link tradition, the problem with (45) does not disappear because this operator quantifies lower than the QNP's in the sentence:

[29] Importantly, Hoeksema shows how to derive this definition in the non-directional Lambek Calculus LP using van Benthem's semantics (van Benthem(1986,1991)). Hoeksema argues that because this definition is derivable in LP from the basic definition for non-Boolean conjunction it is not stipulated *ad hoc* (Hoeksema(1988:p.35)). Considering the other features of LP this argument looks less impressive because LP cannot derive other more elementary cases of coordination. For example: even *Boolean* predicate coordination is non-derivable in LP from propositional coordination (van Benthem(1991:p.40)). However, as to be stressed below, the fact that LP is successful in lifting non-Boolean conjunction is not coincidental. It is due to the conditionalization axiom of LP, which will be also used in what follows.

(45') $\forall x(\mathbf{man}'(x) \rightarrow \forall y(\mathbf{woman}'(y) \rightarrow \mathbf{sleep}^D(\{x,y\}_g))) \Leftrightarrow$
$\forall x(\mathbf{man}'(x) \rightarrow \forall y(\mathbf{woman}'(y) \rightarrow [\lambda z.\forall z' \in_g z(\mathbf{sleep}'(z'))](\{x,y\}_g)))$

Obviously, (45') is also automatically true when no woman or no man exists.

If we follow Hoeksema's proposal to consider quantifier conjunction as ambiguous between Boolean and non-Boolean interpretations, then we can of course analyze (41) as above using Boolean conjunction. Still, as Hoeksema notes[30], nothing predicts why the conjunction is Boolean in (41) and not non-Boolean. In addition to the methodological problems discussed above, this is one of the *empirical* dangers for theories assuming lexical ambiguity of *and*. Stipulating ambiguity can do the job for many cases, but it often also overgenerates.

Two general negative conclusions may be drawn from the points made above:

1. It is unrecommended to use a Boolean conjunction of universal quantifiers in the semantic representation for collective sentences like (42).

2. It is unrecommended to use i-sums, groups or other amalgamating mechanisms on the semantic representation for the QNP's in distributive sentences like (41).

The second conclusion is further supported by the following contrast between the possible number agreement in distributive and collective sentences with QNP conjunction:

(46) Every woman and every man *is/are* sleeping.

(47) Every woman and every man **is/are* meeting.

We see that English allows singular QNP conjunctions that are interpreted distributively to bear the singular number agreement with the verb as in (46), whereas collective predications allow only plural agreement for such NP's as in (47). In a way, this contrast suggests that (41) and (46) are cases of "singular" quantification while the predicate in (42) or (47) applies to "pluralities". This surprising fact should be explained independently (perhaps using Hoeksema(1983)'s notion of atomicity). However, even unexplained it seems to give a clue for the direction of treating the problem.

### 5.1.2 The collectivity operator reintroduced

As far as I know, the questions raised above are problematic for any existing theory of coordination and collectivity. A simple minded extension of the theory proposed in section 3 is no exception. Let us see what problems arise if the $\mathsf{C}$ operator is used too freely with singular universal QNP's and how these difficulties can be prevented.

Reconsider (44), restated here:

(48) Every woman and every man met.

The conjuncts in the subject of this sentence are analyzed as denoting the following quantifier terms of type $(et)t$: $\lambda P.\mathbf{woman}' \subseteq P$, $\lambda P.\mathbf{man}' \subseteq P$. The predicate is as before a collective predicate of type $(et)t$. Following the analysis in section 3, the type mismatch between the predicate and the conjunction of the quantifiers is to be resolved using the operator $\mathsf{C}$. However, as stressed above, a collectivization of the quantifiers along the lines of the analysis in section 3 would result in undesired interpretations. Consider for example a model with $\mathbf{woman}' = \{\mathbf{m}', \mathbf{s}'\}$, $\mathbf{man}' = \{\mathbf{j}', \mathbf{b}'\}$. We get two interpretations for the subject:

[30] "A major unsolved problem with the type lifting [of non-Boolean conjunction] approach is that we must block the use of type lifting in situations where it is not needed." (Hoeksema(1988:p.35))

1. $\mathsf{C}((\lambda P.\mathbf{woman'} \subseteq P) \sqcap (\lambda P.\mathbf{man'} \subseteq P)) =$
   $\mathsf{C}(\lambda P.\mathbf{woman'} \subseteq P \wedge \mathbf{man'} \subseteq P) =$
   $\mathsf{C}(\lambda P.\{\mathbf{m'}, \mathbf{s'}, \mathbf{j'}, \mathbf{b'}\} \subseteq P) =$
   $\lambda \mathcal{P}.\exists P(P \in min(\lambda P.\{\mathbf{m'}, \mathbf{s'}, \mathbf{j'}, \mathbf{b'}\} \subseteq P) \wedge \mathcal{P}(P)) =$
   $\lambda \mathcal{P}.\mathcal{P}(\{\mathbf{m'}, \mathbf{s'}, \mathbf{j'}, \mathbf{b'}\})$

2. $\mathsf{C}(\lambda P.\mathbf{woman'} \subseteq P) \sqcap \mathsf{C}(\lambda P.\mathbf{man'} \subseteq P) =$
   $\mathsf{C}(\lambda P.\{\mathbf{m'}, \mathbf{s'}\} \subseteq P) \sqcap \mathsf{C}(\lambda P.\{\mathbf{j'}, \mathbf{b'}\} \subseteq P) =$
   $\lambda \mathcal{P}.\mathcal{P}(\{\mathbf{m'}, \mathbf{s'}\}) \sqcap \lambda \mathcal{P}.\mathcal{P}(\{\mathbf{j'}, \mathbf{b'}\}) =$
   $\lambda \mathcal{P}.\mathcal{P}(\{\mathbf{m'}, \mathbf{s'}\}) \wedge \mathcal{P}(\{\mathbf{j'}, \mathbf{b'}\})$

This means that (48) would be analyzed either as claiming that one meeting took place between all the women and the men simultaneously or as claiming that the women met each other and so did the men. Neither of these readings seems as the right meaning of the sentence (although the first entails it).

The problem occurs because we apply C with no attention to the semantic nature of the quantifier. More specifically, C should not apply to coordinations with a QNP like *every woman*, because then it "collectivizes" individuals from the denotation of the QNP. Sentences like (48) show that in a sense, such quantifiers in English remain "distributive" even when they quantify over individuals that are finally "collectivized" with other individuals. We conclude that C should be restricted to guarantee that it does not apply to NP's with a "distributive" conjunct– a singular NP whose determiner is at least *every*, *each*, or *no*.[31] There is an independent motivation for such a restriction as observed in the following sentences:

(49) a. ?* Every woman gathered.
     b. All women gathered.

(50) a. ?* No woman gathered.
     b. No women gathered.

The singular NP's in the a sentences above do not allow collective predicates, by contrast to the corresponding plural b sentences. It is evident that whatever our notion of collectivization is, we cannot allow it to apply to singular QNP's as in (49a)-(50a). This is one way in which C should be restricted when applied to arbitrary generalized quantifiers. [32] The implementation of such a restriction is a general issue in theories of plurality which I will not discuss here (see e.g. Roberts(1987), van der Does(1993) for proposals). For our purposes, it suffices to state this independently motivated constraint as a rough condition in (**P**), which is informally modified as follows:

(**P'**) The C operator is applicable for lifting the denotation of only "non distributive" NP's.

The exact definition of the notion "non distributive NP" is beyond the scope of this paper. For the moment it suffices to define as distributive those singular NP's whose determiner is *every*, *each* and *no* and those NP's which are coordinations with at least one distributive NP conjunct.

[31] See Roberts(1987:chapter 3) for a survey of some proposals for a distributive/collective typology of determiners.

[32] Another restriction is necessary if C is to be used in a theory of *plural* quantification. For one example, C should never apply to downward monotone quantifiers as in a sentence like ?*Less than four girls met.* Although we cannot discuss here the exact meaning of such sentences it is clear that C does not yield an acceptable result. The minimum of a downward monotone quantifier is the empty set and thus the sentence is interpreted as $\mathbf{meet}'(\emptyset)$. This seems absurd.

The conclusion from this discussion is that adding C to a system of universal QNP interpretation does not necessarily *over*generate because its application should be restricted by independently motivated principles. But can our treatment generate at all the collective readings which were shown to be problematic to the intersective analysis of conjunction? Without further mechanisms the answer is negative, as claimed above. The answer is positive once we consider also standard mechanisms of scope.

### 5.1.3 Quantifying-in and the collectivity operator

As shown above, the analysis of universal QNP conjunction is problematic both for the Boolean and for the non-Boolean approaches. The Boolean approach seems impossible in collective contexts if we use a conjunction of universal quantifiers. However, using the mechanism of Quantifying-in (henceforth $Q_{in}$), we can analyze (48) correctly:[33] The representation for the subject NP of (48) after $Q_{in}$ applies to both conjuncts is:

$$[\![\text{she}_1 \text{ and he}_2]\!]^{34} = (\lambda P.P(x_1)) \sqcap (\lambda P.P(x_2)) = \lambda P.P(x_1) \wedge P(x_2)$$

C can apply to this term the way it applies to terms without free variables like $\lambda P.P(\mathbf{m}') \wedge P(\mathbf{j}')$:

$$\mathsf{C}(\lambda P.P(x_1) \wedge P(x_2)) = \lambda \mathcal{P}.\exists A(A \in min(\lambda P.P(x_1) \wedge P(x_2)) \wedge \mathcal{P}(A)) = \lambda \mathcal{P}.\mathcal{P}(\{x_1, x_2\})^{35}$$

The rest of the derivation is standard in Montague semantics:

application: $\mathbf{meet}'(\{x_1, x_2\})$
$\lambda$ abstraction: $\lambda x_1.\mathbf{meet}'(\{x_1, x_2\})$
$Q_{in}$ of $[\![\text{every woman}]\!]$: $(\lambda P.\mathbf{woman}' \subseteq P)(\lambda x_1.\mathbf{meet}'(\{x_1, x_2\})) \Leftrightarrow$
$\forall x_1[\mathbf{woman}'(x_1) \rightarrow \mathbf{meet}'(\{x_1, x_2\})]$
$\lambda$ abstraction: $\lambda x_2.\forall x_1[\mathbf{woman}'(x_1) \rightarrow \mathbf{meet}'(\{x_1, x_2\})]$
$Q_{in}$ of $[\![\text{every man}]\!]$: $(\lambda P.\mathbf{man}' \subseteq P)(\lambda x_2.\forall x_1[\mathbf{woman}'(x_1) \rightarrow \mathbf{meet}'(\{x_1, x_2\})]) \Leftrightarrow$
(51) $\forall x_2[\mathbf{man}'(x_2) \rightarrow \forall x_1[\mathbf{woman}'(x_1) \rightarrow \mathbf{meet}'(\{x_1, x_2\})]]$

Symmetrically we get another interpretation for the other order of applying the quantifiers:

$$\forall x_1[\mathbf{woman}'(x_1) \rightarrow \forall x_2[\mathbf{man}'(x_2) \rightarrow \mathbf{meet}'(\{x_1, x_2\})]]$$

These two equivalent formulas represent correctly the meaning of (48). We conclude that a mechanism like $Q_{in}$, which is independently motivated for analyzing effects of "wide scope" readings for QNP's can derive the correct truth conditions for (48) without having to change anything in the definition of Boolean conjunction. This is of course encouraging. However, there is also some bad news.

[33] Quantifying-in is used here only as one well known and well defined way of giving "scope" to quantified NP's. Similar results can be achieved using other operations for the same effect as Quantifier Storage or Quantifier Raising.

[34] I henceforth use the notation she$_i$, he$_i$ or they$_i$ for "Quantified-in" NP's. There is no difference between the ways these symbols are interpreted - the distinction between them is only for convenience. The reason for this notational variation is my objection to Montague's assumption that such abstract "NP's" identify with lexical pronouns. This notation suggests the important similarity between Montague's $Q_{in}$ and the QR transformation in GB theory. Also the traces created by the latter procedure are empty categories.

[35] $\{x_1, x_2\}$ can be a singleton in assignments that satisfy $x_1 = x_2$. In such cases we get exactly the same situation as with conjunctions of coreferential NP's. See footnote 20 and section 6.

### 5.1.4 A theoretical clash?

The analysis above of sentences like (48) involves one highly undesired feature: quantifying-in of the conjuncts separately in a coordination like *every woman and every man* seems to violate the Coordinate Structure Constraint (CSC). According to this descriptive generalization, familiar since Ross(1967), an element within a coordinate structure cannot be overtly extracted to a syntactic position outside the coordination. For example, in GB theory CSC comes to describe the unacceptability of sentences like:

(52) * Who$_1$ did Mary see John and $e_1$?

where the *wh* clause cannot be moved from its position within a coordination, unlike its normal behaviour (i.e. *Who$_1$ did Mary see* $e_1$?)

That CSC probably holds in the same way also with respect to "covert scope" of QNP's was noticed in Lakkof(1970), and further discussed in Rodman(1976), Cooper(1978), Chierchia(1988) and Ruys(1992:pp.31-39), among others. One example from Rodman(1976) for this effect is that (53) does not have the reading (53a), with the existential quantifier having "intermediate scope" inbetween the two universal quantifiers of the subject coordination.

(53) Every dog or every cat loves a woman.
a. * $\forall x(\mathbf{dog}'(x) \rightarrow \exists z(\mathbf{woman}'(z) \wedge \forall y(\mathbf{cat}'(y) \rightarrow (\mathbf{love}'(z,x) \vee \mathbf{love}'(z,y)))))$

CSC is not only a valid restriction on the interactions between QNP coordinations and other quantificational elements in the sentence. Also for the main topic of this paper- the interpretation of NP coordination itself, CSC seems important. Reconsider (41) and the analysis it gets using $\mathrm{Q_{in}}$ freely for both conjuncts.

(54) Every woman and every man slept.
a. $[\![\text{she}_1 \text{ and he}_2 \text{ slept}]\!] = \mathbf{sleep}'(x_1) \wedge \mathbf{sleep}'(x_2)$
$\mathrm{Q_{in}}$ of $[\![\text{every woman}]\!]$: $\forall x_1(\mathbf{woman}'(x_1) \rightarrow (\mathbf{sleep}'(x_1) \wedge \mathbf{sleep}'(x_2)))$
$\mathrm{Q_{in}}$ of $[\![\text{every man}]\!]$: $\forall x_2(\mathbf{man}'(x_2) \rightarrow (\forall x_1(\mathbf{woman}'(x_1) \rightarrow (\mathbf{sleep}'(x_1) \wedge \mathbf{sleep}'(x_2)))))$

The derivation is completely parallel to the derivation of the desired reading (51) but (54) is exactly the same reading (45') derived by Hoeksema's mechanism criticized above. We seem to be facing an embarrassing situation: the mechanism required for deriving the correct collective reading seems to violate CSC and in addition it derives the reading we wanted to eliminate at the first place!

Let us reflect for a while on the dilemma, summarizing the complex meta-theoretical puzzle as in table 2.

It seems that an attempt to follow some solid and innocent looking assumptions led to a theoretical dead end. Namely, starting from the assumptions

- Conjunction is unambiguously intersective.
- Universal QNP's are standardly interpreted as universal $(et)t$ quantifiers.
- CSC restricts scope mechanisms.

we have reached a point where we cannot get further because of the problem of collective predication with universal QNP coordination. Which part of these assumptions should be renounced?

Table 2: Some problems for theories with universal QNP conjunction

| | Non-Boolean Conjunction (Hoeksema) | Boolean Conjunction with the optional C operator | |
|---|---|---|---|
| | | without $Q_{in}$ | free $Q_{in}$ (no CSC) |
| Successful | collectivity | distributivity | distributivity + collectivity |
| Problematic | distributivity (**u**+**o**) | collectivity (**u**) | distributivity (**o**) |

**u** = undergeneration  **o** = overgeneration  **u**+**o** = wrong generation

### 5.1.5 A possible resolution

I believe a correct answer to the question can be: "actually none". The reason is that, while the first two assumptions above are completely well-defined, the third assumption should be given a precise content before considering its exact implications. The common practice in the GB literature on Logical Form is to assume that Quantifier Raising operates in the same way overt extraction applies - via syntactic movement. However, when semantics is involved as in the case of QNP "scopal" readings there are certain possibilities to reanalyze the "wide scope" derivation in (51) in a way which does not strictly correspond to surface island violations. Such an analysis appears in some works of the categorial semantic framework (see Carpenter(1994b) for an extensive overview) where *hypothetical reasoning* as in the Lambek Calculus is used as a part of the axiomatic mechanism. If we allow hypothetical reasoning then (48) can be analyzed also as follows:

(55) Every woman and every man met.

$[\![\text{she}_1 \text{ and } \text{he}_2]\!] \;=\; \lambda P.P(x_1) \wedge P(x_2)$

$\mathsf{C}([\![\text{she}_1 \text{ and } \text{he}_2]\!]) \;=\; \lambda \mathcal{P}.\mathcal{P}(\{x_1, x_2\})$

(**a**) Hypothetical assumption of $\mathcal{A}$ : $[\lambda \mathcal{P}.\mathcal{P}(\{x_1,x_2\})](\mathcal{A}) \;\Leftrightarrow\; \mathcal{A}(\{x_1,x_2\})$

$Q_{in}$ $[\![\text{every woman}]\!]$: $\forall x_1(\mathbf{woman}'(x_1) \rightarrow \mathcal{A}(\{x_1,x_2\}))$

$Q_{in}$ $[\![\text{every man}]\!]$: $\forall x_2(\mathbf{man}'(x_2) \rightarrow \forall x_1(\mathbf{woman}'(x_1) \rightarrow \mathcal{A}(\{x_1,x_2\})))$

(**b**) Withdrawal of $\mathcal{A}$: $\lambda \mathcal{A}.\forall x_2(\mathbf{man}'(x_2) \rightarrow \forall x_1(\mathbf{woman}'(x_1) \rightarrow \mathcal{A}(\{x_1,x_2\})))$

Predication: $[\lambda \mathcal{A}.\forall x_2(\mathbf{man}'(x_2) \rightarrow \forall x_1(\mathbf{woman}'(x_1) \rightarrow \mathcal{A}(\{x_1,x_2\})))](\mathbf{meet}')$

$\forall x_2(\mathbf{man}'(x_2) \rightarrow \forall x_1(\mathbf{woman}'(x_1) \rightarrow \mathbf{meet}'(\{x_1,x_2\})))$

In this derivation $Q_{in}$ applies *before* predication in the sentence applies. Thus, a denotation for the NP is derived in the conditionalization stage (**b**) after $Q_{in}$ has applied *internally* within the coordination. In this way the conjuncts do not get sentential scope as in the traditional application of $Q_{in}$ in (51), so in a sense they do not escape the coordinate structure. Therefore, there should be a way to state the CSC in a way the derivation in (55) does not violate it.

A surprising evidence in favour of the above strategy is given in Roberts(1987:p.166):

(56) Every professor and every student of his are writing a paper together.

According to Roberts, this example (attributed to Mats Rooth) shows that the first conjunct should be analyzed as having "scope" over the whole sentence, in a clear violation of the CSC. However, the analysis given above applies step by step (revising the order of the $Q_{in}$ steps) to get the correct bound pronoun reading of (56):

$\mathsf{C}([\![\text{she}_1 \text{ and he}_2]\!]) \;=\; \lambda\mathcal{P}.\mathcal{P}(\{x_1, x_2\})$
Assumption of $\mathcal{A}$ : $\mathcal{A}(\{x_1, x_2\})$
$\mathrm{Q_{in}}$ $[\![\text{every student of his}_1]\!]$: $[\lambda P.\lambda x_2.\mathbf{student\_of'}(x_1, x_2) \subseteq P](\lambda x_2.\mathcal{A}(\{x_1, x_2\})) \Leftrightarrow$
$\forall x_2(\mathbf{student\_of'}(x_1, x_2) \rightarrow \mathcal{A}(\{x_1, x_2\}))$
$\mathrm{Q_{in}}$ $[\![\text{every professor}]\!]$: $[\lambda P.\mathbf{prof'} \subseteq P][\lambda x_1.\forall x_2(\mathbf{student\_of'}(x_1, x_2) \rightarrow \mathcal{A}(\{x_1, x_2\}))] \Leftrightarrow$
$\forall x_1[\mathbf{prof'}(x_1) \rightarrow \forall x_2(\mathbf{student\_of'}(x_1, x_2) \rightarrow \mathcal{A}(\{x_1, x_2\}))]$
Withdrawal of $\mathcal{A}$ and predication:
$\forall x_1[\mathbf{prof'}(x_1) \rightarrow \forall x_2(\mathbf{student\_of'}(x_1, x_2) \rightarrow \mathbf{write\_a\_paper'}(\{x_1, x_2\}))]$

It seems then that a principled use of hypothetical reasoning can provide a way out of the dilemma: for the analysis of (48) the quantifiers do not necessarily have to have sentential scope over the dominating coordinate NP so they do not separately partake in scope relations with other quantifiers in the sentence in cases like (53).

It should be noted that it was exactly hypothetical reasoning axiomatized into the Lambek Calculus that enabled Hoeksema(1988) to derive the non-Boolean quantifier conjunction in the LP system. Thus, the desired results of Hoeksema's treatment of the collective cases are obtained in the present proposal using the logical assumptions in his analysis plus the standard assumption on scope mechanisms minus the stipulative assumption on the ambiguity of *and*.

### 5.1.6 Back to the distributive case

Because of allowing the derivation in (55) we automatically face the problems of Hoeksema's definition when we deal with the distributive case (41). However, since (55) is derived using a quantifier scope mechanism and not by the non-Boolean stipulation I think we have a clue for eliminating such readings coming from recent works on quantifiers scope (Fox(1995),Reinhart(1995)).

In relevance to the present discussion, one proposal by Reinhart is especially interesting. Reinhart suggests that scope mechanisms for NP interpretation might involve violations of economy constraints. This is supposed to be the reason for the "markedness" of many wide scope construals if not supported by some need to eliminate the narrow scope reading (e.g. pragmatic cooperative principles, world knowledge, etc.). Wide scope, according to Reinhart, might be allowed only as a non-economical "last resort" operation. If this approach is tenable, then the account above predicts that while (41) involves only the standard "in situ" scope for the conjoined NP's, in (42) the mechanism forces "wide scope" as a last resort: recall that **(P')** eliminates narrow scope construals of the quantifiers in this case because $\mathsf{C}$ cannot apply to them.

This kind of consideration, although not very common in the semantic literature, was seminally proposed also in Keenan & Faltz(1985:p.22). It offers the hope that if further developed, it might allow eliminating the reminder of overgeneration in the system sketched above due to a general account of economy restrictions on scope mechanisms, assumed on top of the well established syntactic restrictions.

### 5.1.7 A note on negative QNP's

Nothing was said above about NP's like *no woman*, which in the generalized quantifiers practice are treated as negative universal QNP's. Examples for the appearance of such NP's in singular NP coordinations are the following sentences:

(57) No woman and no man slept.

(58) No woman and no man carried the piano together.

While (57) is unproblematic for the generalized quantifier analysis, thus also for the analysis proposed here, (58) is a hard case, involving what is referred to sometimes as "branching quantification". [36] The prominent reading of this sentence is:

(58') a. There is no couple of a man and a woman who carried the piano together.

According to the analysis proposed in this paper (58) is given only two (probably non-existent) interpretations, obtained by linear scope of the quantifiers:

(58') b. ? No woman is a woman who carried the piano with no man.
c. ? No man is a man who carried the piano with no woman.

The unlikelihood of (58'b-c) is completely parallel to the problems to accept the predictions in GB and Montagovian systems, which both assume linear quantifier scope in the logical translation for transitive sentences like:

(59) No woman saw no man.

The problem with (59) is further discussed in van Benthem(1983) and in May(1985:pp.88-97) and some solutions are proposed in the literature (see Sher(1991) for a bibliographical survey and a comprehensive discussion). I have nothing to add on this problem. However, because this difficulty for the analysis above is a direct consequence of the standard quantificational analysis, there is good reason to expect that any principled solution to the problem of (59) will automatically extend to the treatment of (58) in the proposed system of coordination.

## 5.2 Coordination of existential NP's

Indefinite NP's are often treated in the generalized quantifier literature as representing existential quantifiers. This has some interesting effects on the analysis of NP coordinations with singular indefinites. I will first discuss some of these effects and show that this treatment has some undesired consequences in the analysis of coordinations with indefinites in collective contexts. Then I will show that these difficulties can be overcome by treating indefinite NP's as representing quantifiers with free variables which are bound by "existential closure".

Consider the following pair of sentences:

(60) John slept.

(61) John and some man slept.

A curious prediction of the generalized quantifiers approach to indefinites is that (60) and (61) are considered equivalent, assuming that John is a man. The reason is that the two generalized quantifiers $\lambda P.P(\mathbf{j'})$ and $\lambda P.P(\mathbf{j'}) \wedge \mathbf{man'} \cap P \neq \emptyset$ are equal if $\mathbf{j'} \in \mathbf{man'}$. Pragmatically this is certainly not a satisfying account, for (61) is normally used in situations in which *two* men slept, whereas (60) can well be used if *only* John slept. However, for semantic purposes we can probably ignore this fact. Indeed, indefinites make the impression that some "unfamiliar" object is referred to, but it would be a bit dangerous to assume that this is always the case by encoding such a restriction into the semantic denotation of indefinite NP's. A rather striking evidence in favour of this claim is the case of "appositional" conjunction:

[36] See note 3 in Hoeksema(1988), which agrees on this classification. It is not clear to me why such examples are implied to be treated in Hoeksema's proposal, which employs standard linear quantification.

(62) A great man and a good father has passed away. (Hoeksema(1988:p.36))

Typically, (62) can be asserted when only one person, who was both a good father and a great man has died. This is in clear contrast to (61). So, it would probably be a mistake to claim that indefinites truthconditionally make a reference to an "unfamiliar" object, because such an assumption is problematic in sentences like (62). See some further remarks on similar problems in section 6.

So, there seems to be no harm in analyzing (60) and (61) as logically equivalent. However, the analysis of indefinites as generalized quantifiers makes it hard to account for the contrast between the following sentences:

(63) ?* John met.

(64) John and some man met.

If the subjects in both (63) and (64) denote the same quantifier then nothing semantic can account for the difference in acceptabilities and it is completely unclear how to get the interpretation of (64).

One may try to follow the line of the treatment given above for universal QNP's and to use $Q_{in}$ in the analysis of indefinites. This can lead to a proper treatment of (64), which would be analyzed correctly as:

(64) a. $[\![\text{John and he}_1 \text{ met}]\!] \Leftrightarrow \mathbf{meet'}(\{\mathbf{j}, x_1\})$
$Q_{in}$ $[\![\text{some man}]\!]$: $(\lambda P.P \cap \mathbf{man'} \neq \emptyset)(\lambda x_1.meet'(\{\mathbf{j}', x_1\})) \Leftrightarrow$
$\exists x_1(\mathbf{meet'}(\{j, x_1\}) \wedge \mathbf{man'}(x_1))$

But this is also not a correct general approach to indefinites in NP coordinations. Consider the following sentence:

(65) Mary and [ Sue or some man ] met.

Using $Q_{in}$ (65) should be analyzed as follows:

(65) a. $[\![\text{Mary and [ Sue or he}_1 \text{ ] met}]\!] \Leftrightarrow \mathbf{meet'}(\{\mathbf{m'}, \mathbf{s'}\}) \vee \mathbf{meet'}(\{\mathbf{m'}, x_1\})$
$Q_{in}$ $[\![\text{some man}]\!]$: $(\lambda P.P \cap \mathbf{man'} \neq \emptyset)(\lambda x_1.\mathbf{meet'}(\{\mathbf{m'}, \mathbf{s'}\}) \vee \mathbf{meet'}(\{\mathbf{m'}, x_1\})) \Leftrightarrow$
$\exists x_1(\mathbf{man'}(x_1) \wedge (\mathbf{meet'}(\{\mathbf{m'}, \mathbf{s'}\}) \vee \mathbf{meet'}(\{\mathbf{m'}, x_1\})))$

(65a) is close to the meaning of (65) but not close enough: it asserts the existence of some man whereas (65) does not. (65) would be perfectly true if no man existed and Mary met Sue. (65a) would be false in such a situation. To see the same point in a more realistic situation consider the following conversation:

A: Mary and Sue or a twin sister of Sue met yesterday in the concert.
B: Come on, you must be wrong; Sue does not have any twin sister!

B's reaction is certainly not in place. If her second assertion is true then A's claim reduces to the claim that Mary and Sue herself met, but not to falsity. For another similar point on the interaction between disjunction and indefinites see Winter(1995b).

These considerations show that an analysis of indefinite NP's as existential quantifiers is incompatible with the Boolean approach to coordination. Different considerations independently led Discourse Representation Theories following Heim(1982) and Kamp(1981) to analyze indefinites as denoting free variables, whose existential import is carried by binding operations at the clause or the sentence level. Using a very simple version of the DRT approach to indefinites we can handle the problems introduced above. We analyze an indefinite like *some man* as a generalized quantifier containing a free variable: $\lambda P.P(x_1) \wedge \mathbf{man}'(x_1)$. A simple sentence like *some man slept* is then analyzed as follows:

$$(\lambda P.P(x_1) \wedge \mathbf{man}'(x_1))\mathbf{sleep}' \ \Leftrightarrow\ \mathbf{sleep}'(x_1) \wedge \mathbf{man}'(x_1)$$

Application of existential closure at the sentence level yields:

$$\exists x_1(\mathbf{sleep}'(x_1) \wedge \mathbf{man}'(x_1))$$

which is the correct interpretation. Similarly, (64) and (65) are analyzed correctly as in (66) and (67) respectively:

(66) $[\![\text{John and some man}]\!] = (\lambda P.P(\mathbf{j}')) \sqcap (\lambda P.P(x_1) \wedge \mathbf{man}'(x_1)) =$
$\lambda P.P(\mathbf{j}') \wedge P(x_1) \wedge \mathbf{man}'(x_1)$
$\mathsf{C}([\![\text{John and some man}]\!]) = \lambda \mathcal{P}.\exists A(A \in min(\lambda P.P(\mathbf{j}') \wedge P(x_1) \wedge \mathbf{man}'(x_1)) \wedge \mathcal{P}(A)) =$
$\lambda \mathcal{P}.\exists A(A = \{\mathbf{j}', x_1\} \wedge \mathbf{man}'(x_1) \wedge \mathcal{P}(A)) = \lambda \mathcal{P}.\mathcal{P}((\{\mathbf{j}', x_1\}) \wedge \mathbf{man}'(x_1))$
$(\mathsf{C}([\![\text{John and some man}]\!]))\mathbf{meet}' \Leftrightarrow \mathbf{meet}'(\{\mathbf{j}', x_1\}) \wedge \mathbf{man}'(x_1)$
Existential closure: $\exists x_1(\mathbf{meet}'(\{\mathbf{j}', x_1\}) \wedge \mathbf{man}'(x_1))$

(67) $[\![\text{Mary and [ Sue or some man ]}]\!] = (\lambda P.P(\mathbf{m}')) \sqcap [(\lambda P.P(\mathbf{s}')) \sqcup (\lambda P.P(x_1) \wedge \mathbf{man}'(x_1))] =$
$\lambda P.P(\mathbf{m}') \wedge [P(\mathbf{s}') \vee (P(x_1) \wedge \mathbf{man}'(x_1))]$
$\mathsf{C}([\![\text{Mary and [ Sue or some man]}]\!]) =$
$\lambda \mathcal{P}.\exists A(A \in min(\lambda P.P(\mathbf{m}') \wedge [P(\mathbf{s}') \vee (P(x_1) \wedge \mathbf{man}'(x_1))]) \wedge \mathcal{P}(A)) =$
$\lambda \mathcal{P}.\mathcal{P}(\{\mathbf{m}', \mathbf{s}'\}) \vee (\mathcal{P}(\{\mathbf{m}', x_1\}) \wedge \mathbf{man}'(x_1))$
$(\mathsf{C}([\![\text{Mary and [ Sue or some man]}]\!]))\mathbf{meet}' \Leftrightarrow$
$\mathbf{meet}'(\{\mathbf{m}', \mathbf{s}'\}) \vee (\mathbf{meet}'(\{\mathbf{m}', x_1\}) \wedge \mathbf{man}'(x_1))$
Existential closure: $\exists x_1(\mathbf{meet}'(\{\mathbf{m}', \mathbf{s}'\}) \vee (\mathbf{meet}'(\{\mathbf{m}', x_1\}) \wedge \mathbf{man}'(x_1)))$

The problems mentioned above do not appear with this analysis. However, I do not mean to imply that this treatment is introduced as a theory of indefinites. The only point it comes to exemplify is that the apparent problems for combining the proposed account with the generalized quantifiers approach to indefinites are due to a treatment that assumes that indefinites *exclusively* represent generalized quantifiers. This view has been extensively criticized in the literature on independent grounds. In this respect, the analysis of indefinites using choice functions in Reinhart(1995) and Winter(1995b) copes with the mentioned problems as successfully as the DRT-like analysis above. Examples and elaborations must wait for another occasion.

Another technical development I spare here is the extension of the treatment of *ccl* predicates given in section 3 to the case of QNP coordination, which as stressed there does not have a particular theoretical interest.

Concluding, this section extended the treatment of collectivity with NP coordination to some problematic cases with quantified NP's. Almost inevitably, many other problematic aspects of the data were left untreated. One such curious aspect is discussed in the following section.

# 6 Some remarks on NP intensionality, disjoint reference constraints and "appositional" conjunction

A hard challenge for any theory of coordination is the following question: what are the referential relations allowed between conjuncts and how do they affect the syntactic number of the coordination?

The theories proposed in Hoeksema(1983) and Hoeksema(1988) predict that an NP conjunction with coreferring proper names or definite descriptions is semantically ill-formed. An argument given by Hoeksema in favour of this prediction is the unacceptability of the following sentence:

(68) ? John and John are similar.

According to the theory proposed in section 3, sentence (68) is to be considered unacceptable because the predicate *to be similar* is probably *ccl* and the conjunction *John and John* is equivalent to *John*, which is not *cpl*. However, no *semantic* principle blocks *the conjunction* itself and therefore sentences like (69a) are considered semantically acceptable and can be interpreted like (69b).

(69) a. ? John and John and Mary are similar.
b. John and Mary are similar.

Both (68) and (69a) should probably be blocked independently by some principle of disjoint reference in the language. Such a restriction is imposed by the traditional "condition C" in GB theory (see Reinhart(1983), Chierchia(1988), Lasnik(1991), to name only two of the many different accounts for such a condition). The fact that such conjunctions should be blocked by an independent principle in the grammar is an argument in favour of the more "liberal" semantics adopted here. Notice also that the unacceptability of these sentences seems to be of the same origin as the unacceptability of the following sentences, not ruled out by Hoeksema's account:

(70) ? Every woman and every woman is/are sleeping.

(71) ? Every woman and every woman are meeting.

This is a fact that may do also with conventional maxims of discourse, due to some redundant information in such sentences. Semantically speaking, these facts do not seem particularly problematic or interesting.

However, Hoeksema notes that such examples do not cover at all the complexity of the problem. Consider now the following sentences (variations of examples by Hoeksema), with all NP's extensionally coreferential:

(72) a. Dr. Jekyll and Mr. Hyde *was / *were hung this morning.
b. Dr. Jekyll and Mr. Hyde ?was / were the same person.

(73) a. The doctor and the killer was / *were hung this morning.
b. The doctor and the killer ?was / were the same person.

(74) a. A doctor and a killer was / *were hung this morning.
b. A doctor and a killer ?was / ?were the same person.

(75) a. Dr. Jekyll and the killer *was / *were hung this morning.
b. Dr. Jekyll and the killer ?was / were the same person.

Sentences (73a) and (74a) exemplify what is called in the literature by the name "appositional" conjunction. This term refers to the possibility to conjoin *in extensional contexts* two NP's which are *extensionally* coreferential. Like Hoeksema, I consider the contrast between these sentences and (72a) striking: for some reason, coreferential proper names do not allow this kind of conjunction. Even when only one conjunct is a proper name as in (75a) appositional conjunction is ruled out. On the other hand, in intensional contexts like the b sentences above the conjunction of any two extensionally coreferential NP's is possible. The latter fact is not that surprising because *intensionally* the conjuncts are distinguishable, just like in Frege's celebrated *The morning star is the evening star*, or in our non astronomical cases:

(76) Dr. Jekyll is Mr. Hyde.

(77) The doctor is the killer.

These sentences are logically equivalent to (72b) and (73b), respectively.

The facts concerning number agreement and indefinites add complexity to the puzzle. However, with respect to number agreement the pattern at least is quite clear: coreferential conjuncts in extensional contexts ("appositional" conjunction) allow only singular agreement. Intensional contexts require plural agreement.

Preliminary discussions of possible partial accounts to this enigmatic collection of data appear in Hoeksema(1988) and van Eijck(1983). Both papers use some ideas from Discourse Representation Theories. These problems were beyond the scope of the present work, where no relativization to theories of intensionality, discourse or (in)definites appears.

# 7 Conclusions

The investigation in this paper originated in some observations on methodological and empirical difficulties for present theories of coordination in natural language. I aimed to show that many of these difficulties can be overcome if we readopt a unified Boolean treatment of *and* conjunctions. The promising paradigm on type flexibility of semantic representations and the use of a hierarchy of type shifting operators have proved to be fruitful also in analyzing the problematic distinction between distributive and collective interpretations of NP coordinations. One "natural" type shifting operator was shown to be able to handle this foundational problem. We may count the operation of principles like the $\mathsf{C}$ operator as a manifestation of non-lexical semantic processes in the interpretation of natural language. The possibility to present the existential operator using the operator of collectivity is especially interesting in this respect. Using this perspective "existential closure" and "collective predication" can be viewed (at a high level of abstraction) as different names for the same phenomenon. We may try to explain why there exist languages in which there is no morphologically overt indefinite article using the same considerations that account for the free collective interpretation in English. To be more specific: Hebrew is a language in which singular indefinite NP's can appear without any indefinite article. For example, the following Hebrew sentence is interpreted as existential quantification:

(78) adam nixnas laxeder.
person entered into-the-room
"A person entered the room."

The quantification can be described as an operation of type mismatch resolution: the subject's denotation for *person* of type $et$ is lifted into type $(et)t$ using the operator $\mathsf{E}(=\mathsf{C})$ to resolve the type mismatch with the predicate of type $et$. This operation is a free procedure allowed in such cases. In a completely parallel way, this paper proposed that the operator $\mathsf{C}$ allows a collective interpretation to English sentences like (79), in which there is no morphological realization for a "collectivizing" morpheme.

(79) Mary and John weigh 100 Kg.

Although the existential quantification in (78) and the collective predication in (79) do not have a clear morphological manifestation, we know that in English an indefinite article is morphologically overt and a *together* adverbial can be used to force a collective interpretation:

(80) *A* person entered the room.

(81) Mary and John *together* weigh 100 Kg.

Some theories assume that *a* is interpreted (at least basically) as an existential determiner and that *together* is interpreted as an NP modifier, with the role of a collectivity operator. So, such theories can be understood to assume that an operator like C does not *have to* have a morphological realization, but it is certainly a possibility in some languages and in some constructions.

These preliminary general ideas are of course very far from proposing a unified theory of existential quantification and collectivity in natural language. On the other hand, they do point on one of the interesting directions a standard analysis of conjunction without ambiguity might lead to.

There are many other challenges for combining a comprehensive theory of coordination with other syntactic and semantic theories. Naturally, this paper can offer only a partial answer to some of the many questions. However, I believe that this part can constitute a contribution for a broader enterprise. Further research can make it fit into a clearer picture of the amazing puzzle of coordination in natural language.

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