16 Plurality

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1 Cumulative Readings

In his seminal paper, (Scha (1981)), Remko Scha discusses what he calls the cumulative reading of sentences like (1):

(1) Three boys invited four girls.

On this reading, what the sentence expresses is the following: the total number of boys that invited a girl is three and the total number of girls that were invited by a boy is four. (Such and similar readings have also been discussed by others, e.g. Langendoen (1978), Carlson (1980), Higginbotham and May (1981) and Gil (1982).) Scha distinguishes cumulative readings from collective and distributive readings, and he introduces a mechanism of binary quantification to deal with cumulative readings. In Scha's analysis, sentence (1) involves a binary determiner [three-four],, which combines with a binary noun [boysgirls], to form a binary noun phrase. Thus, at the semantically relevant level of representation (1), has the structure (la):

(1) a. [[[three–four],, [boys–girls],]], [invite],]

The rationale for this analysis is that on the cumulative reading the interpretation of each noun phrase seems to require information expressed by the other noun phrase: the sentence does not talk about three boys and four girls, but about boys that invited a girl and girls that were invited by a boy. We seem to need to access the information expressed by the noun phrases simultaneously, and we can do that by encoding this in the meaning of the binary determiner:

> $[\text{three–four}]_{\text{DET}}$ denotes the relation that holds between a binary noun ***boys-girls*** and a transitive verb invite iff the number of boys that invite a girl is **three** and the number of girls invited by a boy is four.

The analysis of cumulative readings in terms of binary quantification is rather complicated and introduces categories into the grammar (like binary determiners) that one would want to have independent justification for. Since Scha's paper, several people have argued that we do not need to add a mechanism of binary quantification to the grammar to deal with cumulative readings, because we do not need to recognize cumulative readings as an independent category that the grammar needs to account for. This is most explicitly argued by Craige Roberts (1987). She argues that we do not need to generate cumulative readings, because we can reduce them to collective readings. The grammar will generate a reading where both three boys and four girls get a collective reading, as in (1b):

(1) b. A group of three boys invited a group of four girls.

Following Dowty (1986), we can assume that such a collective reading of (1) may in context have implicatures concerning whether, and if so how, the inviting is distributed over the members of these two groups. This means that the reading that the grammar generates for **(1)** is underspecified as to how the inviting is actually done. The cumulative reading is not a separate reading, but one instance of a situation in which the double collective reading is true. Hence, Roberts argues, the grammar does not have to deal with cumulative readings.

This approach is tempting, but it requires in turn a re-evaluation of what is to count as a collective or a distributive reading. In the first part of this paper, I will discuss the notions of distributivity and collectivity and propose a criterion for telling whether or not we are dealing with a collective reading or not. I will argue that on this criterion, both distributivity and cumulativity are to be distinguished from collectivity. Moreover, I will argue that distributivity and cumulativity are in essence the same semantic phenomenon: semantic plurality. In the second part of this paper, I will develop (the beginnings of) an event-based theory of plurality, and use this as a framework for comparing different proposals concerning distributive, collective, cumulative (and other) readings of sentences like (1).

2 Distributivity and Collectivity in Landman (1989a)

Godehard Link (1983) introduced an operation of semantic pluralization*. Link assumes that the domain of individuals consists of singular, or atomic, individuals, plus plural individuals, where plural individuals are regarded as sums of singular individuals under an operation of sum-formation $\sqcup$; equivalently, the domain is ordered by a part-of relation $\sqsubseteq$, and singular individuals are those individuals that have only themselves as parts. In Link's semantics, a

singular predicate like BOY denotes a set of singular individuals only, a set of atoms. Pluralization is closure under sum: *BOY adds to the extension of BOY all the plural sums that can be formed from elements of BOY:

$$\text{*BOY} = \{d \in D\text{: for some non-empty } X \subseteq \text{BOY: } d = \sqcup X\}$$

It can be shown that when we restrict the domains of interpretation properly (essentially to structures isomorphic to Boolean algebras with the bottom element removed, structures which I will call atomic part-of structures), Link's operation of pluralization predicts some very general properties of plural nouns. In particular, the pattern in (2) becomes valid:

(2) John is a boy and Bill is a boy iff John and Bill are boys.
(2) a. $\text{BOY}(j) \wedge \text{BOY}(b) \leftrightarrow \text{*BOY}(j \sqcup b)$

The inference pattern that we find for plural nouns in (2) is exactly the same as what we find for verbs, when they are interpreted distributively, as in (3):

(3) John carried the piano upstairs and Bill carried the piano upstairs iff John and Bill carried the piano upstairs (on the distributive interpretation of carry the piano upstairs).

In view of this, I argued in Landman (1989a) for reducing distributivity to semantic plurality. I assumed that the grammar contains a single operation that forms semantically plural predicates out of semantically singular predicates. In the nominal domain, the operation of pluralization leads to plural nouns. In the verbal domain, pluralization creates distributive interpretations. The aim of this proposal was to give a unified account to examples like (2) and **(3).** A special problem is raised by cases of distribution to collections like (4):

(4) The boys meet and the girls meet iff the boys and the girls meet (on the distributive interpretation of meet. This interpretation is triggered for instance when we add but not in the same room).

We would like to give a unified explanation for the patterns in (2), **(3)** and (4), but this leads, in the case of (4) to a problem or grid: if the boys and the girls in (4) denotes the sum of the boys and the girls, then pluralization will distribute the predicate MEET to the individual boys and girls. The problem is that on the relevant interpretation, we do want the predicate to distribute, but only to the sum of the boys and to the sum of the girls, and not all the way down to the individuals. The solution that I proposed (in part following Link (1984)) was to assume that the noun phrase the boys can shift its interpretation from a plural interpretation, σ(*BOY), the sum of the individual boys, to a group interpretation, $\uparrow(\sigma(\text{*BOY}))$, **the boys** as a **group.** Here the group-forming operation $\uparrow$ is an operation that maps a sum onto an atomic (group) individual in its own right.

I assumed then that collective interpretations are group interpretations. In essence, what I assumed was that the collective reading of sentence (5) comes about through an implicit group-operator, an operator which is explicit in (6):

(5) the boys carried the piano upstairs.
(6) the boys, as a group, carried the piano upstairs.

In this view, collective predication is singular predication: a semantically singular predicate is predicated of an atomic individual, a group: $P(\uparrow(\sigma(^*BOY)))$. On the other hand, distributive predication is plural predication: a semantically plural predicate is predicated of a plural individual: $^*P(\sigma(^*BOY))$. Furthermore, the capacity to shift from sum interpretations to group interpretations introduces the required grid to give a unified account of pluralization that applies to (4) as well. If we assume that the boys and the girls can denote the sum of the boys as a group and the girls as a group, we get exactly the pattern of distribution to collections:

(4) a. $\text{MEET}\ (\uparrow(\sigma(^*\text{BOY}))) \wedge \text{MEET}\ (\uparrow(\sigma(^*\text{GIRL}))) \leftrightarrow$
$^*\text{MEET}\ (\uparrow(\sigma(^*\text{BOY})) \sqcup \uparrow(\sigma(^*\text{GIRL})))$

In sum, then, in Landman (1989) I assumed the following:

- all basic predicates, nominal or verbal, are Semantically interpreted as sets of atoms;
- there are (at least) two modes of predication:

  1. singular predication applies a basic predicate to an atomic (singular or group) individual;
  2. plural predication applies a plural predicate distributively to a plural sum of such atomic individuals.

- noun phrases like John and *Bill* and the boys can shift their interpretation from sums to groups (the boys as a group).

3 Thematic and Non-thematic Roles

Above I have made the distinction between basic, singular predicates and plural predicates that are pluralizations of basic predicates. These are not the only kinds of predicates that need to be distinguished. The grammar will contain, besides pluralization, operations that turn plural predicates into complex plural predicates, and the latter need not be pluralizations of basic, singular, predicates. However, all this stays rather abstract theorizing, as long as we do not determine what counts as a basic predicate.

I think of basic predicates as by and large corresponding to those lexical items that assign thematic roles (though not all of them, some lexical items like for instance look alike – if that is a lexical item – I would assign internal logical structure, making it in effect a plural predicate). Basic predicates are predicates that have thematic commitment. If a basic, singular predicate applies to a certain argument, that argument fills a thematic role of that singular predicate. This means that whatever semantic properties are associated with that thematic role, the object that fills that role in that predication has those properties. Thus, for example, I assume that sing is a basic predicate assigning the agent role to its subject. By that, I assume that whatever semantic inferences and implicatures follow from filling the agent role of sing, if John sings is true then those inferences and implicatures hold with respect to John. This is rather straightforward. But it has an interesting consequence. I have assumed in the previous section that collective predication is an instance of singular predication. If singular predication is thematic predication, it follows that collective predication is thematic predication. Moreover, if collective predication is nothing but singular, thematic predication, it follows that there is no place in the grammar for a separate theory of collective predication, i.e. there is no separate theory of collective inferences. This means that all inferences and implicatures associated with collective readings have to be derived from two sources: the general theory of thematic roles and inferences associated with those, and the nature of the argument filling the role, i.e. the fact that a group, rather than an individual fills a role. (This idea is, I think, in the spirit of some of the discussion of Scha (1981). The alternative, i.e. trying to delineate a theory of collective inferences, finds, I think, its origin in Dowty (1986), and is most worked out in Lasersohn (1988).)

Let me give some examples.

Example 1. Collective body formation:

(7) a. The boys touch the ceiling.

This example is a variant of an example discussed in Scha 1981. For (7a) to be true on a collective reading, there is no need for more than one boy to do the actual touching: (7a) is true if the boys form a pyramid and the topboy touches the ceiling. A theory of collective inferences would explain this by assuming that the predicate touch as applied to a collection distributes semantically to at least one of the members of the collection, while the involvement of the others is a matter of cancelable implicatures. The alternative explanation that I would propose (following basically Scha 1981) is the following: Compare (7a) with (7b):

(7) b. I touch the ceiling.

What does it mean for me to touch the ceiling? It means that part of my body is in surface contact with part of the ceiling. This follows from the meaning of touch: part of the agent is in surface contact with part of the theme. Exactly the same meaning is involved in (7a). The only difference between (7a) and *(7b)* is that in (7a) it is a collection that fills the agent role and a collection has different parts than an individual does. In particular it can be individuals that are part of collections (in a sense of part-of which is analogous to the relation between me and my body parts). Thus, we do not need to assume anything special about collective predication to explain this case.

Example 2: Collective action:

(8) a. The boys carried the piano upstairs.

In a collective action, the predicate does not necessarily distribute to each of the boys (the actual predicate needn't distribute at all), nor does it have to be the case that all the boys in (8a) have to be directly involved in the action, i.e. not all boys have to do actual carrying (like the one who is walking in front with a flag). In a normal context, (8a) will implicate some other things about the boys, like that some of them are (at least partly) under the piano some of the time, and that some of them move up the stairs. However, let us again compare this with the singular case (8b):

(8) b. I carried the piano upstairs.

Also in (8b), not all my parts do the carrying (my big toe doesn't). While it tends to be the case that when I carry the piano upstairs all my parts move up the stairs, such differences can easily be attributed again to the differences in the relation between me and my parts and collections and their parts: collections can be spatially discontinuous.

Example **3:** Collective responsibility:

Lasersohn (1988) argues that often in collective readings, we do not require that the individuals are directly involved in the action, but that they do share in the responsibility: we ascribe collective responsibility to the agent in a collective predication. Cf. (9a):

(9) a. The gangsters killed their rivals.

While not every gangster may have performed any actual killing, that will not help them in court: the individual gangsters are co-responsible for the killings. Again this is not different from the singular case, cf. (9b):

(9) b. Al Capone killed his rivals.

It is a general property of agents (of verbs like kill) that we can assent to the truth of the sentence, even though the agent does not literally perform the action: (9b) is true even if Capone didn't pull the trigger himself, because he bears the responsibility for the action (the difference being that responsibility tends not to carry over to non-sentient parts of an agent, though Capone's bad liver may have had something to do with it).

The conclusion is: all these cases involve thematic predication where a collection fills a thematic role. Differences with singular predicates are reduced to the differences between individuals and collections.

It now becomes interesting to compare these cases with what I have called plural predication. Look at (10) on the distributive reading:

(10) The boys sing.

The crucial difference with the previous cases is that on the distributive interpretation of (10), it is not the entity that is the subject in the predication, the denotation of the boys, that is claimed to have the semantic properties that agents have, but the individual boys. On this reading, no thematic implication concerning the sum of the boys follows. This means that the distributive predication is not an instance of thematic predication of the predicate sing to its subject.

This has an important theoretical consequence about the way we set up the grammar. Some analyses of plurality assume that also in a distributive predication in (10), the boys fills the agent role of a basic predicate sing. This is, for instance, what Scha (1981) does for examples like (10). Scha, and others following him, would derive the distributive reading through an optional meaning postulate on sing (on one of its meanings X sings is equivalent to every part of X sings). However, since there are no thematic inferences concerning what fills the agent role in the distributive reading, on such a theory, it follows that there cannot **be** any semantic content to the notion of agent at all. That is, this approach is incompatible with any theory that assigns any semantic, thematic property to a thematic role, because in the distributive cases the entity that fills the role doesn't have the relevant property. (Note that I have formulated the problem in terms of thematic roles, but the problem is just the same in an ordered argument theory: we would want the lexical predicate to constrain its arguments in certain ways, but in the distributive case, those arguments aren't constrained in those ways.) This would mean that thematic roles cannot have any content. Not even a weak theory of thematic roles, like the one in Dowty 1989 would be possible: thematic roles become meaningless labels. Now, some might be willing to accept the impossibility of a theory of thematic roles without batting an eyelid. My feeling is that whatever the possibility of a contentful theory of thematic roles, it is not the business of the theory of plurality to make it impossible.

This means, then, that in plural, distributive, predication in (10), the subject *the boys* does not fill a thematic role R of the predicate sing. I will assume that it does fill a role, and that the role that it fills is a non-thematic, plural role defined on R.

I define thematic predication as predication of a thematic basic predicate to an argument, predication where the argument fills a thematic role of a basic predicate. (A remark: I am not assuming that basic predicates have to assign thematic roles to all their arguments, I don't want to commit myself here, for instance, to a particular view on raising predicates. Furthermore, I don't assume that basic predicates cannot have internal lexical structure, like aspectual structure in say Dowty's (1979) theory, and other theories following that. Basic here means basic as far as plurality and scope phenomena are concerned.)

In theories of plurality, including my own, a lot of unclarity exists about what counts as a collective reading and how to distinguish collective readings from non-collective readings. The framework that I am developing here suggests a criterion for determining when we are dealing with a collective reading:

The collectivity criterion:

The predication of a predicate to a plural argument is **collective** iff the predication is predication of a **thematic** basic predicate to that plural argument, i.e. is a predication where that plural argument fills a **thematic** role of the predicate.

One side of this criterion is the proposal that I made before: there is not a special theory of collectivity implications. Collectivity implications are instances of thematic implications:

The presence of collectivity implications indicates that the predication is thematic predication.

I think that, though not much discussed explicitly in this form, this part of the collectivity criterion is widely accepted in the literature on plurality. What turns it into a criterion is the other direction:

Lack of collectivity implications indicates non-thematic predication.

This part tells us that we cannot use the notion of collectivity as a plural waste-paper basket. It tells us that if a certain predication arguably lacks collectivity implications, we cannot subsume it under collective predication, and this means that we cannot leave it unanalyzed: we have to assume that it is a complex plural predicate, derived from other predicates through the plurality operations that are available in the grammar (of which simple pluralization of a basic predicate is an instance). The interesting thing is that when one reads the literature (for instance the literature arguing in favor of a distributive operation, e.g. Link (1991), Roberts (1987), Hoeksema (1988), Landman (1989a), and many others), one gets the impression that also this part is widely accepted (though implicitly) in the literature. If so, then-it is more accepted as a virtuous ideal than as a matter of praxis, because I don't know a single theory that actually manages to live up to this part. And the reason is that, while it has the great advantage of clarifying the notion of collectivity, it makes life difficult. For instance, many cases that I regarded in Landman (1989a) as instances of collective predication that maybe the lexicon, but not the grammar needs to analyze further, can no longer be regarded as such. Applying the collectivity criterion to predicates like look *alike*, *separate* or *sleep in different dorms* tells us that these predicates cannot be regarded as collective predicates, and shows (in line with Roberts (1991), Schwartzschild (1991,1992), Carlson (1987), Moltmann (1992)) that we need to regard these as complex plural predicates. I do not have space in this paper to discuss these cases more. While I am aware that the application of the collectivity criterion is difficult in various subtle cases, and while I am not sure that in a final account (if there is such a thing) the criterion can hold unmodified, I think (and hope to show) that the criterion has very interesting empirical and theoretical consequences, and provides a healthy methodology in determining what should be part of the grammatical theory of plurality and what can be left to the lexicon.

4 Application 1: Partial Distributivity and Distributivity

As an application of the collectivity criterion, let us look at the following examples from the literature:

(11) The marines invaded Grenada. (Carlson (1977b))

(12) The leaves of tree A touch the leaves of tree B. (Scha (1981))

(13) The journalists asked the president five questions. (Dowty (1986))

These are all cases where for the sentence to be true, it is not necessary that **all** individual parts of the plural entities involved have the relevant property, invading, **touching, asking.** But it does seem to be necessary that **some** individual parts have the relevant property. One could call this phenomenon **partial distributivity**: the relevant property distributes to some, but not necessarily all parts of a plural argument. Since total distributivity is the borderline case of partial distributivity, one could use this as an argument to eliminate distributivity from the grammar. The argument would go as follows: the lexical meaning of the predicates in (11)–(13) tells us that some parts have the relevant property. Total distributivity is compatible with that. The so-called distributive reading is not a separate reading, but an instance of the basic reading, i.e. it represents one type of situation in which the basic reading of (11)-(13) is true. Given this, we would not need a separate distributive operator or a pluralization operator.

The problem with this proposal is that in all cases (11)–(13) there are collective, thematic implications. Another way to say this is that all these cases are **non-inductive**.

Take (11): Suppose that two members of the Marine Corps in a totally unauthorized action land on Grenada. Would we say that this is sufficient to make (11) true? I don't think so. Now, maybe if we increase the number of Marines landing we reach at a certain moment a point where we're inclined to count (11) as true. But crucially, this is not because of the numbers, but because at a certain moment, this becomes an action that reflects on the whole Marine Corps, a collective responsibility. And it is this collective responsibility, rather than the number of individual Marines involved, that makes (11) true.

Similarly, in (12), it is because we easily conceive of the leaves on a tree as a coherent body (the foliage) (and there is surface contact) that we regard (12) as true. (14) is a funny sentence:

(14) The green leaves in Holland touch the yellow leaves in Holland.

If (12) were inductive, then the touching of two individual leaves would be sufficient to make (12) true. But then there is no reason why (14) shouldn't be a perfectly fine and true sentence. But (14), out of the blue, is weird, and the reason is collectivity: out of the blue it is difficult to turn the green and the yellow leaves in Holland into coherent bodies (coherent enough to make "touching" a sensible relation between them). (13) may seem more inductive: if five individual journalists happen to ask a question, isn't that sufficient to call (13) true? While it is harder to detect, I think that also (13) is in fact not inductive and involves collective responsibility. A press-conference is a kind of allegorical play with fixed roles filled by certain individuals or groups (The President, The Press); it is the business of journalists at a press-conference to ask questions and it is part of the play that this is done in a certain way (distributing question asking over journalists). Yet, (13) makes an evaluative statement about the functioning of the whole Press-corps: they got in five questions, which means, depending on the press-conference, that THEY (the press) did or didn't do their job well. Another reason to assume that (13) involves a collective reading is the following. Look at (15):

(15) The press asked the president five questions.

(15), I think, does not differ at all from (13) in how inductive or non-inductive it is. But (15) involves a singular collective expression. While Schwarzschild (1991) argues convincingly (against Landman (1989)) in favor of distinguishing such singular collective expressions from plurals in collective readings, there doesn't seem to be a difference here, and since also for Schwarzschild, singular collective expressions are as prototypically collective as you get, this provides another reason to assume that partial distributivity is a collectivity effect.

In all these cases, then, there are collectivity implications. By applying the collectivity criterion, this means that in all the cases (11)–(13) we are in fact dealing with collective readings. Now compare the previous cases with the distributive interpretation of (16):

(16) The boys carried the piano upstairs.

Think of the following context: in a game show the girls each have to swim fifteen meters, while each of the boys carries a toy-piano upstairs (which then, each time, is brought down again for the next boy. To make it difficult, we assume that the stairs are greased). In that context, the distributive interpretation of (16) is fine after the following question: What were the boys doing while the girls were swimming?

The important thing here is that, on this interpretation, (16) is **purely** inductive: if boy 1 carried the piano upstairs, **. . . . ,** boy *n* carried the piano upstairs, then we can truthfully say (16) on the distributive interpretation. This means that (16) does not involve any thematic implications concerning the plural argument of the predication, the boys, itself. Applying the collectivity criterion, it follows that (16) is not a collective reading, and does not involve a basic, thematic predicate. It follows then from the collectivity criterion, that the attempt to eliminate distributivity from the grammar by trying to reduce it to lexical partial distributivity fails: partial distributivity is collectivity, and hence thematic predication, while true distributivity is non-thematic predication.

5 Application 2: Partial Cumulativity and Cumulativity

Now let us look at (17):

(17) Forty journalists asked the president only seven questions.

(17) looks like a cumulative reading, except that, because of the distribution of the numbers (assuming that questions don't get asked more than once), if it is a cumulative reading, it can only be a partial cumulative reading. But (17) isn't different from (13), so by the same argument as before, we should conclude that (17) is a collective reading, and that the partial cumulativity effect is really a thematic, collectivity implication. More evidence for this is example (18):

(18) Fifteen women gave birth to only seven children.

Out of the blue, (18) is weird. The natural reaction to (18), out of the blue, is something like: how did they manage to do that? There is a natural explanation for this: give birth to, as a relation between women and children, is a relation that strongly resists its first argument being interpreted collectively:

give birth to is a hyper-individual relation between a woman and a child: we do not think of women as giving birth to children in groups. Thus, (18) does not, out of the blue, have a collective reading, and that's why it is weird. Compare (18) with (19):

(19) Seven hundred chickens laid fifty eggs.

Unlike (18), (19) is not weird out of the blue. In the context of what is called in Dutch the Bio Industry, (19) can easily be interpreted as a comment on the malfunctioning of a particular chicken battery. The reason is that the role of chickens in a battery is similar to that of journalists at a press conference: who cares that a chicken also has a hyper-individual relation to her egg: for us, chickens are means of producing eggs: it is the business of chickens in a battery to produce a certain quota of eggs. For that matter, it is easy for us to ascribe collective responsibility to the chickens in a certain battery for the malfunctioning of the battery. For this reason, a collective reading of (19) is easily available. This is much more difficult in (18). I'm not claiming that (18) doesn't have a collective reading. For instance in the not so natural context of hospital statistics, (18) can get a collective reading as well, and it can be seen as a comment on the malfunctioning of the maternity ward. Nevertheless, out of the blue, this reading is not available for (18). Now look at (20):

(20) Seven women gave birth to fifteen children.

There is a sharp difference, out of the blue, between (18) and (20). Unlike **(18)**, (20) is fine and the reading that is in fact most prominent is the **cumulative reading:** seven women gave birth to children and fifteen children were born to them.

These facts form a serious problem for Roberts' (1987) proposal to reduce cumulative readings to collective readings. If cumulative readings are collective readings, then the cumulative reading of (20) should be a collective reading, like (18). But we have seen that (18) doesn't have a collective reading. (18) is weird out of the blue. But if (18) doesn't have a collective reading out of the blue, neither should (20): i.e. (20) should be just as weird as (18). But (20) isn't weird out of the blue. It is fine. Hence we have a strong argument here that cumulative readings are in fact not collective readings.

In sum: (18) is weird because it does not naturally have a collective reading and it cannot have a cumulative reading (because of the numbers). (20) is weird on a collective reading, just like (18), but it is fine on a cumulative reading.

A second argument that cumulative readings should not be reduced to collective readings involves the collectivity criterion directly. Cumulative readings are as inductive as distributive readings (as argued in Krifka (1989,1990a), and in other work by him). If Sarah gave birth to Chaim and to Rakefet, and Hanah gave birth to Avital, we can truthfully say (21) on a cumulative reading:

(21) Sarah and Hanah gave birth to Chaim, Rakefet and Avital.

The collectivity criterion then tells us that cumulative readings are non-thematic, and hence non-collective. This means that Roberts' attempt to eliminate cumulativity from the grammar by reducing it to collectivity fails, and we have strong arguments that the grammar needs to deal with cumulative readings after all. In fact, cumulative readings are not like collective readings at all, rather they are very closely related to distributive readings. Hence, if we want to reduce cumulative readings to something else, it shouldn't be collectivity, but plurality. In the remainder of this paper, I will develop the beginnings of a theory of plurality and scope, which will present a unified analysis of distributive and cumulative readings: both are reduced to plurality. Cumulative readings are plural readings, like distributive readings, but unlike distributive readings, they are scopeless. What we need then is a theory of plurality, scope and scopelessness. To this I now turn.

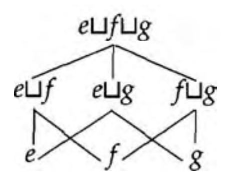
6 A Neo-Davidsonian Theory of Events and Plurality

I will now sketch the (bare) outlines of the language of events and plurality that I will assume. The language has lambda-abstraction and set-abstraction (following Scha (1981)), includes a neo-davidsonian theory of events (following Parsons (1990)), and a theory of plurality. In particular with respect to the analysis of cumulativity, the theory is very close to Schein (1993) and Krifka (1989). It differs from both by strictly adhering to the collectivity criterion.

The language is based on the following types:

– the type of events e.

e is interpreted as a structure $\langle E, \sqcup, ATOM\rangle$, an atomic part-of structure: this is a structure of atomic (singular) events and their (plural) sums. (These structures are in essence atomic boolean algebras with their bottom element *removed.* For discussion of these structures, see Landman (1989a), Landman (1991), Lønning (1989), Krifka (1990a).) An example:



plural events

ATOMS: singular events

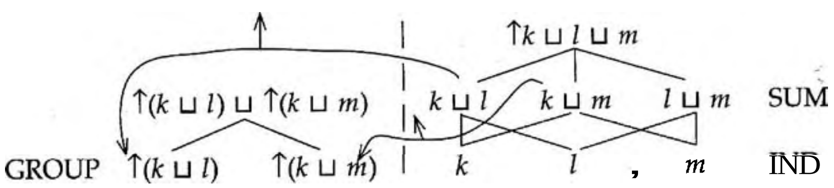
– the type of individuals ***d***

d is interpreted as a structure $\langle D, \sqcup, \mathrm{IND}, \mathrm{GROUP}, \uparrow, \downarrow \rangle$, an atomic part-of structure of singular individual and group atoms (IND and GROUP) and their plural sums, with an operation of group formation $\uparrow$. SUM is the set of sums of individuals. $\uparrow$ turns a sum of individuals $(a \sqcup b)$ into a group atom $\uparrow(a \sqcup b)$: $a \sqcup b$ as an entity in its own right, a group, more than the sum of its parts. The definition of $\uparrow$ and $\downarrow$ follows Landman (1989a), but includes some improvements from Schwarzschild (1991):

$\uparrow$ is a one-one function from SUM into ATOM such that:
1. $\forall d \in$ SUM-IND; $\uparrow(d) \in$ GROUP
2. $\forall d \in$ IND: $\uparrow(d) = d$

$\downarrow$ is a function from ATOM onto SUM such that:
1. $\forall d \in$ SUM: $\downarrow(\uparrow(d)) = d$
2. $\forall d \in$ IND: $\downarrow(d) = d$

Example (partial):



– the type of sets of individuals, pow(d)
– the type of sets of events, pow(e)

Nominal predicate constants like BOY, GIRL are of type pow(d) and denote sets of atomic individuals.

Verbal predicate constants like SING, KISS are of type pow(e) and denote sets of atomic events.

Pluralization is a predicate operation and is defined on pow(d) and on pow(e): $^*P$ is the closure of P under sum. Hence,

*BOY is the set of individual boys and their plural sums.
*SING is the set of atomic singing events and their plural sums.

– further we have the usual function types: $\langle a,b \rangle$ is the type of functions from type a into type b. Of special importance is the type $\langle e,d \rangle$: $\langle e,d \rangle$ is the type of thematic and non-thematic roles. I assume that the theory incorporates an undefined object and a theory of partiality: these roles are partial functions from events into individuals. This incorporates the Unique Role Requirement (cf. Carlson 1984, Parsons 1990): no event has more than one agent, theme, etc.

The language contains Role constants: Ag, Th, . . . , which denote thematic roles. I assume that the domain corresponding to $\langle e,d \rangle$ contains a subset TR, the set of thematic roles. Thematic constraints are constraints on the members

of TR. In line with the collectivity criterion, thematic roles will indicate thematic, singular or collective, predication. This is captured as a singularity constraint:

Singularity constraint on thematic roles:
1. thematic roles are only defined for atomic events.
2. thematic roles only take atomic individuals (singular individuals or groups) as value.

We define: $\mathrm{AT}(x) = \{a \in \mathrm{AT}: a \sqsubseteq x\}$

AT(x) is the set of atomic parts of x.

We have in the theory up to now singular events and singular individuals (and groups), which are linked by singular thematic roles. Pluralization of event predicates adds sum events, pluralization of nominal predicates adds sum individuals. We now add pluralization on roles, which creates plural roles:

Plural roles:
Let R be a role.
$^*R$, the plural role based on R is defined by:
$^*R(e) = \sqcup(\{R(e'): e' \in \mathrm{AT}(e)\})$
if for every $e' \in \mathrm{AT}(e)$: $R(e')$ is defined; otherwise undefined.

This tells us that the plural agent, theme, . . . of a sum of events is the sum of the agents, themes, . . . of the atomic parts of that events. (This is very similar to Krifka's (1989) cumulativity requirement.) If e is an event of John singing and f is an event of Mary singing, then the thematic role Ag is defined for e (Ag(e) = j) and for f (Ag(f) = m), but not for the sum event $e \sqcup f$, because thematic roles are only defined for singular events. However, the plural role *Ag is defined for $e \sqcup f$: the agents of the atomic parts of $e \sqcup f$ are j and m, hence the plural agent of $e \sqcup f$ is $j \sqcup m$: $^*\mathrm{Ag}(e \sqcup f) = j \sqcup m$.

The ideas about thematic and non-thematic predication are captured in this theory as follows:

– singular verbal constants are sets of atomic events.
– plural verbal constants are sets of plural events.
– Singular predication is predication where an atomic individual (individual or group) fills a thematic role (in **TR**) of an atomic event. Since lexical constraints are constraints on thematic roles in TR, such predication is indeed thematic.
– Plural predication is predication where a plural individual fills a plural role of a plural event. This predication is non-thematic, the plural object that fills the plural role is not itself required to satisfy the thematic constraints imposed in thematic roles.

7 The Grammar

7.1 Verbs

In a classical Montague style analysis (with type shifting), verbs are interpreted as n-place properties of type $\langle d, \ldots, \langle d,t \rangle\rangle$ (n-times d): functions that taken-arguments into a truth value. In the present theory (in essence following Parsons (1990)), verbs are interpreted as n-place scope domains of type $\langle d, \ldots, \langle d, pow(e)\rangle\rangle$ (n-times d): functions that take n-arguments into a set of events. A (0-place) scope domain is a set of events tied together by roles.

We associate with each verb a verbal predicate constant of type pow(e). The basic interpretation of the verb is unmarked for semantic plurality. However, since for any predicate P the singular form P is a subset of the plural form *P, this means that the plural form is the unmarked form. We have the following interpretations:

$$\text{walk} \rightarrow \lambda x.\{e \in {}^*\text{WALK}: {}^*\text{Ag}(e) = x\}$$
$$\text{kiss} \rightarrow \lambda y \lambda x.\{e \in {}^*\text{KISS}: {}^*\text{Ag}(e) = x \wedge {}^*\text{Th}(e) = y\}$$

i.e. kiss is a function (of type $\langle d, \langle d, pow(e)\rangle\rangle$) that maps an object and a subject onto the set of (sums of) kissing events with that subject as plural agent and that object as plural theme.

We can now illustrate the predictions of the theory concerning thematic and non-thematic predication. Look at examples (22) and (23):

(22) John sings.
(23) John and Mary sing.

As will become clear presently, the grammar derives the following interpretation for (22):

(22) a. $\exists e \in {}^*\text{SING}: {}^*\text{Ag}(e) = j$
There is a sum of singing events with plural agent John.

For (23), two interpretations will be derived:

(23) a. $\exists e \in {}^*\text{SING}: {}^*\text{Ag}(e) = \uparrow(j \sqcup m)$
There is a sum of singing events with the group of John and Mary as plural agent.

(23) b. $\exists e \in {}^*\text{SING}: {}^*\text{Ag}(e) = j \sqcup m$
There is a sum of singing events with the sum of John and Mary as plural agent.

Let's concentrate first on (22a) and (23a). Clearly, these interpretations sound much too plural. However, since j and $\uparrow(j \sqcup m)$ are atoms, they have only themselves as parts. Hence, an atom is the plural agent of a sum of singing events iff it is the agent of all the atomic part events. This means that (22a) and (23a) are equivalent to (22b) and (23c) respectively:

(22) b. $\exists e \in \text{SING}: \text{Ag}(e) = j$
(23) c. $\exists e \in \text{SING}: \text{Ag}(e) = \uparrow(j \sqcup m)$

In (22b) and (23c) the predication is thematic: hence (23a) and (23c) are the collective interpretation of (23).

Now look at (23b). The atomic parts of the sum $j \sqcup m$ are j and m. ${}^*\text{Ag}(e) = \sqcup\{\text{Ag}(e'): e' \in \text{AT}(e)\}$. This means that some of the atomic parts of e will have to have j as agent, and the rest m. This means that (23b) is equivalent to (23d):

(23d) $\exists e \in \text{SING}: \text{Ag}(e) = j \wedge \exists e \in \text{SING}: \text{Ag}(e) = m$

This means that (23b) indeed is the distributive interpretation of (23), and, as can be seen from the equivalence with (23d), the predication in (23b) is non-thematic.

7.2 Noun Phrases

The theory will treat non-quantificational noun phrases differently from quantificational noun phrases. Non-quantificational NPs are proper names, definites and indefinites. For these, I will assume, following Landman (1989a), that they can shift their interpretation from plural to group interpretations. This gives two interpretations for John and Mary and three boys:

John and Mary $\rightarrow j \sqcup m, \uparrow(j \sqcup m)$
three boys $\rightarrow \lambda P.\exists x \in {}^*\text{BOY}: |x| = 3 \wedge P(x)$ (sum)
The set of properties that a sum of three boys has.
$\rightarrow \lambda P.\exists x \in {}^*\text{BOY}: |x| = 3 \wedge P(\uparrow(x))$ (group)
The set of properties that a group of three boys has.

(Note that for most purposes in this paper – with the exception of problems of grid – I could have taken an alternative road, and worked the shift between plural and collective predication into the predicates, i.e. choose, say, only the sum interpretation for the NPs, and let a shift operation on the verbs optionally introduce the $\uparrow$ operation, or the other way round. I think that in a full-fledged theory we need both options; just as I think that for examples like The boys, as a group, left, the grammar will need to deal both with collective NPs like the boys, as a group and collective predicates *left* as a group. I do not have space here to pursue this further.) Since I do not have space to go into the subtleties of quantificational NPs, I will just assume that they get their standard interpretation:

every girl $\rightarrow \lambda P.\forall x \in \text{GIRL}: P(x)$
no girl $\rightarrow \lambda P.\neg\exists x \in \text{GIRL}: P(x)$

7.3 *In-situ Application*

In-situ application is the mechanism with which arguments are associated with verbs. This is constrained by the following scope domain principle:

Scope domain principle:
Non-quantificational NPs can be entered into scope domains. Quantificational NPs cannot be entered into scope domains.

The second part is a standard assumption in neo-Davidsonian theories. It has the consequence that quantificational NPs take scope over the event argument. The first part is particular to the present theory: the possibility of entering non-quantificational NPs into the scope domain will create scopeless readings.

I assume that verbs are functions on **all** their arguments. In-situ application is in essence functional application, except that I assume a type shifting theory (e.g. Partee and Rooth (1983)). Functional application gets generalized to an operation APPLY which does the following: APPLY does functional application if the types fit; if they don't fit, it lifts the function or the argument to make them fit and then does functional application.

More precisely:

The type shifting operation LIFT has three instances:
NPs: $\text{LIFT}[\alpha] = \lambda P.P(\alpha)$ (a of type d)
VPs: $\text{LIFT}[\beta] = \lambda T.\{e \in E: T(\lambda x.e \in \beta(x))\}$
(T of type $\langle\langle d,t\rangle,t\rangle$, x of type d, P of type $\langle d,\text{pow}(e)\rangle$)
TVs: $\text{LIFT}[\beta] = \lambda T\lambda x.\{e \in E: T(\lambda y.e \in [\beta(y)](x))\}$
(T of type $\langle\langle d,t\rangle,t\rangle$, x, y of type d, P of type $\langle d,\langle d,\text{pow}(e)\rangle\rangle$)

APPLY is defined as:
APPLY: 1. If α is of type $\langle a,b\rangle$ and β of type a then:
APPLY $[\alpha,\beta] = \alpha(\beta)$
2. If $\text{LIFT}[\alpha]$ is of type $\langle a,b\rangle$ and β of type a then:
APPLY $[\alpha,\beta] = \text{LIFT}[\alpha](\beta)$
3. If α is of type $\langle a,b\rangle$ and LIFT $[\beta]$ of type a then:
APPLY $[\alpha,\beta] = \alpha(\text{LIFT}[\beta])$

Given this, in-situ application is defined as follows:
IN-SITU APPLICATION:

TV + NP $\Rightarrow$ VP; VP' = APPLY[TV',NP']
NP + VP $\Rightarrow$ S; S' = APPLY[VP',NP']

The effect of in-situ application is that the noun phrase meaning is fed into the scope domain. We will see this shortly, when I discuss the predictions of the theory.

7.4 *Existential closure*

After in-situ application, but before quantifying in, existential closure takes place. This again follows Parsons' neo-Davidsonian theory:

EXISTENTIAL CLOSURE: Let a be a scope domain (type pow(e)):
$\text{EC}(\alpha) = \exists e \in \alpha$

7.5 *Scope and quantifying in*

The theory has a scope mechanism. **Any** of the well-known scope mechanisms can be used here. I will choose storage (Cooper (1983)).

7.5.1 *Storage*

In a storage theory, the scope domain principle gets the following form: quantificational NPs are obligatorily stored, non-quantificational NPs can be stored with the following rule of

STORE$_n$:
Let a be an NP meaning and S the quantifier store:
$\text{STORE}_n\,(\langle\alpha,S\rangle) = \langle X_n, S \cup \{\langle n,\alpha\rangle\}\rangle$

The meaning of a is stored, and in-situ application will use a variable instead. As usual, stores are inherited in building up meanings.

7.5.2 *Quantifying in*

In the next section I will compare different theories of plurality and scope that can be found in the literature. For reasons of comparison, I will present here three possible rules of quantifying in:

Non-scopal quantifying in:
$\text{NQI}_n(\langle\varphi,S\rangle) = \langle\text{APPLY}\,[\alpha,\lambda x_n\varphi],\, S - \{\langle n,\alpha\rangle\}\rangle$

This is just Montague's rule. It forms the property $\lambda x_n\varphi$ which (as we will see) is a non-scopal property: "the property that you have if you have φ".

Scopal quantifying in:
$\mathrm{SQI}_n(\langle \varphi, S\rangle) = \langle \mathrm{APPLY}[\alpha, \lambda x.\forall x_n \in \mathrm{AT}(x)\varphi], S - \{\langle n,\alpha\rangle\}\rangle$

This is the rule that I will assume myself. It forms the property $\lambda x.\ \forall x_n \in \mathrm{AT}(x){:}\ \varphi$, which is a scopal property: "the property that you have if all your atomic parts have φ".

Distributive quantifying in:
$\mathrm{DQI}_n(\langle \varphi, S\rangle) = \langle \mathrm{APPLY}[\alpha, \lambda x.\forall x_n \in \mathrm{AT}(\downarrow(x))\varphi], S - \{\langle n,\alpha\rangle\}\rangle$

This rule is almost the same as SQI except that it works on groups rather than sums. It forms the property $\lambda x.\ \forall x_n \in \mathrm{AT}(\downarrow(x)) : \varphi$: "the property that you have if all the atomic parts of the sum corresponding to the group have φ".

8 Three Theories of Scope and Plurality

We will now be concerned with examples like (24)

(24) Three boys invited four girls.
(25) Exactly three boys invited exactly three girls.

The question is: how many readings should the grammar generate for sentences like (24), and what should they be? The abundant literature on sentences like (24) is far from unanimous on this. In fact, proposals range between one reading and infinitely many readings, and basically everything in between.

The difficult question, which seems to be underdetermined by native (and non-native) speakers' judgements is how to distinguish between a reading of (24) and a situation in which (24) is true. Given the problems with intuitions, the empirical basis for any grammar proposal for (24) is somewhat shaky. Nevertheless, I do think that there are empirical and theoretical considerations that allow us to compare and evaluate different proposals. In this section I will compare three such proposals.

Even with the data as muddled as they are, there is one piece of data that does constrain possible grammars for examples like (24). The constraint is in fact clearer in (25), which avoids the problems of at least/exactly readings. The constraint is the following:

> Distributive scope generalization:
> When we look at all situations where (25) is true, the number of girls invited can vary between 4 and 12: (25) is not true if less than four girls are invited, and (25) is not true if more than 12 girls are invited.

This seems to be a solid fact, and it provides an argument that the grammar has to generate at least two readings. One could be the double collective reading (which says that a group of three boys invites a group of four girls). But this reading will not cover situations where all in all twelve girls get invited. The standard explanation, which is very sensible, is that the other reading is derived through a scope mechanism in the grammar. A scope mechanism can interpret the NP four girls in the scope of three boys and derive an interpretation where it is four girls per boy (giving maximally twelve girls).

Thus a scope mechanism will add at least one more reading for examples like (24) and (25), a scoped reading.

In its most general form, a scope mechanism has the following four properties: it is optional (in particular, non-quantificational NPs are not obligatorily scoped out); it is iterable (the mechanism can apply to a structure to which it has already applied before); it defines and uses a (transitive) notion of scope, and scope sets up a relation between a scopal element (say an NP) and its scope (this means that scope is only indirectly a relation between NPs, and hence that the mechanism applies to cases that involve only one NP); finally, the mechanism creates a scope dependency, a situation where an expression is interpreted as dependent on a (quantificational) operator.

For quantificational NPs, Montague's quantifying-in rule NQI is a scope mechanism in the above sense. For non-quantificational NPs (in particular plural NPs), Montague's NQI is not a scope mechanism, because it is in fact not capable of creating a scope dependency. The other two quantifying-in rules, SQI and DQI, are scope mechanisms.

Now, the situation is that – while we have empirical evidence from the distributive scope generalization that we need a scope mechanism to create a scoped reading – because of the properties listed above, a general scope mechanism (without separate restrictions) will in fact add not just one reading, but four. This can be seen by discussing the first theory.

THEORY I: Lakoff 1970

On this theory, collective readings are in-situ readings. Distributivity is not reduced to plurality, but to scope: distributivity is created by the scope mechanism. In Lakoff's theory, the scope mechapism is quantifier lowering. Equivalently, this theory assumes that quantifier raising, QR, creates scope dependencies. This theory can be modelea in the framework given before as follows. We assume that NPs have only collective interpretations (i.e. we allow no shifting to sum interpretations). Furthermore, we take as our quantifying-in rule the rule DQI. This theory produces five readings.

1. Cs–Co: leave subject and object in situ.
This is the double collective reading.

Derivation:
Invite $\to \lambda y\lambda x.\ \{e \in {}^*\mathrm{INVITE}{:}\ \ {}^*\mathrm{Ag}(e) = x \wedge {}^*\mathrm{Th}(e) = y\}$
Three boys $\to \lambda P.\exists x \in {}^*\mathrm{BOY}{:}\ \ |x| = 3 \wedge P(\uparrow(x))$
Four girls $\to \lambda P.\exists y \in {}^*\mathrm{GIRL}{:}\ \ |y| = 4 \wedge P(\uparrow(y))$

Enter four girls into the scope domain with in-situ application; enter three boys into the result with in-situ application; apply existential closure. The result (after reduction) is:

$$\exists e \in {}^*\text{INVITE}:\ \exists x \in {}^*\text{BOY}:\ |x| = 3 \wedge {}^*\text{Ag}(e) = \uparrow(x) \wedge \exists y \in {}^*\text{GIRL}:\ |y| = 4 \wedge {}^*\text{Th}(e) = \uparrow(y)$$

Both plural agent and plural theme are atoms, so we derive the thematic statement:

$$\exists e \in \text{INVITE}:\ \exists x \in {}^*\text{BOY}:\ |x| = 3 \wedge \text{Ag}(e) = \uparrow(x) \wedge \exists y \in {}^*\text{GIRL}:\ |y| = 4 \wedge \text{Th}(e) = \uparrow(y)$$

There is an event of a group of three boys inviting a group of four girls.

A model where this reading is true is:

$$\uparrow(a \sqcup b \sqcup c) \rightarrow \uparrow(1 \sqcup 2 \sqcup 3 \sqcup 4)$$

The operation of QR, interpreted as DQI, creates a distributive dependency: the scope of the QR-ed NP is interpreted relative to the atomic parts of the QR-ed NP. We can apply QR in four ways: we can either QR the subject, or QR the object, or QR both in two orders. This gives four scoped readings:

2. *Ds*(*Co*). QR the subject: A GROUP OF FOUR GIRLS PER BOY

$$\exists x \in {}^*\text{BOY}: |x| = 3 \wedge \forall a \in \text{AT}(x):$$
$$\exists e \in \text{INVITE}: \text{Ag}(e) = a \wedge \exists y \in {}^*\text{GIRL}: |y| = 4 \wedge \text{Th}(e) = \uparrow(y)$$

There are three boys such that each boy invites a group of four girls.

$$a \rightarrow \uparrow(1 \sqcup 2 \sqcup 3 \sqcup 4)$$
$$b \rightarrow \uparrow(5 \sqcup 6 \sqcup 7 \sqcup 8)$$
$$c \rightarrow \uparrow(9 \sqcup 10 \sqcup 11 \sqcup 12)$$

3. *Do*(*Cs*): QR the object: A GROUP OF THREE BOYS PER GIRL

$$\exists y \in {}^*\text{GIRL}: |y| = 4 \wedge \forall b \in \text{AT}(y):$$
$$\exists e \in \text{INVITE}: \exists x \in {}^*\text{BOY}: |x| = 3 \wedge \text{Ag}(e) = \uparrow(x) \wedge \text{Th}(e) = b$$

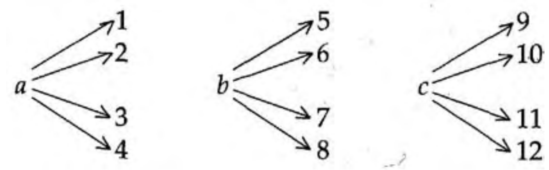
There are four girls such that each girl is invited by a group of three boys.

$$\uparrow(a \sqcup b \sqcup c) \rightarrow 1$$
$$\uparrow(d \sqcup e \sqcup f) \rightarrow 2$$
$$\uparrow(g \sqcup h \sqcup i) \rightarrow 3$$
$$\uparrow(j \sqcup k \sqcup l) \rightarrow 4$$

4. *Ds*(*Co* ()): QR the object, then the subject: FOUR GIRLS PER BOY

$$\exists x \in {}^*\text{BOY}: |x| = 3 \wedge \forall a \in \text{AT}(x): \exists y \in {}^*\text{GIRL}: |y| = 4 \wedge \forall b \in \text{AT}(y):$$
$$\exists e \in \text{INVITE}: \text{Ag}(e) = a \wedge \text{Th}(e) = b$$

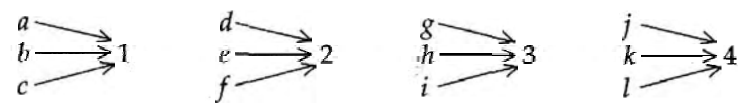
There are three boys such that for each boy there are four girls such that that boy invites each of those four girls.



5. *Do*(*Ds* ( )) QR the subject, then the object: THREE BOYS PER GIRL

$$\exists y \in {}^*\text{GIRL}: |y| = 4 \wedge \forall b \in \text{AT}(y): \exists x \in {}^*\text{BOY}: |x| = 3 \wedge \forall a \in \text{AT}(x):$$
$$\exists e \in \text{INVITE}: \text{Ag}(e) = a \wedge \text{Th}(e) = b$$

There are four girls such that for each of those girls there are three boys such that each of those boys invites that girl.

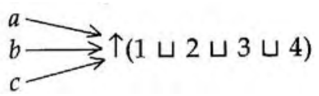


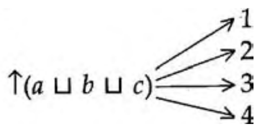
Note: 3. and 5. are inverse scope readings. They are usually exceedingly difficult to get (some, like Scha (1981), set up the scope mechanism in such a way that these readings are not produced by the basic scope mechanism, but only as part of an optional principle).

Now, we can argue the reasonableness of these results as follows: The collectivity criterion requires us to distinguish between readings 2. and 4. (where the object is collective and distributive, respectively). The distributive scope generalization distinguishes reading 1. from both 2. and 4. The opinion of the theory on inverse readings 3. and 5. is less compelling. These readings are produced by the general scope mechanism and are not independently motivated. If wanted, a separate condition forbidding inverse scope could get rid of these. On the other hand, in some cases inverse scope seems to be less of a problem. For that reason, one could let the grammar generate them and try to give an independent reason why these readings are usually so difficult to obtain.

Thus Lakoff's theory produces five readings, three of which are well motivated independently, and it seems that this is the minimum number of readings that any grammar will have to generate (again, except for the problem of inverse readings).

Roberts (1987) discusses various problems with Lakoffs theory, arguing that the theory undergenerates. I will here discuss yet another problem showing the same. Look at the situations 6. and 7., where as before letters indicate boys, numbers girls, and the arrows inviting.

6. 

7. 

When we evaluate sentence (24) in either of these situations, we observe that these are situations where it is very easy to agree that (24) is true. The readings corresponding to these situations are the following:

6. Ds–Co:

$\exists x \in$ +BOY: $|x| = 3 \wedge \exists y \in$ +GIRL: $|y| = 4 \wedge \forall a \in AT(x)$:

$\quad\exists e \in$ INVITE: $Ag(e) = a \wedge Th(e) = \uparrow(y)$

There are three boys and there is a group of four girls such that each of those boys invites that group of girls.

7. *Cs–Do*

$\exists x \in$ *BOY: $|x| = 3 \wedge \exists y \in$ *GIRL: $|y| = 4 \wedge \forall b \in AT(y)$:

$\quad\exists e \in$ INVITE: $Ag(e) = \uparrow(x) \wedge Th(e) = b$

There is a group of three boys and there are four girls such that that group of boys invites each of those girls.

Lakoff's theory does not generate these readings.

There is a ready response to this. One could argue the following: reading 6. is the borderline case of reading 2. and reading **7.** is the borderline case of reading 3. Thus, reading 2. is in fact true in situation 6., and reading **3.** is true in situation 7. Thus Lakoff's theory does generate two readings of sentence (24) that are true in situations ***6.*** and **7.** Hence, we could say: even better that the theory doesn't generate readings 6 and 7, it doesn't have to generate these.

There is a serious problem with this argument. As we have seen, reading **3.** is an inverse reading, and very difficult to get. If our judgement that sentence (24) is true in situation **7.** involves interpreting (24) on reading 3., we predict that it should be at least as difficult to judge (24) to be true in situation 7., as

it is in situation 3. But this is not the case. It is very easy to judge (24) to be true in situation *7.*, hence the truth of (24) in situation 7. cannot be reduced to reading 3. In fact, it can't be reduced to any of the other readings either. This means that we need a mechanism producing reading **7.** Now, since reading 2. is not an inverse reading, we don't have a similar argument for reading 6. However, typically a general mechanism that will produce reading **7.** will produce reading 6 as well. This means then, that we have evidence for seven readings, two more than Lakoff's theory gives.

THEORY **II:** Roberts **1987**

Such a theory is provided by Roberts' 1987 theory of scopal and non-scopal derived predicates. I do not have space to present the details of Roberts' theory, but in terms of QR, the theory can be reconstructed as follows:

Let us assume that we have two flavors of QR: QR_1 moves and creates a scopal dependency, while QR_2 moves or does not create a scopal dependency. In the present framework, this comes down to the following extension of Lakoff's theory: As before, we assume that we have only collective NPs. The two flavors of QR correspond to two quantifying-in rules: as before we have distributive quantifying-in DQI, but we add to the theory also non-scopal quantifying-in NQI. Thus, both these rules are available. This gives us indeed seven readings. Lakoff's five readings, plus readings 6. and **7.:**

6. Ds–Co: quantify in the subject with DQI, after that quantify in the object with NQI
7. Cs–Do: quantify in the object with DQI, after that quantify in the subject with NQI

In this way, we solve the problem with situation 7.: Roberts' theory generates reading 7., hence the truth of (24) in situation **7.** no longer relies on inverse reading **3.** There is still a problem: readings 6. and **7.**, as I argued, are very easy to get. Yet in a sense, they have a more complicated derivation than the other readings. Moreover, in this theory now reading 6. becomes an inverse scope reading. But clearly it is much easier to judge (24) to be true in situation 6., than it is to judge the other inverse scope readings to be true in their characterizing situations. While not as serious a problem (for one thing, 6. is the borderline of **2.**), there seems to be something unsatisfactory about the situation.

THEORY **III:** my proposal

Let us now see what the grammar that I have set up in this paper predicts. On my theory, non-quantificational NPs can shift their interpretation between collective and plural interpretations. The scope mechanism (and the only scope mechanism) is SQI.

This theory produces eight readings:

The scope mechanism SQI brings in four scoped readings. These are exactly the four scoped readings from Lakoff's theory (which shouldn't come as a surprise, since SQI is in essence the same rule as DQI). However, the simplest. derivations are simpler than in Lakoff's theory, because in each case we only need to invoke the scope mechanism once:

2. *Ds*(*Co*): group object in-situ, quantify-in sum subject
3. *Do*(*Cs*): group subject in-situ, quantify-in sum object
4. Ds(Do): sum object in-situ, quantify-in sum-subject
5. Do(Ds): sum subject in-situ, quantify-in sum-object

Besides these readings, the theory produces four **scopeless** readings, readings that do not invoke the scope mechanism at all, but only use in-situ application:

1. Cs–Co: group subject and group object in-situ
7. Cs–Do: group subject and sum subject in-situ
6. Ds–Co: sum subject and group object in-situ
8. Ds–Do: sum subject 'and sum object in-situ

For example, for reading 7. we enter first the sum interpretation of four girls and then the group interpretation of three boys into the scope domain. We get:

$$\exists e \in {}^*\text{INVITE}: \exists x \in {}^*\text{BOY}: |x| = 3 \wedge {}^*\text{Ag}(e) = \uparrow(x) \wedge$$
$$\exists y \in {}^*\text{GIRL}: |y| = 4 \wedge {}^*\text{Th}(e) = y$$

There is a sum of inviting events with a group of three boys as plural agent and a sum of four girls as plural theme.

This group of three boys will be the agent of each atomic sub-event, while the four girls are distributed as themes over the atomic sub-events. Hence this means:

There is a group of three boys and there are four girls such that for each of those girls there is an event of that group inviting that girl.

This is equivalent to reading 7.

The interesting case is, of course, the one reading that is not produced by Roberts' theory, reading 8.:

8. Ds–Do: scopeless plural reading:

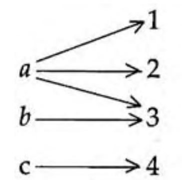
$$\exists e \in {}^*\text{INVITE}: \exists x \in {}^*\text{BOY}: |x| = 3 \wedge {}^*\text{Ag}(e) = x \wedge$$
$$\exists y \in {}^*\text{GIRL}: |y| = 4 \wedge {}^*\text{Th}(e) = y$$

There is a sum of inviting events that has a sum of three boys as plural agent and a sum of three girls as plural theme.

This tells us that every atomic part of e has one of these boys as agent and every atomic part of e has one of these girls as theme. In other words, every one of these boys invites one (or more) of these girls and every one of these girls is invited by one (or more) of these' boys.

This is the cumulative reading (apart from the exactly part, which Scha (1981) builds into the meaning of the cumulative reading, but which is arguably a matter of conversational implicatures, e.g. Horn (1972), Kadmon (1987)).

A situation in which 8 is true:



In this theory, then, in the case of one-place predicates, distributive readings fall out of the theory as plural readings. In the case of two-place predicates, plural readings come in two varieties: scoped plural readings, which are also distributive readings, and scopeless plural readings, which are cumulative readings.

We can list the following advantages of this theory over the other theories discussed:

In the first place, the two natural readings 6. and ***7.*** do not rely on inverse scope. The fact that they are easy to get, can be explained by the fact that they do not involve the scope mechanism as all: 6. and 7. are scopeless readings.

Second, cumulative readings fall out of the theory, and they fall out of the theory without invoking the complicated mechanism of binary quantification.

Third, cumulative readings are independent from collective readings. They are not reduced to collective readings. Hence the theory obeys the collectivity criterion.

Fourth, cumulative readings are, like distributive readings, non-thematic. Both are reduced to plurality.

Obviously, this is not a full theory, but only the beginning of a theory. For one thing, I am not dealing in the present paper with the urgent problem of how to extend the present theory to cumulative readings of other NPs, like downward entailing NPs, as in (26):

(26) At most three boys invited at most four girls.

I discuss this and many other aspects of the present framework elsewhere (Landman (1994)).

9 Cover Readings

There is one more type of reading of sentences like (24) that I have not yet discussed. These are what Scha (1981) calls second collective readings, and which have since become known as cover readings or partitive readings. Look at (27):

(27) Four hundred fire fighters put out twenty fires.

The reading that we are interested in is the reading where the sentence expresses that some groups of fire fighters put out fires, these groups altogether consist of four hundred fire fighters and altogether twenty fires were put out by these groups. Theories of cover readings are developed, among others, in Scha (1981), Verkuyl and van der Does (1991), Gillon (1987), van der Does (1992), and Schwarzschild (1991). Scha (1981) (and after him Verkuyl and van der Does (1991)) assumes an interpretation for the NP four hundred firefighters which breaks up a group of four hundred fire fighters into subgroups covering that group. This approach is untenable, because it conflicts with the distributive scope generalization. If the cover is part of the noun phrase interpretation, the scope mechanism will predict that when the cover NP is scoped, the rest of the sentence will take scope dependent on not the individual fire fighters but on these subgroups (i.e. the reading will be twenty fires per group of fire fighters). Since there can be far more than four hundred subgroups involved, we predict that the sentence can be true in situations involving far more than 400 x 20 fires, contradicting the distributive scope generalization.

The relevant observation concerning cover interpretations is that they are closely related to cumulative readings: like cumulative readings, they are plural, non-thematic readings, and like cumulative readings they are scopeless. This means that the cover effect should not be regarded as contributed by the noun phrase interpretations, but rather, like cumulative readings, by the verb or the predication.

I will extend the theory with cover roles. For simplicity, I will restrict the models to models where ATOMd = ran (↑). In such models cover roles can be truly roles (otherwise we have to define cover relations). Cover roles will be non-thematic roles, defined in terms of plural roles. They will be partial functions from sum events into atoms.

Let R be a thematic role.
ᶜR, the cover role based on R, is the partial function from De into Dd defined by:
$^{c}R(e) = a$ iff $a \in \mathrm{ATOM} \wedge \sqcup(\{\downarrow(d) \in \mathrm{SUM}: d \in \mathrm{AT}(^{*}R(e))\}) = \downarrow(a)$
undefined otherwise.

To show how this works, suppose the following:

$\mathrm{Ag}(e) = \uparrow(j \sqcup b)$
$\mathrm{Ag}(f) = \uparrow(j \sqcup m)$
$\mathrm{Ag}(g) = \uparrow(b \sqcup m)$
then: $^{*}\mathrm{Ag}(e \sqcup f \sqcup g) = \uparrow(j \sqcup b) \sqcup \uparrow(j \sqcup m) \sqcup ?(b \sqcup m)$

$\{\downarrow(d): d \in \mathrm{AT}(^{*}\mathrm{Ag}(e \sqcup f \sqcup g))\} = \{j \sqcup b, j \sqcup m, b \sqcup m\}$.
Hence: $\sqcup(\{\downarrow(d): d \in \mathrm{AT}(^{*}\mathrm{Ag}(e \sqcup f \sqcup g))\}) = \sqcup(\{j \sqcup b, j \sqcup m, b \sqcup m\})$
$= j \sqcup b \sqcup m = \downarrow(\uparrow(j \sqcup b \sqcup m))$.
Hence $^{c}\mathrm{Ag}(e \sqcup f \sqcup g) = \uparrow(j \sqcup b \sqcup m)$

Let us define a subgroup of a group α as a group β such that ↓(β) ⊑ ↓(α). Let us define: set X of subgroups of group α covers α iff ⊔ {↓(x): x ∈ X} = ↓(α). Given this terminology, a group α is the cover agent of sum-event e if the plural agent of e is a sum of subgroups of α that together cover α.

In the grammar, we now assume a type shifting principle for verbs, which says that verbs can switch from n-place scope domains with a plural role *R to n-place scope domains with a cover role ᶜR:

$\mathrm{A}x_n \ldots x \ldots x_1.\{e \in {}^{*}V: \ldots {}^{*}R(e) = x \ldots\} \Rightarrow$
$\mathrm{A}x_n \ldots x \ldots x_1.\{e \in {}^{*}V: \ldots {}^{c}R(e) = x \ldots\}$

Let us look once more at (24):

(24) Three boys invited four girls.

If we start with the following scope domain:

$\lambda y \lambda x.\{e \in {}^{*}\mathrm{INVITE}: {}^{c}\mathrm{Ag}(e) = x \wedge {}^{c}\mathrm{Th}(e) = y\}$

and enter the group object and group subject into the scope domain, we get the following interpretation:

Ps-Po:
$\exists e \in {}^{*}\mathrm{INVITE}: \exists x \in {}^{*}\mathrm{BOY}: |x| = 3 \wedge {}^{c}\mathrm{Ag}(e) = \uparrow(x) \wedge$
$\exists y \in {}^{*}\mathrm{GIRL}: |y| = 4 \wedge {}^{c}\mathrm{Th}(e) = \uparrow(y)$

Working this out, we get:

$\exists e \in {}^{*}\mathrm{INVITE}: \exists x \in {}^{*}\mathrm{BOY}: |x| = 3 \wedge \sqcup(\{\downarrow(d): d \in \mathrm{AT}({}^{*}\mathrm{Ag}(e))\}) = x \wedge$
$\exists y \in {}^{*}\mathrm{GIRL}: |y| = 4 \wedge \sqcup(\{\downarrow(d): d \in \mathrm{AT}({}^{*}\mathrm{Th}(e))\}) = y$

There is a sum of inviting events, a sum of three boys and a sum of four girls and the plural agent of the sum of inviting events is a sum of groups covering that sum of boys, and the plural theme of the sum of inviting events is a sum of groups covering that sum of girls.

In other words: there is a sum of inviting events with as plural agent a sum of groups of boys (making up three boys in total) and as plural theme a sum of groups of girls (making up four girls in total).

We see that cover readings are really analyzed in terms of distribution to subgroups. A situation where this reading is true is:

$$\uparrow(a \sqcup b) \rightarrow \uparrow(1 \sqcup 2)$$
$$\uparrow(a \sqcup c) \rightarrow \uparrow(3 \sqcup 4)$$

Adding the possibility to shift to cover readings adds five more readings to the theory: basically, for every reading where one of the NPs has a group interpretation, a reading is added where that NP has a cover interpretation.

Following Schwarzschild (1991), we assume that if a ∈ IND: a = ?(a). This means that individuals are their own subgroups. It follows from this that if $^*R(e)$ = x, where $x \in$ SUM, then also $^cR(e) = \uparrow(x)$: if, say, the plural agent of e is a sum of individuals x, then those individuals are subgroups that cover $\uparrow(x)$. Similarly, if $^*R(e) = \uparrow(x)$, then also $^cR(e) = \uparrow(x)$: in this case $\uparrow$(x) is covered by $\{\uparrow(x)\}$. This means that all the four scopeless readings we had before, plus the new ones that are added, are in fact, all borderline cases of the double cover reading. This suggests an alternative to the theory that I am proposing, which actually reduces the number of readings:

THEORY IV: Schwarzschild 1993

This theory makes the following assumptions:
1. NPs have only group interpretations; 2. Verbs have only an interpretation as scope domains where all roles are cover roles; **3.** The scope mechanism is DQI.

This theory reduces distributivity to scope and cumulativity to cover effects. The theory generates five readings for sentence (24): One scopeless reading: Ps–Po and four scoped readings: Ds(Po); Do(Ps); Ds(Do()); Do(Ds()).

The theory does not generate the other scopeless readings, i.e. it doesn't generate directly collective or cumulative readings. But, in the light of the above, it doesn't have to, because those are all special cases of the one scopeless reading it does generate, the double cover reading. Apart from some differ-; ences that are irrelevant in the present context, this theory represents the position of Schwarzschild (1991) quite closely, and probably also that of Gillon (1987).

Note that the arguments that I brought up against the theories I and I1 do not carry over to theory IV. The readings Ds–Co and Cs–Do are not generated by the scope mechanism, neither do they have to be regarded as borderline cases of readings that are generated through inverse scope. They are borderline cases of the most basic scopeless reading: Ps–Po.

If it is the number of readings that we're most interested in, then it is quite clear that theory **IV** is the most attractive of the theories I have discussed here: It generates only five readings, four of which we get just because we have a scope mechanism; it doesn't overgenerate like Scha's theory and all readings discussed in this paper are special cases of readings generated by theory IV.

In fact, I do not have strong arguments against theory IV, I think it is a very strong alternative to theory III. I will end this section with some discussion.

Theory 111 is based on the distinction between two Basic kinds of predication: thematic predication and plural predication. The assumption that there are collective readings corresponds to the assumption that verbs can directly express thematic predication to plural arguments. The assumption that there are plural readings (distributive/cumulative)corresponds to the assumption that semantic pluralization is freely available in the verbal domain. Theory IV argues correctly that the effect of cover readings, or partitivity, as defined here, is a generalization of both, and hence can replace them in the grammar. This is technically correct, but has consequences for the overall architecture of the theory that I find dubious. Rather than making partitivity the center of the theory of plurality, I suggest that we regard it as a special interpretation strategy of verbs, made available by the connections between different semantic domains.

The main problem with theory **IV** is that the process of generalization, and the weakening of the readings cannot stop here. Look at (28):

(28) Three boys ate fifteen breads.

The cover interpretation for (28) tells us that there is a cover of these three boys and a cover of these fifteen breads, and each block of boys eats some block of breads, while each block of breads gets eaten by some block of boys. But as is well-known, this is not the only interpretation possible. ^cR is a **plural partition** of the verbal arguments into subgroups, but (28) also allows a **mass partition** of those arguments that allows a mass interpretation (in (28) the theme) into sub-mass parcels. On that interpretation we associate groups of boys with entities that are not groups of breads.

Given the way we have defined ^cR, we can express such mass-partition in a completely analogous way to plural partition. We assume that we have a mass domain MASS, which is a part-of structure, and we assume that just as $\uparrow$ and $\downarrow$ associate the domain SUMd with the domain ATOMd, there are two similar operations p (package) and g (grind) between MASS and ATOMd (for details, see Landman (1991)). Given this we can define a mass-cover role as:

Let R be a thematic role.
^mR, the **mass-cover role based on** R, is the partial function from De into Dd defined by:
$^mR(e)$ = a iff a ∈ ATOMd ∧ $\sqcup(\{g(d)\colon d \in \mathrm{AT}(^*R(e))\}) = g(a)$
undefined otherwise

Assuming that, for roles that in a predication can have a mass-interpretation, we can shift from a plural role to a mass-cover role, we get (28a) as an interpretation for (28):

(28) a. $\exists e \in {}^*\text{EAT}: \exists x \in {}^*\text{BOY}: |x| = 3 \wedge \sqcup(\{\downarrow(d): d \in \text{AT}({}^*\text{Ag}(e))\}) = x \wedge$
$\exists y \in \text{BREAD}: |y| = 15 \wedge \sqcup(\{g(d): d \in \text{AT}({}^*\text{Th}(e))\}) = g(\uparrow(y))$

Note that, unlike in the plural case, a mass partition of an atom does not necessarily reduce to thematic predication to that atom: The plural partition of (29) reduces to (29a); the mass partition is (29b):

, (29) A boy ate a bread.
(29) a. $\exists e \in \text{EAT}: \exists a \in \text{BOY}: \exists b \in \text{BREAD}: \text{Ag}(e) = a \wedge \text{Th}(e) = b$
(29) b. $\exists e \in {}^*\text{EAT}: \exists a \in \text{BOY}: {}^*\text{Ag}(e) = a \wedge$
$\exists b \in \text{BREAD}: \sqcup(\{g(d): d \in \text{AT}({}^*\text{Th}(e))\}) = g(b)$

(29b) says: there is a sum of events of eating **chunks** of bread by some boy, all together making up a bread. We can think of (29b) as representing a subtle shift of meaning of eat, focusing on the actual process of eating.

Now, it seems that the logic of the argument in favor of theory IV – the reduction of readings and the notion of partitivity as the basis of the theory of plurality – leads to the conclusion that, given the obvious similarities between these two forms of partitivity, the theory cannot stop at plural partitivity, but has to define a notion of cover role that generalizes over these two. This means that the basic representation of sentences will become once more weaker. And it is not clear that the process will stop here. Other semantically relevant part-of relations have been proposed as related to the domain of individuals (like the domain of stages of individuals, see Carlson (1977b), Hinrichs (1985), Krifka (1990a), Moore (1993)) and there is no reason to expect that we cannot partition individuals along those other part-of dimensions as well. For each of these cases the basic representation of the verbs would have to be weakened. My feeling is that this makes the basic representations exceedingly weak, in my view too weak.

Theory III fits in the following more general semantic picture. I assume that we have basic domains of atoms: individuals and events. The theory of plurality associates with these domains of atoms part-of structures of sums. Just as the domains of plurality (sums) are associated with the basic domains of atomic entities (individuals and events), so are other semantic domains that form part-of structures associated with these atomic domains: the mass domain (Link (1983), Landman (1991)), aspectual domains like the domain of processes and their stages (Bach (1986), Landman (1992)), the domain of states and their parts, presumably domains of stages of individuals (or eventual individuals, see Moore (1993)), and probably others. I assume that these partially ordered domains are connected to the domain of atoms through shifting operators. The most important of these is promotion: partially ordered entities can be promoted to individuals (atoms): all partially ordered entities can be shifted to entities that are no longer fully determined by the relations to their parts, and in this way be treated as individuals in their own right. This brings them into the domain of atoms, and there they form input to the theory of plurality. For entities in the plural domain (sums), this is what group formation does. I argue in Landman (1991) for packaging as an operator shifting mass-entities into count atoms. Moore (1993) argues for a similar shift from stages to individual atoms. I would argue that quantified states (as in I was in Amsterdam three times last year) involve a similar shift. On this perspective, it is natural to see partitivity as a shi'ft operation as well: an operation breaking up atoms, shifting an atom to a sum of constituting atoms, where constitution is defined in a related partially ordered domain. I regard partitivity shifts as shifts of meaning of the verbs. The shift from a plural role of the verb to a cover relation can be seen as a shift in perspective of the verb: from the perspective of predication to entities just as entities, to a perspective of predication to entities as made up from parts of a particular kind. For some part-of relations such a shift can be readily available (like from groups to sums of subgroups), for others, this may be much more restricted. The theory of collectivity, plurality and scope I have developed in this paper assigns to a sentence like (24) four scopeless readings and four scoped readings, all of which are plausible. These readings I regard as the primary readings. Other readings, like partitive readings, can be derived in context through optional shifting of the meaning of the verb.

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