Coyote took it. He ate it.
"Ah, mm."
"That's good."
"That's good."
"It's really good
"this breast."
"It's good."

He ate it.
"Ah."
"I'm full."

"Come on."
"Let's
"go to our house."
"You folks come over
"to our house."

"We will come over there."

"Ah."
"Oh."

They left, Coyote and his wife Mole.
They went in the little house.

"Oh,
"I wonder when
"They will come," then

"Coyote!"
"Ah!"
"Come in!"
"Come in!"
Coyote told them.
"You folks sit down!"
"You folks eat!"

"Come here, Mole,
"sit down."

Coyote gets his knife
and he takes Mole's breast and he cuts it.
"Aaah."

Oh.
She died.

"Mole!"
Coyote (cried out).
"Mole!
"What's the matter?"

"Mole!"
Oh, he cried.

She died.

That's all.

How to Get Rid of Groups, Using DRT: A Case for Discourse-Oriented Semantics*

Manfred Krifka

The semantics of NP conjunctions like *Mary and Sue* and plural NPs like *the girls* can be treated satisfactorily by introducing a sum operation on individuals. In addition to that sum operation, it has been claimed, we need a general group formation rule to handle the semantics of collective NPs like *the committee* and certain cases of embedded conjunctions or conjunctions of plural NPs. In this article, I argue that we do not need a general group formation: collective NPs are too idiosyncratic to be captured by a general group formation rule, and the remaining cases can and should be covered in the discourse-oriented part of semantics. I show in some detail how this can be spelled out in Discourse Representation Theory (DRT), and speculate about the relationship between world-oriented and discourse-oriented semantics.

0. Introduction

0.1 Why We Need Sum Individuals

It is well-known that conjunction in natural language is more than just sentence conjunction, and cannot be reduced to sentence conjunction in every case, despite considerable efforts to do so in logic and linguistics. Wierzbicka (1980) gives evidence for that, citing authors as early as Roger Bacon and Peter of Spain; from the early days of transformational grammar we may mention Lakoff & Peters (1966), Wierzbicka (1967) and Smith (1969). The different types of conjunctions are nicely outlined by the Scottish philosopher and poet James Beattie in his treatise *The Theory of Language* (1783). First he argues that sometimes we CAN reduce a conjunction of names to a sentence conjunction:

> So, when it is said, Peter and John went to the temple, it may seem, that the conjunction *and* connects only the two names, *Peter* and *John*: but it really connects two sentences, - Peter went to the temple, - John went to the temple. (p. 346)

* I had the opportunity to discuss the ideas developed above with a number of colleagues -- among others, Nick Asher, Carola Eschenbach, Greg Carlson, Zuzana Dobes, Andreas Kathol, Godehard Link, Cynthia McLemore, Barbara Partee, Craige Roberts, and Carlota Smith, who gave me valuable suggestions concerning the content and form of this paper. Thanks to them all.

But this will not always work:

> (...) as in examples, like the following: Saul *and* Paul are the same: (...) There is war between England *and* France: Each of these, no doubt, is one sentence, and, if we keep to the same phraseology, incapable of being broken into two. For, if instead of the first we say, "Saul is the same - Paul is the same," we utter nonsense; because the predicate *same*, though it agrees with the two subjects in their united state, will not agree with either when separate. (...) And (...), if we say, "There is war between England - there is war between France", we fall into nonsense as before; because the proposition *between*, having a necessary reference to more than one, cannot be used where only one is spoken of. (p. 347)

Beattie actually tries to reduce this second interpretation to the first, as some authors before and many after him -- and with equally little success, I think.

In more recent times, we have come to accept that there are different types of conjunction, and more specifically to distinguish between a DISTRIBUTIVE READING and a COLLECTIVE READING of noun phrase conjunction. The distributive reading can be traced back to sentence conjunction, which can be rendered formally by a type-lifting of the noun phrases to the type of quantifiers, and a corresponding type-lifting of sentence conjunction to quantifier conjunction (cf. Montague 1973, Partee & Rooth 1983, Keenan & Faltz 1985):

(1) *John and Mary walked (in the park).*
= John walked (in the park) and Mary walked (in the park).
$\mathbf{j} \Rightarrow \lambda P P(j)$, $\mathbf{m} \Rightarrow \lambda P P(m)$, $\& \Rightarrow \lambda T \lambda T' \lambda P[T(P) \,\&\, T'(P)]$
$[\lambda P P(\mathbf{j}) \,\&\, \lambda P P(\mathbf{m})](\mathbf{walked})$
$= \mathbf{walked}(\mathbf{j}) \,\&\, \mathbf{walked}(\mathbf{m})$

For the collective readings, theories have been developed which claim that in this case the predication is actually about a complex individual consisting of other individuals (cf. Bennett 1974, Hausser 1974, Massey 1976, Blau 1981, Scha 1981, Link 1983, Hoeksema 1983, and others). For example, in the following sentence, we have a predication over the SUM of John and Mary (which is rendered by the symbol ⊕):

(2) a. *John and Mary met (in the park).*
$\mathbf{met}(\mathbf{j} \oplus \mathbf{m})$

b. *John and Mary carried the piano upstairs.*
$\mathbf{carried.the.piano.upstairs}(\mathbf{j} \oplus \mathbf{m})$

The sum operation ⊕ may be captured in various ways. Link (1983) suggests that we should assume a structured individual domain **A**, where it holds for every object a, b, that there is a third object, denoted by $a \oplus b$[1]. That is, we require ⊕ to be an operation ON **A**.

[1] **A** corresponds to Link's **E**; I do not introduce a domain for mass terms.

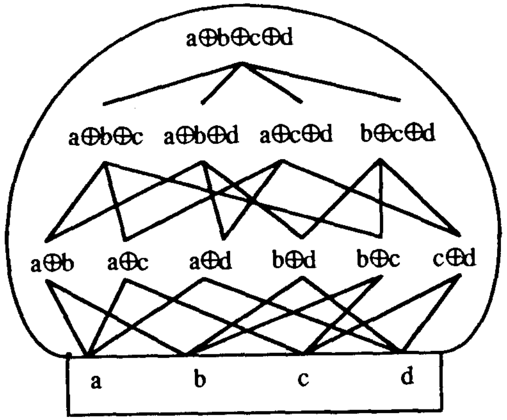
The reason for this is that there seems to be no semantic restriction as to the NPs which can be conjoined: we can easily speak of *the bottle of wine in my fridge and the biggest moon of Jupiter.* The sum operation should satisfy certain properties, among them the following:

- IDEMPOTENCY ($a \oplus a = a$), as taking the sum of John and himself would not yield a new object[2];
- COMMUTATIVITY ($a \oplus b = b \oplus a$), as *John and Mary met* is true just in case *Mary and John met* is true, and hence the two subject NPs should denote the same object;
- ASSOCIATIVITY ($a \oplus (b \oplus c) = (a \oplus b) \oplus c$), as *John, and Mary and Bill met* is true just in case *John and Mary, and Bill met.*, and hence the two subject NPs should denote the same object. Associativity is not accepted by Hoeksema (1983); I will discuss the problems with it later.

To treat cases like *all the students,* which refers to the sum of a possibly infinite number of students, we have to assume that ⊕ can be generalized to a join operation for arbitrary sets, that is, ⊕ is COMPLETE. With the sum operation we can define a PART RELATION ≤ in the standard way: $a \leq b$ iff $a \oplus b = b$. For example, John will be a part of John and Mary, and he also will be a part (though not a proper part) of John.

Link (1983) showed that the intended structure we are after is a COMPLETE ATOMIC JOIN-SEMILATTICE WITHOUT BOTTOM ELEMENT: The join operation is simply the sum operation, which is complete; the domain of individuals should be atomic, that is, have minimal parts; and it should not contain a bottom element, that is, an individual which is a common part of every other individual. Landman (1989) showed that we want to have, more specifically, a lattice which is GENERATED BY THE SET OF ATOMS. That is, two distinct individuals must not have the same set of individuals as parts, but must differ in at least one atomic part. Furthermore, the lattice should be FREE, which roughly means that the lattice should provide for as many elements as possible, under the given requirements. Such lattices are homomorphic to power-set lattices without the empty set, where the atoms are represented by singleton sets, and the sum operation is represented by set union. I give an example of such a lattice with four atoms in a so-called Hasse diagram:

[2] Note that Beattie's example *Saul and Paul* cannot be handled as a sum operation with identical objects; there must be some representation, be it the one of individual concepts or the one of discourse referents, where Saul and Paul actually are different (see Lasersohn 1988 p. 138, Landman 1989).



A sentence with a collective predicate like *carry the piano upstairs* (in its collective interpretation) can be analysed as a predication over sum individuals. In many cases, the collective predicate corresponds to a two-place relation. For example, the predicate *met* in *John and Mary met* corresponds to the relation *met* in *John met Mary.* This can be made explicit by reciprocal pronouns, as in *John and Mary met each other*, and so I will call the predicate use of verbs like *met* (COVERTLY) RECIPROCAL even if there is no reciprocal pronoun present[3]. If we restrict our attention, for sake of simplicity, to cases of reciprocity over the subject argument (that is, if we exclude cases like *Bill introduced John and Mary to each other*), then the correspondence between relational and reciprocal predicates can be spelled out by an operator for reciprocals which takes a two-place relation R and yields a one-place relation which is true of sum individuals, with the following interpretation (here, the relation $\leq_a$ is the atomic part relation; $x \leq_a y$ is true iff $x \leq y$ and x is an atom):

(3) $\mathrm{REC}(R)(x) \leftrightarrow \forall y,z[y \leq_a x \;\&\; z \leq_a x \;\&\; y \neq z \rightarrow R(y,z)] \;\&$
$\exists y,z[y \leq_a x \;\&\; z \leq_a x \;\&\; y \neq z]$

That is, REC(R) is true of x iff every two distinct atomic parts of x stand in the R-relation to each other, and there are such parts. If we render the relational interpretation of *met* by a two-place relation **met**, then the reciprocal interpretation of *met* can be given by REC(**met**).This is a predicate which applies to a sum individual x just in case every two distinct atomic parts of x stand in the relation **met**. As a well-formedness condition, we

3 This terminology is due to Langendoen (1978). Lakoff & Peters (1966) call these terms "symmetric" and argue against an analysis as reciprocals, but with unconvincing arguments. See Dowty (1988) for a recent discussion of covert reciprocals and thematic roles.

have assumed that there are at least two distinct atomic parts of x. Example (2.a) can be rendered as follows:

(4) $\mathrm{REC}(\mathbf{met})(\mathbf{j}\oplus\mathbf{m})$
$= \forall y,z[y \leq_a \mathbf{j}\oplus\mathbf{m} \;\&\; z \leq_a \mathbf{j}\oplus\mathbf{m} \;\&\; y \neq z \rightarrow \mathbf{met}(y,z)] \;\&$
$\exists y,z[y \leq_a \mathbf{j}\oplus\mathbf{m} \;\&\; z \leq_a \mathbf{j}\oplus\mathbf{m} \;\&\; y \neq z]$
$= \mathbf{met}(\mathbf{j},\mathbf{m}) \;\&\; \mathbf{met}(\mathbf{m},\mathbf{j})$

Definition (3) is too strict for many cases of reciprocals; see the appendix for a discussion of how weaker versions may be treated.

For distributive predications, we could still assume the type-shifting analysis (1). However, this would give us trouble in cases like *John and Mary met in town and walked through the park*, where one predicate is collective and therefore needs a sum individual, and the other is distributive (cf. Dowty 1986). To represent conjunction in a uniform way, we can define, after Link (1983, 1984), an operator DST which has the following interpretation:

(5) $\mathrm{DST}(P)(x) \leftrightarrow \forall y[y \leq_a x \rightarrow P(y)]$

The (physically unlikely) distributive reading of (2.b) can be rendered as follows:

(6) $\mathrm{DST}(\mathbf{carried.the.piano.upstairs})(\mathbf{j}\oplus\mathbf{m})$
$= \forall y[y \leq_a \mathbf{j}\oplus\mathbf{m} \rightarrow \mathbf{carried.the.piano.upstairs}(y)]$
$= \mathbf{carried.the.piano.upstairs}(\mathbf{j}) \;\&\; \mathbf{carried.the.piano.upstairs}(\mathbf{m})$

For predicates like the intransitive *walk* we may assume that they always have a distributive interpretation. We can enforce that by the following meaning postulate:

(7) $\mathbf{walk}(x) \leftrightarrow \mathrm{DST}(\mathbf{walk})$

Note that DST can only render distributivity with respect to the subject position; it fails in cases like *Bill gave John and Mary three apples (each)*. For reasons of simplicity I will restrict the discussion to distributivity over the subject position here.

This analysis of the semantics of NP conjunction can be easily extended to cover the semantics of plural predicates, like *children* (cf. Link 1983). Whenever we have a predicate P of atoms, we can form a predicate $^{\oplus}P$ which applies to all the entities which have as their atomic parts individuals to which P applies. Obviously, $^{\oplus}P$ will be the plural predicate corresponding to P. Formally, we can define $^{\oplus}P$ as the closure of the extension of P under sum formation:

(8) If P is a predicate, then $^{\oplus}P$ is the predicate with the smallest extension such that
(i) $\forall x,y[P(x) \;\&\; P(y) \;\&\; x \neq y \rightarrow {}^{\oplus}P(x\oplus y)]$ and
(ii) $\forall x,y[{}^{\oplus}P(x) \;\&\; {}^{\oplus}P(y) \rightarrow {}^{\oplus}P(x\oplus y)]$

In case we represent the meaning of *child* by **child**, the meaning of *children* can be given by $^{\oplus}$**child**. By this, we can render the meaning of sentences like the following one:

(9) *Children carried the piano upstairs.*
$\exists x[^{\oplus}\mathbf{child}(x)\ \&\ \mathbf{carried.the.piano.upstairs}(x)]$

We can generalize the sum operation $\oplus$ to an operator which maps a predicate to a term that denotes the maximal element in the extension of the predicate, that is, the element which has every element in the extension of the predicate as a part. Let us call this operator δ; it can be defined as follows:

(10) $\delta(P) = \iota x[P(x)\ \&\ \forall y[P(y) \rightarrow y \leq x]]$

Of course, it is not guaranteed that such a maximal element will exist for any predicate. It will trivially exist if P applies to only one element: then $\delta(P)$ will be that very element. For example, if **child** applies only to **j**, then $\delta(\mathbf{child})$ is **j**. Furthermore, it will exist for every plural predicate. For example, if **child** applies only to **j**, **m** and **b**, then $^{\oplus}$**child** applies to $\mathbf{j\oplus m}$, $\mathbf{j\oplus b}$, $\mathbf{m\oplus b}$ and $\mathbf{j\oplus m\oplus b}$, and $\delta(^{\oplus}\mathbf{child})$ is $\mathbf{j\oplus m\oplus b}$. And if **child** applies to **j** and **m**, then $\delta(\mathbf{child})$ will be undefined. This makes δ suitable to render the definite article; for example, *the child* can be represented as $\delta(\mathbf{child})$, and *the children* can be represented as $\delta(^{\oplus}\mathbf{child})$. Thus, we can handle sentences like the following:

(11) *The children met.*
$\mathrm{REC}(\mathbf{met})(\delta(^{\oplus}\mathbf{child}))$

According to this analysis, conjoined NPs and NPs based on a plural noun look quite similar. (See the appendix for the treatment of an apparent difference).

1. Do We Need Groups?

In the last section, we have seen some evidence for a sum operation. Several researchers have argued that this is not enough, or that the sum operation just given is too simple (Blau 1981, Hoeksema 1983, Link 1984, Lasersohn 1988, Landman 1989, Lønning 1989).

Link (1984) and Landman (1989) argue that this sum operation must be supplemented by a GROUP OPERATION which yields, in addition to sum individuals, group individuals. One set of arguments is derived from the existence of COLLECTIVE NOUNS like *committee, class, herd, family, couple, parliament, congress, assembly kit* and *deck of cards*.

It is tempting to analyse a noun like *committee* as a predicate which applies to the sum of its members. For example, let us assume that John, Mary and Bill form a committee

a. Under that proposal, we could claim **committee(a)** and $\mathbf{a} = \mathbf{j\oplus m\oplus b}$, hence $\mathbf{committee(j\oplus m\oplus b)}$. The fact that John is a member of that committee could be stated by $\mathbf{j} \leq \mathbf{a}$, identifying membership with being part of a sum individual.

However, as pointed out by Bennett (1974), Lasersohn (1988), Landman (1989) and others, there are serious problems with that approach. One problem is that committees may have some organizational structure, which is not provided by the sum individual. Another problem is that committees and the sum of their members may have different properties. For example, John, Mary and Bill may meet, but not for a meeting of the *committee*; so we should allow that $\mathbf{met(j\oplus m\oplus b)}$ does not contradict $\neg\ \mathbf{met(a)}$. Conversely, the committee may meet in absence of a member; so we should allow that **met(a)** is consistent with $\neg\ \mathbf{met(j\oplus m\oplus b)}$. Furthermore, John, Mary and Bill may start to like forming committees for all kinds of goals, that is, different committees **a**, **a'**, **a"** etc.; these committees must be kept distinct, even if they have the same members. Then we have to think about the possibility that a committee may change its members, but still remain the same committee; this is not possible for a sum individual. The membership may shrink; if a committee has only one member, say John, then the committee and John will be totally identical, and whatever property John has, the committee will have as well. Finally we must consider the odd case that a committee loses all its members, but still exists legally. When we reconstruct committees as sum individuals, then it is unclear what a committee without members should be, let alone how we could prevent different memberless committees from being identical.

The gist of these arguments is that we simply cannot reduce committees and their ilk to the sums of their members. Link (1984, 1984b) and Landman (1989) therefore assume that collective nouns denote entities of a special sort, namely GROUPS INDIVIDUALS, or simply GROUPS.

Although groups have members, they should be analysed as atomic if we want to extend our treatment of collective predications to sentences containing group nouns. This becomes clear with examples like the following (Landman 1989, Blau 1981):

(12) a. *The House of Lords and the House of Commons control each other.*

b. *The decks of cards are numbered consecutively.*

(12.a) has a reading in which the House of Lords controls the House of Commons and vice versa as institutions, that is, as groups. It is easy to render this by the meaning of the reciprocity operator if we assume that the House of Lords and the House of Commons are represented by atomic individuals **l**, **c** respectively:

(12') $\text{REC}(\textbf{control})(\mathbf{l} \oplus \mathbf{c})$
$= \textbf{control}(\mathbf{l}, \mathbf{c})\ \&\ \textbf{control}(\mathbf{c}, \mathbf{l})$

The relation between a group and its members should be captured in some way, of course. As we cannot use the part relation, Landman, after Link, introduces an operator $\downarrow$ which maps groups to the sum of their members. For the example above, we have $\downarrow\mathbf{a} = \mathbf{j} \oplus \mathbf{m} \oplus \mathbf{b}$.

(12.b) is interpreted as saying that the decks of cards, but not the cards they consist of, are numbered consecutively. To handle that, we have to assume that *deck of cards* applies to atomic entities, and that the semantics of *be numbered consecutively* can be spelled out as: Consecutive numbers are assigned to the atomic parts of the subject referent.

Up to now, we have only looked at collective nouns (or names) like *House of Lords* or *deck of cards* as arguments for groups. Hoeksema (1983), Link (1984), Lasersohn (1988) and Landman (1989) present cases which show that conjunction data also lead to the assumption of groups. An example similar to the one given by Hoeksema is the following:

(13) *Napoleon and Wellington and Blücher fought against each other.*

In the historically correct reading of this sentence, Napoleon fought against Wellington and Blücher in the battle of Waterloo, and vice versa. We cannot get this reading by using the sum operation. For one thing, the sentence is reciprocal, hence collective, and cannot be reduced to a case of a type-lifted Boolean conjunction. So the sum operation remains as the only possibility. But as the atomic parts are Napoleon, Wellington and Blücher, our analysis gives only the reading where everyone fought against everyone else:

(13') $\text{REC}(\textbf{fought.against})(\mathbf{n} \oplus \mathbf{w} \oplus \mathbf{b})$
$= \textbf{fought.against}(\mathbf{n}, \mathbf{w})\ \&\ \textbf{fought.against}(\mathbf{w}, \mathbf{n})\ \&$
$\textbf{fought.against}(\mathbf{n}, \mathbf{b})\ \&\ \textbf{fought.against}(\mathbf{b}, \mathbf{n})\ \&$
$\textbf{fought.against}(\mathbf{w}, \mathbf{b})\ \&\ \textbf{fought.against}(\mathbf{b}, \mathbf{w})$

The reason for this is that the sum operation is associative. Therefore we cannot distinguish the object $\mathbf{n} \oplus [\mathbf{w} \oplus \mathbf{b}]$ from the object $[\mathbf{n} \oplus \mathbf{w}] \oplus \mathbf{b}$, and so we may simply write $\mathbf{n} \oplus \mathbf{w} \oplus \mathbf{b}$, as above. So the associative sum operation does not seem to be fine-grained enough to capture the distinctions in readings we are after.

Link (1984, 1984b), and Landman (1989) in his first theory, give the following solution to this problem: the NP *Wellington and Blücher* denotes a group individual in (13), which is atomic. If we assume that every sum individual can be mapped by a function

$\uparrow$ to a group which is atomic and which has the atomic parts of the sum individual as members, then we can render the intended reading of (13) as follows:

(13") $\text{REC}(\textbf{fought.against})(\mathbf{n} \oplus \uparrow[\mathbf{w} \oplus \mathbf{b}])$
$= \textbf{fought.against}(\mathbf{n}, \uparrow[\mathbf{w} \oplus \mathbf{b}])\ \&\ \textbf{fought.against}(\uparrow[\mathbf{w} \oplus \mathbf{b}], \mathbf{n})$

Another case of this sort is provided by the following example (cf. Landman 1989):

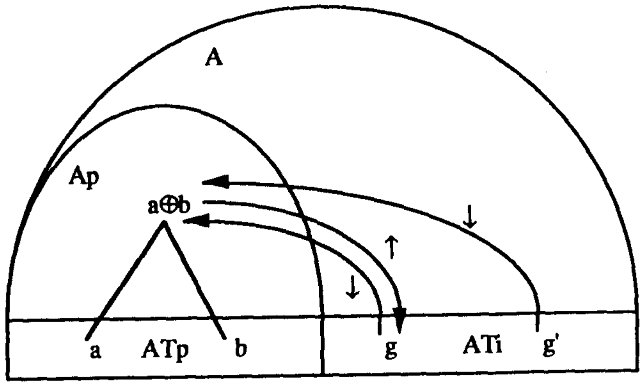
(14) *The cards below seven and the cards from seven up are separated.*

Again, the assumption of a sum individual yields the implausible reading - namely that every card is separated from every other card, as the sum of the cards below seven and the cards from seven up is simply the sum of all the cards (cf. 14'). If we allow for group formation, however, we get the intended reading (cf. 14"):

(14') $\text{REC}(\textbf{separated})(\delta(^{\oplus}\textbf{card.below.7}) \oplus \delta(^{\oplus}\textbf{card.from.7.up}))$
$= \text{REC}(\textbf{separated})(\delta(^{\oplus}\textbf{card}))$

(14") $\text{REC}(\textbf{separated})(\uparrow\delta(^{\oplus}\textbf{card.below.7}) \oplus \uparrow\delta(^{\oplus}\textbf{card.from.7.up}))$
$= \textbf{separated}(\uparrow\delta(^{\oplus}\textbf{card.below.7}), \uparrow\delta(^{\oplus}\textbf{card.from.7.up})\ \&$
$\textbf{separated}(\uparrow\delta(^{\oplus}\textbf{card.from.7.up}), \uparrow\delta(^{\oplus}\textbf{card.below.7})$

Link and Landman propose special model structures to capture the relationship between sums and groups. In the first reconstruction of Landman, which is close to Link's original proposal, he assumes two disjoint sets of atoms, AT_p, or the set of PURE ATOMS (i.e. atomic ordinary individuals), and AT_i, the set of IMPURE ATOMS (i.e. atomic groups). The free lattice generated by AT_p may be called A_p, the set of pure objects. The non-atomic elements in A_p, that is, the elements in $A_p \setminus AT_p$, are called PURE SUMS. The group formation $\uparrow$ is a mapping from pure sums ($A_p \setminus AT_p$) to impure atoms (AT_i). As distinct sum individuals should be mapped to distinct groups, $\uparrow$ is a one-one function. The membership specification $\downarrow$ is a mapping from impure atoms to pure objects, and we have of course for every pure sum x, $\downarrow\uparrow x = x$, that is, the sum of the members of the group corresponding to the sum individual x is x. However, we might have more groups than just the $\uparrow$ – images of the pure sums, as we also want to use groups for the semantics of collective nouns. As the same individuals may be members of an arbitrary number of different committees, clubs, herds etc., we must allow for models in which we have different impure atoms $x_1, \ldots x_n$, all of which have the same members, that is, $\downarrow x_1 = \downarrow x_2 = \ldots \downarrow x_n$. As group-denoting nouns may be conjoined with other group-denoting nouns (e.g. *the House of Commons and the House of Lords*) and with other nouns (e.g. *the Queen and the House of Lords*), we have to assume that all the atoms, pure and impure, generate a free lattice under the sum operation $\oplus$. Call this lattice A; the lattice of pure objects, A_p, is a sublattice of A. Model-structures of that type may be depicted as follows (here, a⊕b form the group g, and there is another group g' which has a and b as members):

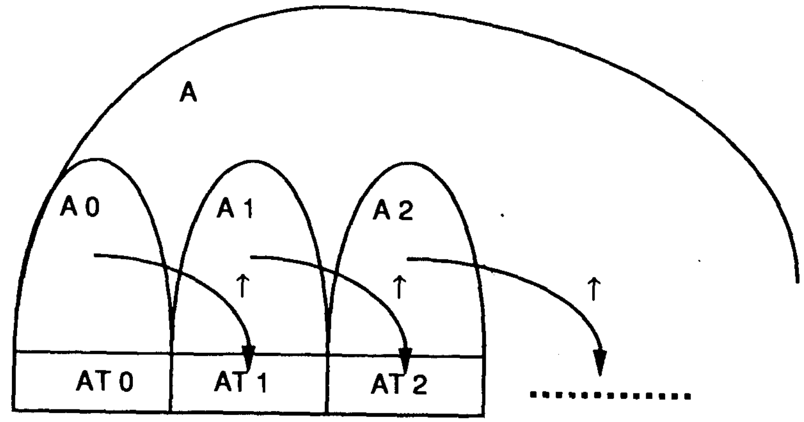


Landman (1989) claims that in addition, there are cases of iterative group formation, and therefore he introduces an even more complex model structure which allows for groups of arbitrary levels. Landman motivates these model structures by sentences with collective nouns. For example, the parliament may consist of two houses as its members; as they are groups themselves, the parliament is a group of second order. Landman also discusses examples like the following one:

(15) *The committees of the State Department and the committees of the CIA control each other.*

In one reading, the committees of the State Department as a group control the group of the committees of the CIA and vice versa. Hence, we must introduce the group of the committees of the State Department as an atomic individual, and similarly the group of the committees of the CIA. As committees are groups themselves, we arrive at second-order groups.

To cover examples like (15) in full generality, Landman argues that this type of group formation actually can be iterated indefinitely. So he in fact proposes models which have an indefinite sequence of atom sets, where an atom set AT_i represents the groups which have individuals of the set A_{i-1} as members:



To render sentences like the following, where one of the groups consists of a simple individual and a group, we perhaps have to assume model structures in which every A_n is contained in A_{n+1}.

(16) *The Queen and the House of Lords and the House of Commons control each other.*
(reading: The Queen and the House of Lords control the House of Commons, and vice versa.)

Another way to cover the relevant readings of (13) and (14) is to assume a non-associative sum operation to begin with. This was proposed by Hoeksema (1983), and similarly by Lasersohn (1988). Hoeksema introduces a conjunction of expressions of a special type of quantifier, which is interpreted as set formation. For example, *Napoleon and Wellington and Blücher* in the reading above is interpreted as the quantifier **f** such that $\mathbf{f}(X)$ iff $\{\mathbf{n}, \{\mathbf{w}, \mathbf{b}\}\} \in X$. With this reconstruction of conjunction, we obviously can distinguish between an individual $\{\mathbf{n}, \{\mathbf{w}, \mathbf{b}\}\}$ and an individual $\{\{\mathbf{n}, \mathbf{w}\}, \mathbf{b}\}$. However, by giving up associativity we must assume a far more complex individual domain. Hoeksema suggests the following (attributed to van Benthem): We start with a set of 'ur elements' U_0, and define each subsequent level U_{n+1} as the union of U_n and all subsets of U_n with at least two elements. The domain of individuals U is defined as the universal closure of all U_n:

(17) U_0 = set of ur elements
$U_{n+1} = U_n \cup \{X: X \subseteq U_n \ \&\ |X| \geq 2\}$
$U = \bigcup_{n=0}^{\infty} U_n$.

By this, we get a sum operation which is commutative (as {a, b} = {b, a}), but not associative. Obviously, this model structure provides us with as many objects we need to handle non-associativity phenomena.

Yet another proposal, Lønning (1989), tries to handle group readings, without complicating the model in the mapping between syntax and semantics, namely by a combination of the associative sum operation and a type-lifted Boolean conjunction. This allows an adequate representation of what he calls the INTERMEDIATE GROUP READING of sentences like the following (where Mary and John got \$10000 and Lisa and Stefan got \$10000):

(18) *Mary and John and Lisa and Stefan got \$ 10000 for the match.*
$[\lambda PP(\mathbf{m}\oplus\mathbf{j})\ \&\ \lambda PP(\mathbf{l}\oplus\mathbf{s})](\mathbf{got.\$10000})$
$= \mathbf{got.\$10000}(\mathbf{m}\oplus\mathbf{j})\ \&\ \mathbf{got.\$10000}(\mathbf{l}\oplus\mathbf{s})$

Collective readings like in (13) are treated as cases of branching quantifiers, similar as in (19):

(13''') *Napoleon and Wellington and Blücher fought against each other.*

$$\begin{array}{ll} \lambda PP(\mathbf{n}) & x \\ \lambda PP(\mathbf{w}\oplus\mathbf{b}) & y \end{array} \Big\rangle\ \mathbf{fought.against.each.other}(x,y)$$

(19) *Every linguist and every philosopher agree with each other.*

$$\begin{array}{ll} \mathbf{every.linguist} & x \\ \mathbf{every.philosopher} & y \end{array} \Big\rangle\ \mathbf{agree.with.each.other}(x,y)$$

As for the semantics of branching quantifiers, Lønning (1989) refers to Barwise (1979) and Westerståhl (1987). One problem with his approach is that he has to assume two different reciprocal predicates, one unary (for sentences like *the linguists agreed with each other*), and one binary, as in (13''') and (19). It is unclear how this distinction is triggered. (See Krifka 1990 for a uniform treatment of branching quantifiers and one-place reciprocals.)

So much for the arguments for the introduction of groups, and for the proposals for their incorporation into a formal semantic framework. Let us try to give an evaluation.

I think that the notion of groups conflates two phenomena which are actually quite different, namely the semantics of collective nouns on the one hand and on the other the non-associativity phenomena we observed with conjunctions like in (13) or conjunctions together with pluralization like in (14).

For collective nouns, we indeed need something like groups. But the groups we need for them are quite different from the ones proposed by Link or Landman: The

relationship between these groups and their members is much more idiosyncratic than it is suggested in these frameworks. Assume that we have **j** and **m** as pure atomic objects in our model; then **j** and **m** may join to form different couples, committees, societies etc, which we have to introduce as impure atoms – **a**, **a'**, **a''** ... etc. We do not know in general how many such entities we have to assume - just as we do not know in general whether we should, together with **j**, introduce an object **j'** to represent John's left little finger. On the other hand, as probably most of our pure atoms will never join to form couples, committees or deck of cards, we do not have to bother to assume groups which have them as members at all. In short, there is NO SYSTEMATIC RELATIONSHIP between groups and their members which should be built into the model structure. As the technical term "group" carries with it the idea of such a systematic relationship, we should choose another one for this type of entities. As the nouns which denote them are called "collective", a good term might be COLLECTIVE OBJECT.

The situation is quite different with sums. Stylistic limitations aside, we can conjoin any two definite NPs by *and*. If we want to give a semantic interpretation to such a conjoined NP, we must have an object in the domain of our entities to which this conjoined NP refers. And therefore we should assume, for any two objects in our domain, a third object to which the conjoined NP can refer. That is, we have to assume a general sum operation.

The case for groups that arise by conjunction of plural NPs, as in (13), or by multiple conjunctions, as in (14), must be taken as a more serious argument for a systematic group formation, as the groups in these cases are formed in a general, non-idiosyncratic way: We can freely form conjunctions of plural NPs, or multiple conjunctions, and get the readings corresponding to (13) and (14).

The difference between idiosyncratic collective objects and the systematic "group" formation induced by conjunction shows up in the following fact: NPs which denote a collective object that is known to consist of different group objects do not allow for reciprocals or distributives on the group level. This becomes obvious in the following contrast:

(20) a. * *The parliament controls each other.*

b. *The parliament received one million pounds.*

(No reading saying that the two houses received one million pounds each)

(21) a. *The House of Lords and the House of Commons control each other.*

b. *The House of Lords and the House of Commons received one million pounds.*

(Has a reading saying that the two houses received one million pounds each)

These examples show that the group structure must be made explicit by a conjunction; only then it is accessible to reciprocal or distributive readings.

I will point out two additional problems with "groups". One, which was pointed out by Landman (1989) himself, are cases of mixed collective/distributive verb phrases:

(22) *The boys and the girls had to sleep in different dorms, met in the morning at breakfast, and were then wearing their blue uniforms.*

In Link's and Landman's theory, the first verbal predicate (*had to sleep in different dorms*) requires the subject to be a sum of two groups, the group of the boys and the group of the girls, by virtue of the adjective *different*. The third verbal predicate (*were wearing their blue uniforms*) should apply to the sum of all boys and all girls together. The second verbal predicate (*met in the morning*) may be attributed to either one of the representations of the subject NP (in the first case, it is expressed that the group of the boys and the group of the girls met, in the second, that all the children met). Landman, in the tradition of generalizing to the worst case, sketches a solution of this problem in terms of a type-lifting operation. He assumes that the subject NP denotes the group of the sum of the group of the boys and the group of the girls, which is needed to handle the predicate *sleep in different dorms*. The predicates *met at breakfast* and *were wearing their blue uniforms* are transformed to expressions that reduce the subject argument to the kind they need. This works, but only for the price of complicating the semantics of verbal predicates.

Another problem of Landman's account was pointed out by Schwarzschild (1990). He argued that the information we need to treat examples like (13) and (14) may be part of the meaning of the verbal predicate, instead of the meaning of the subject NP. He makes this clear with the following example. Imagine a farm, in which there are animals, namely cows and pigs, which are either young or old. In this model, *the animals* denotes the same object as *the cows and the pigs*, and as *the young animals and the old animals*, namely the maximal object in the extension of *animal*. That is, we have $\delta(^{\oplus}\mathbf{animal}) = \delta(^{\oplus}\mathbf{cow}) \oplus \delta(^{\oplus}\mathbf{pig}) = \delta(^{\oplus}\mathbf{young.animal}) \oplus \delta(^{\oplus}\mathbf{old.animal})$. The meaning of a sentence like

(23) *The animals were separated by age.*

can be rendered as $\mathbf{were.separated.by.age}(\delta(^{\oplus}\mathbf{animal}))$, which in turn should amount to $\mathbf{were.separated.from}(\delta(^{\oplus}\mathbf{young.animal}), \delta(^{\oplus}\mathbf{old.animal}))$, or *the young animals were separated from the old animals*. In this case, the proposed "group" structure does not come from the syntactic form of the subject, as in sentences like *the young animals and the old animals were separated*, but from an adverbial modifier, *by age*. Schwarzschild actually shows that a "group" structure induced by the subject NP may be overridden by the adverbial modifier, as in *The cows and the pigs were separated by age*. He argues that this sentence has the same interpretation as *The animals were separated by age*, as *the cows and the pigs* and *the animals* denote the same object.

I agree with Schwarzschild that the "group" structure may be specified by adverbial modifiers like *by age*. The problem is, however, to explain the cases where we lack an adverbial modifier. Why is a sentence like *The cows and the pigs were separated* usually interpreted as *...separated by race*, whereas *The young animals and the old animals were separated* is usually interpreted as *...separated by age*? If the proposed "group" structure is realized with the verbal predicate, how does it get this information? Note that the subject NPs in both examples refer to the same object, namely $\delta(^{\oplus}\mathbf{animal})$. Schwarzschild does not give a solution to this problem.

In the next section, I will propose a way how to handle the non-associativity phenomena we found with examples like (13) and (14). This treatment will take it seriously that the systematic "groups" are only created by conjunction.

Before doing so, let us look at some more examples to get an idea about the complexity we have to expect. The proposals we have discussed so far differ in one property, namely in the level of non-associativity they assume. In the theories of Link (1984), the first proposal of Landman (1989) and Lønning (1989), we only have non-associativity, or groups, of the first level. In the theories of Hoeksema (1983), Lasersohn (1988) and Landman's refined proposal, we have non-associativity, or groups, of arbitrary level. So the question is whether we indeed need groups beyond the first level. Landman (1989) only gives arguments on the basis of sentences which contain collective nouns, such as (15), which are irrelevant when we treat collective objects as suggested above. It requires some ingenuity to find good examples, using solely conjoined NPs and sum individuals, to support the claim that we need higher-level groups as well. Here are three candidates. The first (24.a) is derived from an example by Lasersohn (1988); however, it makes essential use of collective nouns, and therefore is not convincing. The second one (b) is by Lønning (1989), who gives it a '?'. A combination of both may lead to a (linguistically, if not morally) more acceptable case (c):

(24) a. *The Leitches and the Latches, and the Montagues and the Capulets, are similar in that they hate each other.*

(The Leitches and the Latches are similar to the Montagues and the Capulets insofar as the Leitches hate the Latches and vice versa, and the Montagues hate the Capulets and vice versa)

b. *Mary and John and Lisa and Stefan, and Ann and Bill and Steffi and Boris played against each other in the tennis mixed-double semi-finals.*

(Mary and John played against Lisa and Stefan and vice versa, and Ann and Bill played against Steffi and Boris and vice versa.)

c. *Mary and John and Lisa and Stefan, and Ann and Bill and Steffi and Boris, are similar in that they practice partner-swapping.*

(Mary and John and Lisa and Stefan are similar to Ann and Bill and Steffi and Boris insofar as Mary and John practices partner-swapping with Lisa and Stefan, and Ann and Bill practices partner-swapping with Steffi and Boris.)

In the last example, the first predicate, *be similar*, indicates that the subject NP must be analysed as a "group" consisting of two complex individuals, and the second predicate, *practice partner-swapping*, must access a second subdivision of these two individuals. This is accomplished by first distributing that predicate over the two complex individuals, and then interpreting at as reciprocal, that is, by a combination of distributive and reciprocal readings.

Before I develop my proposal for the treatment of non-associativity, let me sketch a strategy for collective objects. Collective objects are a special sort of individuals. They participate, as every individual, in the general sum lattice. A collective object like the one denoted by *the House of Commons* is atomic, as it has no proper $\leq$-parts; a collective object like the one denoted by *the House of Commons and the House of Lords* is non-atomic, just as in the Link/Landman approach. To handle membership, we can introduce a two-place relation $\leq_m$ between collectives and individuals in general. The fact that John is a member of the collective object **a** can then be expressed by $\mathbf{j} \leq_m \mathbf{a}$. Interpreted in a tense logic setting, we can assume that the membership relation holds with respect to a certain time, and so we can account for the fact that collective objects may change their members. The members of collectives will typically be atomic individuals, either simple objects or collective objects. (A case of a collective having collectives as its members may be the British parliament, which consists of the House of Lords and the House of Commons). Actually, we see that the membership relationship must be parametrized, as we may also consider the individual parliamentarians as members, in line with the ordinary use of "member of parliament". See Winston e.a. (1987) for a discussion of different part-whole relationships, and Moltmann (1990) for a parametrization of the part relation.

Sometimes a fact about a collective object may yield conclusions for its members. For example, from the fact that a committee met, we might infer that some of its members met. This consequence can be spelled out by meaning postulates such as the following one (I assume that COL characterizes collective objects):

(25) $\mathbf{met}(x)\ \&\ \mathrm{COL}(x) \rightarrow \exists y,z[y \leq_m x\ \&\ z \leq_m x\ \&\ \mathbf{met}(y,z)]$

It is obvious that we will need additional meaning postulates of this sort for different predicates. However, the semantics of collective nouns is not the main topic of this paper, and we return to non-associativity induced by conjunction.

2. A Treatment of Non-Associativity in DRT

In this section, we will see how the non-associativity phenomena can be captured without the assumption of either a non-associative sum operation or an intermediary group formation. My proposal is in the spirit of Lønning (1989), as it tries to keep the model simple and locates the non-associativity in the mapping between syntactic structures and semantic representations. It accomplishes that, however, in a different way. The basic idea is that the so-called "group" individuals do not come prefabricated with the model structure, but instead are constructed on the spot in discourse, by NP-conjunction. This captures the fact that "groups" arise with this specific syntactic construction of NP conjunction.

Let us assume a semantic framework designed to represent discourse phenomena such as DRT (cf. Kamp 1981, or Heim 1982 for a related framework). Take the example *the cows and the pigs* in Schwarzschild's scenario. This NP will introduce three discourse referents (DRs) in all: the embedded NP *the cows* introduces a DR anchored to $\delta(^{\oplus}\mathbf{cow})$, the embedded NP *the pigs* introduces a DR anchored to $\delta(^{\oplus}\mathbf{pig})$, and the NP *the cows and the pigs* introduces a DR anchored to $\delta(^{\oplus}\mathbf{cow}) \oplus \delta(^{\oplus}\mathbf{pig})$, which is of course the same object as $\delta(^{\oplus}\mathbf{animal})$. Let us call the discourse referents which are anchored to $\delta(^{\oplus}\mathbf{cow})$ and $\delta(^{\oplus}\mathbf{pig})$ SUB-REFERENTs of the DR anchored to $\delta(^{\oplus}\mathbf{cow}) \oplus \delta(^{\oplus}\mathbf{pig})$. The NP *the young animals and the old animals*, similarly, will introduce DRs anchored to $\delta(^{\oplus}\mathbf{young.animal})$, $\delta(^{\oplus}\mathbf{old.animal})$ and $\delta(^{\oplus}\mathbf{young.animal}) \oplus \delta(^{\oplus}\mathbf{old.animal})$, which is $\delta(^{\oplus}\mathbf{animal})$, where the first two discourse referents are subreferents of the latter one. Although the two NPs *the cows* *and the pigs* and *the young animals and the old animals* introduce discourse referents which are anchored to the same object, $\delta(^{\oplus}\mathbf{animal})$, they make distinct contributions to the discourse, as they introduce different subreferents. The reciprocal predicate, in turn, makes use of that difference.

The association between the NP structure and the interpretation of the verbal predicate, which remained unexplained in Schwarzschild (1990), should be treated as an anaphoric dependency. That is obvious in the case of overt reciprocals, which (in English) are marked by a special type of anaphora (cf. 23.a). In other cases, we can assume that the verbal predicate has an argument place which might be specified by an adverbial like *by age* (cf. 23.b), or that it is related by a non-overt reciprocal anaphor to the subject (c):

(26) a. [*The cows and the pigs*]$_i$ *were separated* [PP *from* [*each other*]$_i$].

b. [*The cows and the pigs*] *were separated* [PP *by age*].

c. [*The cows and the pigs*]$_i$ *were separated* [e_i].

Although *the cows and the pigs* and *the young animals and the old animals* denote the same object, they might differ in their anaphoric properties, as they consist of different NPs that are related to different DRs.

Let us now see how these ideas can be incorporated into DRT. We don't want to get too much involved into general problems of DRS-construction; so I will stay relatively informal here. When we restrict our attention to non-quantificational NPs[4], the rule for the construction of a DRS by a coordinated NP can be formulated as follows. I assume that every NP bears a unique index in its syntactic representation that determines the DR it is associated with; this is not essential, but facilitates the formulation of the semantic rules.

(27) An NP of the syntactic form $[_{NP}[_{NP}\alpha]_{i1}\ (\left\{\begin{matrix}\textit{and}\\ ,\end{matrix}\right\}[[_{NP}\ \alpha]_{i2}\ldots)\ \textit{and}\ [_{NP}\alpha]_{in}]_{in+1}$

introduces n+1 DRs $d_{i1}\ldots d_{in+1}$ with the following conditions:

- for $1\leq k\leq n$, if α_{ik} is an definite or indefinite NP based on a noun α, then add $[\![\alpha]\!](d_{ik})$, (and other conditions, e.g. identify d_{ik} with an accessible DR in the definite case), if α_{ik} is a name, then add $d_{ik} = [\![\alpha_{ik}]\!]$
- $d_{in+1} = d_{i1} \oplus d_{i2} \oplus \ldots \oplus d_{in}$, where $\oplus$ is interpreted by the sum operation;
- for $1\leq k\leq n$, $d_{ik} \leq_d d_{ik+1}$, where $\leq_d$ stands for the subreferent-relation.

[4] See Krifka (1990) for a possible way to handle quantified NPs by means of a generalized sum operation, though not in DRT.

For the interpretation of predicate/argument-structures, I assume that at some level of syntactic representation, an argument is coindexed with an argument slot of the predicate to which it stands in syntactic construction. This syntactic coindexation is interpreted by putting the discourse referent associated with the syntactic argument into the corresponding argument slot of the semantic representation of the predicate. I distinguish two types of argument slots, normal slots and reciprocal slots (marked by *rec*). Reciprocal slots have to be coindexed with one argument slot. In the examples we considered so far, this has always been the subject slot; in cases like *John introduced Mary and Bill to each other*, the reciprocal slot is coindexed with the direct object slot of the predicate *introduced*.

(28) If $[_{NP}\alpha]_i$ is a NP with *index i that is in syntactic construction* with a predicate $\beta[_k i]$, where $[_k i]$ is the k-th argument slot, and if $[_{NP}\alpha]_i$ is associated with the discourse referent d, then the DRS-condition by which $\beta[_k i]$ is interpreted will have the form $[\![\beta]\!][_k d]$, that is, d is in the k-th argument slot of β's semantic representation.

For the interpretation of reciprocal predicates, I assume the following rule:

(29) If (i) $[_{NP}\alpha]_i$ is a NP with index i in syntactic construction with a predicate $\beta[_k i][_l i/rec]$, where $[_k i]$ is the k-th argument slot and $[_l i/rec]$ is the l-th argument slot which is marked as reciprocal (either covertly or overtly, by a reciprocal pronoun) and bears the same index i,
and (ii) $[_{NP}\alpha]_i$ is related to a DR d that has distinct subreferents d', d" (that is, there are conditions $d' \leq_d d$ and $d'' \leq_d d$ with $d' \neq d''$), then add for every two distinct subreferents d', d" of d the condition $[\![\beta]\!][_k d'][_l d'']$.

As an example, consider the following sentence and its discourse representation structure (DRS):

(30) *The cows and the pigs were separated (from each other).*
$[_{NP}[_{NP}$ *The cows* $]_1$ *and* $[_{NP}$ *the pigs*$]_2]_3$ *were separated* [3, 3/rec].

d_1 d_2 d_3
$d_1 = \delta(^{\oplus}\mathbf{cow})$
$d_2 = \delta(^{\oplus}\mathbf{pig})$
$d_3 = d_1 \oplus d_2$
$d_1 \leq_d d_3$
$d_2 \leq_d d_3$
were.separated(d_1, d_2)
were.separated(d_2, d_1)

The rule for conjoined NPs (24) introduces the DRs d_1, d_2 and d_3 and yields the first five conditions. The rule for reciprocal predicates (26) introduces the last two conditions. 7 9

Note that the $\le_d$-conditions are special, insofar as their satisfaction does not depend on the model and on the embedding function. They do not capture anything in the "world"[5], but a relation that is established by the discourse. Call these conditions META CONDITIONS. Also, the discourse referent symbols d, d', d" mentioned in rule (24) are special as they are metalanguage variables over real DRs. Let us call them META DRS.

An alternative formulation of (29) specifies the semantics of reciprocal predicates as a quantification in the representation language of DRT itself:

(29') - If (i) and (ii) as in (26), 9
- then add the sub-DRS

$$\boxed{\begin{array}{l} d' \quad d'' \\ \hline d' \le_d d \\ d'' \le_d d \\ d' \neq d'' \end{array}} \rightarrow \boxed{\begin{array}{l} \\ \hline [\![\beta]\!][_k d'][_l d''] \end{array}}$$

In our example, this would lead to the following DRS:

(31)

$$\boxed{\begin{array}{l} d_1 \quad d_2 \quad d_3 \\ \hline d_1 = \delta(^{\oplus}\mathbf{cow}) \\ d_2 = \delta(^{\oplus}\mathbf{pig}) \\ d_3 = d_1 \oplus d_2 \\ d_1 \le_d d_3 \\ d_2 \le_d d_3 \\ \boxed{\begin{array}{l} d' \quad d'' \\ \hline d' \le_d d_3 \\ d'' \le_d d_3 \\ d' \neq d'' \end{array}} \rightarrow \boxed{\begin{array}{l} \\ \hline \mathbf{were.separated}(d', d'') \end{array}} \end{array}}$$

Here, the sub-DRS can be spelled out in such a way that we arrive at the representation (31), as d', d" can get either the values d_1, d_2 or d_2, d_1, respectively. Note that the DRs d', d" have to be taken as meta-discourse-referents, which are anchored to other discourse referents, and the subreferent conditions and the inequality relation have to be taken as meta conditions, which are checked not with respect to the model, but with respect to the (preceding) DRS itself.

The rule for reciprocal predicates given above cannot be the only one, as we also have reciprocals in cases like *The animals were separated from each other*, where we indeed refer to atomic objects in the model. To handle this case, we can assume the following rule:

(32) If (i), but not (ii) as in (29),
then add the following sub-DRS (where d_n, d_{n+1} are new DRs):

$$\boxed{\begin{array}{l} d_n \quad d_{n+1} \\ \hline d_n \le_a d \\ d_{n+1} \le_a d \\ d_n \neq d_{n+1} \end{array}} \rightarrow \boxed{\begin{array}{l} \\ \hline [\![\beta]\!][_k d_n][_l d_{n+1}] \end{array}}$$

As we should presuppose that the quantification in this rule is non-vacuous, it is required that d is anchored to a non-atomic individual. With this rule, our example gets the following interpretation:

(33) *The animals were separated (from each other).*
[$_{NP}$ *The animals*]$_1$ *were separated* [1,1/rec]

$$\boxed{\begin{array}{l} d_1 \\ \hline d_1 = \delta(^{\oplus}\mathbf{animal}) \\ \boxed{\begin{array}{l} d_2 \quad d_3 \\ \hline d_2 \le_a d_1 \\ d_3 \le_a d_1 \\ d_2 \neq d_3 \end{array}} \rightarrow \boxed{\begin{array}{l} \\ \hline \mathbf{were.separated}(d_2, d_3) \end{array}} \end{array}}$$

Two remarks are in order here. First, the reciprocal rule (32) looks quite similar to the reciprocal rule (29'). The only difference is that they employ different part relations ($\le_d$ in 29', $\le_a$ in 32), and that the DRs are mapped to different kinds of entities (to other discourse referents in 29', to entities in the world model in 32). So we can assume that reciprocity is indeed a uniform notion, and varies only insofar as we can either apply it to the world model or to the discourse representation itself. But note that the reciprocal rule cannot use just any part relation. For example, it cannot be spelled out in terms of membership to collective objects; therefore a sentence like **The committee argued against each other* is ill-formed (cf. also 20).

[5] But note that whenever we have a condition like $d_1 \le_d d_3$, we also have a condition like, e.g., $d_3 = d_1 \oplus d_2$, which implies that the object that d_1 is anchored to is a part of the object d_3 is anchored to.

Second, the formulation of (32) says that only when the subject DR lacks subreferents, we have to assume reciprocity over objects. This might be too rigid, as a sentence like *the cows and the pigs were separated (from each other)* also has the reading that each animal was separated from every other animal. However, if the subject NP does introduce subreferents, then rule (29') seems to be preferred.

The rules for NP conjunction and reciprocal predicates handle cases like *Napoleon and Wellington and Blücher fought against each other* quite nicely. There are three possible syntactic structures of the subject NP: [*Napoleon and Wellington and Blücher*], [[*Napoleon and Wellington*] *and Blücher*], and [*Napoleon and* [*Wellington and Blücher*]]. To get the historically correct reading, we have to assume the last structure. That *Wellington and Blücher* indeed forms a constituent can be shown by the fact that we cannot permutate all three basic NPs and still get the historically correct reading (as in *Wellington and Napoleon and Blücher fought against each other*). Furthermore, the NP *Napoleon and Wellington and Blücher*, in the intended reading, will typically have an intonation pattern by which it becomes clear that *Wellington and Blücher* form a subconstituent. So we can assume the following analysis:

(34) *Napoleon and Wellington and Blücher fought against each other.*
$[_{NP}[_{NP}\ \textit{Napoleon}]_1\ \textit{and}\ [_{NP}[_{NP}\ \textit{Wellington}]_2\ \textit{and}\ [_{NP}\ \textit{Blücher}]_3]_4]_5$
fought against [5,5/rec]

$$
\begin{array}{|l|}
\hline
d_1 \quad d_2 \quad d_3 \quad d_4 \quad d_5 \\
\hline
d_1 = n \\
d_2 = w \\
d_3 = b \\
d_4 = d_2 \oplus d_3 \\
d_2 \leq_d d_4 \\
d_3 \leq_d d_4 \\
d_5 = d_1 \oplus d_4 \\
d_1 \leq_d d_5 \\
d_4 \leq_d d_5 \\
\begin{array}{|l|}
\hline
d' \quad d'' \\
\hline
d' \leq_d d_5 \\
d'' \leq_d d_5 \\
d' \neq d'' \\
\hline
\end{array}
\rightarrow
\begin{array}{|l|}
\hline
\\
\hline
\textbf{fought.against}(d', d'') \\
\hline
\end{array} \\
\hline
\end{array}
$$

The rule for NP-conjunction (27) triggers the introduction of five DRs and the first nine conditions, given the proposed syntactic structure of the subject NP. The rule for reciprocal predicates (in the version 26') says that for every d', d" with $d' \neq d''$ and d' ikd d_5 and $d'' \leq_d d_5$ it holds that **fought.against**(d', d"). In this case, we have only two pairs of discourse referents for which the antecedent is satisfied, namely d_1 and d_4, and d_4 and d_1. Note that we do not assume that the subreferent relation is transitive; this is essential for our account. So the complex condition amounts to two simple conditions, **fought.against**(d_1,d_4) and **fought.against** (d_4,d_1). In this way, we arrive at the correct truth conditions.

We have formulated two related rules for reciprocal predicates. Similar rules have to be assumed for distributive readings. A predicate may either distribute down to atomic entities, as in (35.a), or down to subreferents, as in the intermediary distributive reading of (35.b) (cf. 18):

(35) a. *The players got $ 10000 for the match.*
b. *Mary and John and Lisa and Stefan got $10000 for the match.*

I will consider only distributivity over the subject here, and I assume that this reading is marked (by a subscript D). The rule can be formulated as follows:

(36) If there is a condition $[\![\beta_D]\!](d)$, where β_D is a distributive predicate, and β is its non-distributive form, then:

a. If there are subreferents d' of d, then add the sub-DRS

$$
\begin{array}{|l|}
\hline
d' \\
\hline
d' \leq_d d \\
\hline
\end{array}
\rightarrow
\begin{array}{|l|}
\hline
\\
\hline
[\![\beta]\!](d') \\
\hline
\end{array}
$$

b. Otherwise, add the sub-DRS

$$
\begin{array}{|l|}
\hline
d' \\
\hline
d' \leq_a d \\
\hline
\end{array}
\rightarrow
\begin{array}{|l|}
\hline
\\
\hline
[\![\beta]\!](d') \\
\hline
\end{array}
$$

It is obvious that (36.a) gives us the intermediary distributive reading for examples like (35.b), given a proper syntactic analysis of the subject NP:

(37) [[*Mary*$_1$ *and John*$_2$]$_3$ *and* [*Lisa*$_4$ *and Stefan*$_5$]$_6$]$_7$ *got $10000 for the match.*

$d_1\ d_2\ d_3\ d_4\ d_5\ d_6\ d_7$

$d_1 = \mathbf{m}$	$d_4 = \mathbf{l}$
$d_2 = \mathbf{j}$	$d_5 = \mathbf{s}$
$d_3 = d_1 \oplus d_2$	$d_6 = d_4 \oplus d_5$
$d_1 \leq_d d_3$	$d_4 \leq_d d_6$
$d_2 \leq_d d_3$	$d_5 \leq_d d_6$
$d_7 = d_3 \oplus d_6$	
$d_3 \leq_d d_7$	
$d_6 \leq_d d_7$	

$$\boxed{\begin{array}{c} d' \\ \hline d' \leq_d d_7 \end{array}} \rightarrow \boxed{\begin{array}{c} \\ \hline \mathbf{got.\$10000}(d') \end{array}}$$

It may be interesting to note that the theory developed here is indeed able to cope with predications in which distributivity and reciprocity occurs together, as in example (20.c):

(38) [[[*Mary*$_1$ *and John*$_2$]$_3$ *and* [*Lisa*$_4$ *and Stefan*$_5$]$_6$]$_7$ *and* [[*Ann*$_8$ *and Bill*$_9$]$_{10}$ *and* [*Steffi*$_{11}$ *and Boris*$_{12}$]$_{13}$]$_{14}$]$_{15}$ *are similar* [15,15/rec] *in that they*$_{15}$ [*practice partner-swapping*$_D$[15,15/rec]]

$d_1\ d_2\ d_3\ d_4\ d_5\ d_6\ d_7\ d_8\ d_9\ d_{10}\ d_{11}\ d_{12}\ d_{13}\ d_{14}\ d_{15}$

$d_1 = \mathbf{m}$	$d_4 = \mathbf{l}$	$d_8 = \mathbf{a}$	$d_{11} = \mathbf{e}$
$d_2 = \mathbf{j}$	$d_5 = \mathbf{s}$	$d_9 = \mathbf{b}$	$d_{12} = \mathbf{o}$
$d_3 = d_1 \oplus d_2$	$d_6 = d_4 \oplus d_5$	$d_{10} = d_8 \oplus d_9$	$d_{13} = d_{11} \oplus d_{12}$
$d_1 \leq_d d_3$	$d_4 \leq_d d_6$	$d_8 \leq_d d_{10}$	$d_{11} \leq_d d_{13}$
$d_2 \leq_d d_3$	$d_5 \leq_d d_6$	$d_9 \leq_d d_{10}$	$d_{12} \leq_d d_{13}$
$d_7 = d_3 \oplus d_6$		$d_{14} = d_{10} \oplus d_{13}$	
$d_3 \leq_d d_7$		$d_{10} \leq_d d_{14}$	
$d_6 \leq_d d_7$		$d_{13} \leq_d d_{14}$	
$d_{15} = d_7 \oplus d_{14}$			
$d_7 \leq_d d_{15}$			
$d_{14} \leq_d d_{15}$			

$$\boxed{\begin{array}{l} d' \quad d'' \\ \hline d' \leq_d d_{15} \\ d'' \leq_d d_{15} \\ d' \neq d'' \end{array}} \rightarrow \boxed{\begin{array}{c} \\ \hline \mathbf{similar}(d', d'') \end{array}}$$

$$\boxed{\begin{array}{l} d' \\ \hline d' \leq_d d_{15} \end{array}} \rightarrow \left[\boxed{\begin{array}{l} d'' \quad d''' \\ \hline d'' \leq_d d' \\ d''' \leq_d d' \\ d'' \neq d''' \end{array}} \rightarrow \boxed{\begin{array}{c} \\ \hline \mathbf{practice.p\text{-}s}(d'', d''') \end{array}} \right]$$

The complex NP introduces fifteen DRs. The rule for reciprocal predicates (29') yields the first pair of sub-DRSs, which can be spelled out by the two simple conditions **similar**(d_7, d_{14}) and **similar**(d_{14}, d_7). We assume that *they* simply picks up the DR d_{15}, and that the predicate *practice partner-swapping* is interpreted as distributive. The rule for distributive predicates yields the second pair of sub-DRSs, which expresses a quantification over all subreferents d' of d_{15} (here, d_7 and d_{14}). The consequent contains a reciprocal predicate, the interpretation of *practice partner-swapping (with each other)*. Hence we get an embedded pair of sub-DRs which expresses a quantification over the distinct subreferents of d'. This amounts to the following four simple conditions: **practice.p-s**(d_3, d_6), **practice.p-s**(d_{10}, d_{13}), **practice.p-s**(d_6, d_3), and **practice.p-s**(d_{13}, d_{10}). No effort was made to render the relation between the two predicates given by *in that*.

We have developed a way to represent the non-associativity due to conjoined NPs in DRT by assuming that these NPs introduce DRs that stand in the subreferent-relation to each other, and that the interpretation of reciprocal and distributive readings makes use of this relation. However, I have not shown yet how a DRS that contains subreferent-relations and meta-DRSs is to be interpreted with respect to a model. This will be the subject of the remainder of this section.

The interpretation rules for standard DRs should be extended as follows. Assume that we have, in addition to a set of ordinary DRs **D**, a *set of meta* DRs **MD**; we assume $\mathbf{D}\cap\mathbf{MD}=\varnothing$. Let a MODEL for DRSs, $\langle \mathbf{A}, \mathbf{F}\rangle$, consist of a set of objects **A** (the universe of entities) and an interpretation function **F** for simple conditions whose argument slots are filled by ordinary DRs. The possible ANCHORS FOR ORDINARY DR'S are the partial functions from **D** to **A**; I will refer to them by **f**, **f'** etc. The possible ANCHORS FOR META DR'S are the partial functions from **MD** to **D**; I will refer to them by **g**, **g'**, etc. The possible PART RELATIONS FOR DR'S are subsets of the cartesian product **DXD**; I will refer to them by **P**, **P'** etc.

A DRS consists of a set of (ordinary or meta-) discourse referents DRF and a set of (simple or complex) conditions DC; so let us represent them in general by pairs $\langle$DRF, DC$\rangle$. The interpretation for a DRS will depend on the "world", represented by the model $\langle \mathbf{A}, \mathbf{F}\rangle$. In addition, it will depend on the discourse up to the current point, and will in turn influence the interpretation of the later discourse. In particular, it will depend on the anchoring functions for ordinary and meta discourse referents, and on the part relation for DRs constructed by the preceding discourse. So let us assume that the interpretation of a DRS is dependent upon an INPUT CONTEXT, consisting of anchors **f**, **g** and a relation **P**, and that it creates an OUTPUT CONTEXT, consisting of anchors **f'**, **g'** and a relation **P'**. This format is reminiscent of the interpretation rules in dynamic semantics (e.g. Barwise 1987, Groenendijk & Stokhof 1989); the difference is that we have in addition to the normal variable assignment **f** *a second* variable assignment **g** and a part relation **P**.

The truth conditions for DRS can now be spelled out as follows:

(39) A DRS $\langle$DRF, DC$\rangle$ is **true** with respect to the model $\langle \mathbf{A},\mathbf{F}\rangle$, the input **f**, **g**, **P** and the output **f'**, **g'**, **P'** iff:
i) $\mathrm{DRF}\cap\mathrm{DOM}(\mathbf{f}) = \mathrm{DRF}\cap\mathrm{DOM}(\mathbf{g}) = \varnothing$;
ii) $\mathrm{DOM}(\mathbf{f'}) = \mathrm{DOM}(\mathbf{f}) \cup(\mathrm{DRF}\cap\mathbf{D})$;
iii) $\mathrm{DOM}(\mathbf{g'}) = \mathrm{DOM}(\mathbf{g}) \cup(\mathrm{DRF}\cap\mathbf{MD})$;
iv) $\mathrm{RNG}(\mathbf{g'}) \subseteq \mathrm{DOM}(\mathbf{f'})$;
v) $\mathbf{f}\subseteq\mathbf{f'}$, $\mathbf{g}\subseteq\mathbf{g'}$, and $\mathbf{P}\subseteq\mathbf{P'}$;
vi) the conditions in DC are true with respect to $\langle \mathbf{A},\mathbf{F}\rangle$ and **f'**, **g'**, **P'**;
vii) **P'** is the smallest relation satisfying the requirements (v) and (vi).

(i) says that the DRs in DRF are new with respect to the input (DOM stands for "domain"). (ii) and (iii) say that the anchors of the output are defined on the DRs of the input, plus the new DRs introduced by DRF. (iv) says that the output anchor for meta DRs may map meta DRs only to those ordinary DRs that are already introduced at the current point (RNG stands for "range"). (v) says that the output is an extension of the input. (vi) says that all the conditions must be satisfied with respect to the output; this requirement will be discussed in a moment. (vii) says that we should assume only those part relations that are indeed licensed by conditions in DC. This entails, in particular, that the relation $\leq_d$ is neither transitive nor reflexive (in combination with the next statement).

Next let us look at the interpretation for simple conditions. Note that their truth will be defined with respect to the model, two anchor functions **f**, **g** and a part relation **P**, according to (39) above.

(40) i. A condition $a(d_j...d_k)$ (alternatively, $d_i = a$) is TRUE with respect to $\langle \mathbf{A}, \mathbf{F}\rangle$ and **f**, **g**, **P** iff $\langle h(d_j),...h(d_k)\rangle \in \mathbf{F}(a)$ (alternatively, $h(d_i) = \mathbf{F}(a)$), where $h(d) = \mathbf{f}(d)$, if $d\in\mathbf{D}$, and $h(d) = \mathbf{f}(\mathbf{g}(d))$, if $d\in\mathbf{MD}$.

ii. A condition $d_i\leq_d d_k$ (alternatively, $d_i \neq d_k$) is **true** with respect to $\langle \mathbf{A},\mathbf{F}\rangle$ and **f**,**g**,**P** iff $\langle h(d_i), h(d_k)\rangle \in \mathbf{P}$ (alternatively, $h(d_i) \neq h(d_k)$), where $h(d) = d$, if $d\in\mathbf{D}$, and $h(d) = \mathbf{g}(d)$, if $d\in\mathbf{MD}$.

There are two types of simple conditions. (i) covers usual simple conditions that are interpreted with respect to the model, like **were.separated**(d_1,d_2) in (30), or d_1 = **n** in (34). Ordinary discourse referents are interpreted as usual by the anchor function **f**; in the case of meta DRs, we first have to find the ordinary DR for which they stand, given **g**. We understand the condition $a(d_i...d_k)$ broadly; it should also cover conditions like "$d=d'\oplus d''$", which corresponds to a three-place relation. (ii) covers the two relations $\leq_d$ and $\neq$ that do not correspond to anything in the model, but are interpreted by the part relation **P** or the inequality relation on DRs. Again, we have to distinguish between the cases of ordinary DRs and meta DRs. Finally, we have the interpretation rule for complex conditions:

(41) A complex condition $DRS_1 \rightarrow DRS_2$ is true with respect to $\langle \mathbf{A}, \mathbf{F} \rangle$ and **f**, **g**, **P** iff
for every **f'**, **g'**, **P'** such that DRS_1 is true with respect to $\langle \mathbf{A}, \mathbf{F} \rangle$, the input **f**, **g**, **P** and the output **f'**, **g'**, **P'**,
there are **f"**, **g"**, **P"** such that DRS_2 is true with respect to $\langle \mathbf{A}, \mathbf{F} \rangle$, the input **f'**, **g'**, **P'** and the output **f"**, **g"**, **P"**.

This is the usual condition for complex conditions, now enriched with the additional parameters of an anchor for meta DRs and a part relation for DRs.

In (39) we have defined what it means that a DRS is true with respect to a model, an input and an output. Let us say that a DRS is TRUE WITH RESPECT TO A MODEL SIMPLICITER iff it is true with respect to that model, some input, and some output. This corresponds to the familiar rule of existential closure.

To see how these rules work, it is perhaps best to look at an example. Take the DRS (34), for *Napoleon and Wellington and Blücher fought against each other.* Let us assume that the set of individuals **A** contains N, W and B as elements, and hence also their sums N+W, W+B, etc., where + is the sum operation on individuals in **A**. Furthermore, let us assume that **F** assigns the constants to their appropriate value; in particular, let **F**(**n**) = N, **F**(**w**) = W, **F**(**b**) = B, and **F**(**fought.against**) = FOUGHT.AGAINST, with <N, B+W> ∈ FOUGHT.AGAINST, <B+W, N> ∈ FOUGHT.AGAINST. Also, let **F**(⊕) = +. For reasons of simplicity, we start with an empty input, that is, **f** = **g** = **P** = ∅.

According to (39), the DRS (34) is true with respect to the model <**A**, **F**>, the input **f**, **g**, **P** and the output **f'**, **g'**, **P'** iff DOM(**f'**) = $\{d_1, d_2, d_3, d_4, d_5\}$, DOM(**g'**) = ∅, and the following conditions are satisfied:

(Cond. 40)

- $\mathbf{f}(d_1) = \mathbf{F}(\mathbf{n}) = N$, $\mathbf{f}(d_2) = \mathbf{F}(\mathbf{w}) = W$, $\mathbf{f}(d_3) = \mathbf{F}(\mathbf{b}) = B$;
- $\mathbf{f}(d_4) = \mathbf{F}(\mathbf{f}(d_2))\mathbf{F}(\oplus)\mathbf{F}(\mathbf{f}(d_3)) = W{+}B$;
- $\mathbf{f}(d_5) = \mathbf{F}(\mathbf{f}(d_1))\mathbf{F}(\oplus)\mathbf{F}(\mathbf{f}(d_4)) = N{+}(W{+}B) = N{+}W{+}B$ (associativity of +);
- $\langle d_2,d_4\rangle \in \mathbf{P'}$, $\langle d_3,d_4\rangle \in \mathbf{P'}$, $\langle d_1,d_5\rangle \in \mathbf{P'}$, $\langle d_4,d_5\rangle \in \mathbf{P'}$, and as **P'** is the smallest such relation, that is, $\mathbf{P'} = \{\langle d_2,d_4\rangle, \langle d_3,d_4\rangle, \langle d_1,d_5\rangle, \langle d_4,d_5\rangle\}$;

(Cond. 41)

for every **f"**, **g"**, **P"** such that $\langle \{d',d"\}, \{d' <_d d_5, d" <_d d_5, d' \neq d"\}\rangle$ is true with respect to <**A**, **F**>, the input **f'**, **g'**, **P'** and the output **f"**, **g"**, **P"**,
that is, for **f"** = **f'**, **P"** = **P'**, DOM(**g"**) = {d', d"}, RNG(**g"**) ⊆ $\{d_1, d_2, d_3, d_4, d_5\}$
such that $\langle \mathbf{g"}(d'), d_5\rangle \in \mathbf{P"}$, $\langle \mathbf{g"}(d"), d_5\rangle \in \mathbf{P"}$, and $\mathbf{g"}(d') \subseteq \mathbf{g"}(d")$,
that is, for $\mathbf{g"} = \{\langle d', d_1\rangle, \langle d", d_4\rangle\}$ and $\mathbf{g"} = \{\langle d', d_4\rangle, \langle d", d_1\rangle\}$,

there is a **f'''**, **g'''**, **P'''** such that <∅, {**fought.against**(d',d")}> is true with respect to <**A**, **F**>, the input **f"**, **g"**, **P"**, and the output **f'''**, **g'''**, **P'''**,
that is, for **f'''**=**f"**, **g'''**=**g"**, **P'''**=**P"**, the condition **fought.against**(d',d") is true,
that is, $\langle \mathbf{f'''}(\mathbf{g'''}(d')), \mathbf{f'''}(\mathbf{g'''}(d"))\rangle \in \mathbf{F}(\mathbf{fought.against})$,
that is, $\langle \mathbf{f'''}(d_1), \mathbf{f'''}(d_4)\rangle$, $\langle \mathbf{f'''}(d_4), \mathbf{f'''}(d_1)\rangle \in \mathbf{F}(\mathbf{fought.against})$,
that is, <N, W+B> ∈ FOUGHT.AGAINST and <W+B, N> ∈ FOUGHT.AGAINST.

Given the model specified above, this is indeed true. So the DRS (34) is true with respect to <**A**, **F**> simpliciter, as expected.

3. World-Oriented and Discourse-Oriented Semantics

The analysis presented in the last section has a moral. Our procedure can be characterized as follows: Instead of assuming model structures with built-in groups, we construct the "groups" we need at a specific point in discourse from scratch, by the subreferent relation. For example, instead of assuming model structures which contain a group consisting of Wellington and Blücher in the model, we introduced (in 34) a DR d_4 which refers to the ordinary sum of Wellington and Blücher and stands in the subreferent relation to d_5 which represents the subject of the reciprocal predicate. We could say that the sum of Wellington and Blücher is HIGHLIGHTED by the subreferent relation in the discourse, and that the semantics of reciprocal predicates may be spelled out in terms of such highlighted sum individuals, if they are present.

A consequence of this is that the model structure for the semantic representation that captures the ontology of the "world" becomes simpler. We no longer assume an independent group level, or alternatively a non-associative sum formation; it suffices to have one, associative, sum formation. However, in other respects the semantic representation will get more complicated: We have to assume meta-DRs with meta DRs that are anchored to other discourse referents, and we have to assume a separate variable assignment for meta DR and a part relation that is changed during discourse. That is, the semantic representation of an expression will not only depend on the model of the world, but also on the structure of the discourse itself.

The framework developed here has one essential advantage: It factorizes the structures that serve to interpret a sentence into two "modules", the world and the discourse. Although we may argue that the discourse is part of the world that it describes, it is useful to keep these two modules distinct, as they are governed by different principles. For example, whereas the discourse module will change during discourse, the world module typically will stay constant.

The interpretation of conjoined NPs is only one example of the phenomenon that the interpretation of an expression may be dependent on the prior discourse. The classical case, and the one which is treated in standard DRT, is anaphoric reference: The reference of a pronominal element depends on its antecedent. Related to anaphors are discourse-deictic NPs like *the above-mentioned*, or *the latter*.

A further example, perhaps closer to the main topic of this paper are *respectively*-constructions:

(42) *John, Mary and Sue went to the pub, visited a museum and stayed home* (*respectively*).

In this case, it is the SEQUENCE of the noun phrases which make up the subject NP that influences the interpretation of the following expressions. As we have assumed that sum formation is commutative, we cannot handle that in our model structure; according to that, *John, Mary and Sue* denotes the same object as, say, *Mary, John and Sue*. One possibility would be to introduce a sum formation which is not commutative; this would be an operation similar to list formation (cf. Link 1984b, Lasersohn 1988). However, such a sum formation would obviously require a model structure which is drastically more complex than the one with a commutative sum formation. It would have to introduce different complex objects for every possible sequence in which we can mention simpler objects, once and for all, in our model. Again, we should prefer a theory in which we encode the order of the sub-NPs only in the discourse representation, namely in their discourse referents and the order in which they are introduced. Note that we need the information about the temporal order anyway for the central task of discourse representations, namely anaphora resolution, as we have pronominal forms like *the former* and *the latter*, or *the first, the second* etc. which make use of that order information.

Another, though related, case is that the sequence of events in a narrative discourse is often not indicated overtly, but follows from the order in which they are described. To cite a well-known example, *Sue married and got pregnant* will normally be interpreted differently from *Sue got pregnant and married*. There are different ways to handle this phenomenon, among others the assumption that *and* is ambiguous and can mean *and then*. Alternatively, we can assume a general rule that the sequence of the reports of events is, by default, the same as the sequence of the reported events. We can incorporate this in different ways – for example, we may assume that episodic sentences like *Sue married* introduce DRs which are anchored to events, and that the order of the introduction of these DRs is the same as the temporal order of the events they refer to.

The concept of a discourse-oriented module of semantics that evolves from these observations has some methodological consequences. When we want to exploit the discourse in the way sketched above, its structure becomes essential for the semantic representation. This means that there is some representation of the discourse (that contains more than just its truth conditions and the DRs that are introduced) that is essential for the interpretation of the discourse itself. Hence we have found evidence that this level of discourse representation cannot be taken as a mere auxiliary construction. That can be seen as contrary to the spirit of the recent work by Groenendijk & Stokhof (1989). However, it is still possible to develop a compositional semantics for discourses, essentially by the same device as proposed by Groenendijk & Stokhof (and Heim 1982, chapter 3, or Barwise 1987), namely "contexts". The contexts we need, however, will contain much more than just a variable assignment.

Let us come back to the main topic of this paper, the elimination of groups. If we really are after model structures that cover the intuitive ontology, it is tempting to try out whether we can get rid of the sum formation itself, using a more complex discourse representation. Why should we assume, in case we have two individuals **j**, John, and **m**, Mary, in our universe, that we also have a third one, **j⊕m**, John and Mary? We could argue that whenever we want to ascribe a property to that individual, e.g. that John and Mary met each other, we can construct this individual from scratch, by the NP *John and Mary* which introduces three DRs, d_1, which is anchored to **j**, d_2, which is anchored to **m**, and d_3, which need not be anchored directly to any individual but to which d_1 and d_2 stand in the subreferent relation. Our semantics for reciprocal predicates would handle these cases, and it is easy to define a proper semantics for distributive predicates as well. So we would not need the sum individual **j⊕m** anymore. By this move, we would get a plausible and uniform theory for NP conjunction.

However, there are problems with such a radical view. One problem is that it is unclear how we should handle the other case which supports the introduction of sum individuals, namely plural NPs. For example, with an NP like *the boys*, anchored to a DR d, we would have to assume that we introduce subreferents of d for every individual in our model which is a boy, for cases like *the boys met* or *the boys walked*. But this is quite to the contrary of the spirit of DRT, as we did not mention the individual boys with the NP *the boys*, and they are not accessible as antecedents for pronouns. For the sentence like *the 10000 soldiers marched into the country*, we would have to introduce 10001 new DRs, and for the sentence *These mosquitos are nasty* we would have to introduce an arbitrary number of DRs. These consequences are as untenable as it was untenable for Generative Semantics to derive those sentences from deep structures consisting of

10000 or an arbitrary number of sentences (cf. Postal 1966, Tai 1969, after Wierzbicka 1980).

Another problem is that even for cases like (34) we need plural entities. We have assumed above that the pair <N, W+B> stands in the FOUGHT.AGAINST relation. In doing so, we made essential use of the sum individual W+B.

It seems, thus, that although we make up "groups" on our own in discourse, sums are real objects, out there in the world.

Appendix:

Coordinated NPs and Plurals, and Weaker Forms of Reciprocity

As pointed out by Link (1984, 1987), there seems to be a slight difference between coordinated NPs like *John, Mary and Bill* and definite plural NPs like *the children*, even if they refer to the same object: We tend to understand a sentence like *John, Mary and Bill built the raft* as saying that all of them contributed in the building of the raft. A sentence like *The children built the raft* allows more easily for an interpretation where some of the children did not actually take part in it. Similarly, with a distributive sentence like *John, Mary and Bill went to school* we must assume that every one of them went to school. A sentence like *The children went to school* may have an interpretation which allows for an occasional sick child that stayed home.

However, this difference between a strict interpretation with conjoined NPs and a lax, or 'grosso modo' interpretation with a plural NP need not be taken as evidence that these two NPs refer to different entities, as there are pragmatic reasons for that difference. We can assume that whenever an object x has a property P, then this property is projected to objects containing x; for example, when John and Mary have built the raft, then it is also true that John, Mary and Bill have built the raft. Of course, this semantic property projection must be limited. It is restricted by a pragmatic principle which follows from the maxim of quantity (Grice 1967) and which we need anyhow: In the example just cited, the sentence *John, Mary and Bill built the raft* would be less informative than the sentence *John and Mary built the raft*, and as the speaker is obliged to make his contributions as informative as possible, he is forced to use the second sentence in case Bill did not participate in the raft building. The maxim of quantity may conflict with other maxims, such as the one which requires to make contributions not too complex. This maxim might license sentences like *The children built the raft* even if not every child participated, as the sentence *The children, with the exception of Bill, built the raft* may be too complex. In the case of conjunctions, both maxims coincide; in our example, *John, Mary and Bill built the raft* is both less informative and more complex than *John and Mary built the raft* (if indeed only John and Mary participated). Dowty (1986) employs a similar argument for cases like *the children built the raft* and *all the children built the raft*.

Another point which needs some qualification is the semantics of reciprocity. Both in the meaning postulate for REC (3) and in the DRS-rules for reciprocal predicates (29, 29') we assumed a rather strong interpretation. There are many cases where reciprocity cannot be taken as a quantification over every pair of distinct elements of a set

– a sentence like *The children took each other by the hand* does not necessarily entail that each possible pairing of two children is such that they took each other by the hand (cf. Langendoen 1978).

One way to handle that is simply to weaken the formula or rule for reciprocity. Another way, which was proposed in Krifka (1990), is to retain the strict definition of reciprocity, but allow for a distributive interpretation of reciprocal predicates, similar to (38). The idea is the following: Many predicates α are such that whenever $\alpha(\beta)$ and $\alpha(\gamma)$ holds, then $\alpha(\beta\oplus\gamma)$ holds as well. For example, if *John walks* is true and *Mary walks* is true, then *John and Mary walk* is true as well. This is, of course, the distributive reading, and we should have marked the predicate a accordingly, e.g. by writing $\alpha_D(\beta\oplus g)$. Now we can assume that reciprocal predicates can occur distributively as well, as in example (38). So, if α[i,i/rec] is a reciprocal predicate and we have α[i,i/rec] and α[j,j/rec], (in the strict interpretation), then we can conclude (in a sloppy notation) $[\alpha[i\oplus j, i\oplus j/rec]]_D$. This in turn will yield the weak interpretation. For example, if we know that John and Sue took each other by the hand, and that Bill and Mary took each other by the hand, then *John and Sue and Bill and Mary took each other by the hand* will be true, and similarly (if these people are the children), *The children took each other by the hand.*

Obviously, we lose information by this reduction - similarly as in arithmetic, where one and the same number may be the result of different additions. If we have to make precise sense of a sentence like *The children took each other by the hand,* we have to take into consideration every possibility which could have lead to that distributive statement. In terms similar to the set-theoretic treatment by Gillon (1987), we have to find a COVER of sub-sumindividuals $x_1...x_n$ of the children such that $x_1\oplus..\oplus x_n$ make up the children and for every x_i it holds in the strict sense that x_i took each other by the hand. The sentence *The children took each other by the hand* is true just in case we can find such a cover. It is true in the strict reading if the maximal cover for which the predication holds is the individual which is denoted by *the children* itself. This means that whenever we encounter a condition like $[\![\alpha]\!](d)$ (in the DRT-format) which might be distributive, then we first have to transform this to a condition which says that there is a cover of d whose elements have the property α.

There are cases of reciprocity which still cannot be handled, exemplified by *The plates are stacked on top of each other.* Note that this does not imply that, for any two plates p, p', that p is stacked on top of p', and p' is stacked on top of p. In fact, this is excluded by non-linguistic principles. We might formulate the condition for "basic" (non-distributive) reciprocity in such a way that $\alpha[i\oplus j, i\oplus j/rec]$ implies $\alpha[i, j]$ and $\alpha[j, i]$, if this is physically possible, and $\alpha[i, j]$ or $\alpha[j, i]$, otherwise.

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