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CUMULATION IS NEEDED:
A REPLY TO WINTER (2000)*

Winter (2000) argues that so-called co-distributive or cumulative readings do not involve polyadic quantification (contra proposals by Krifka, Schwarzschild, Sternefeld, and others). Instead, he proposes that all such readings involve a hidden anaphoric dependency or a lexical mechanism. We show that Winter's proposal is insufficient for a number of cases of cumulative readings, and that Krifka's and Sternefeld's polyadic **-operator is needed in addition to dependent definites. Our arguments come from new observations concerning dependent plurals and clause-boundedness effects with cumulative readings.

1. INTRODUCTION

Kroch (1974), Scha (1981), and others observed that sentences containing more than one plural determiner phrase (DP) often have interestingly weak truth conditions. Consider the example in (1):

(1)   The soldiers hit the targets.
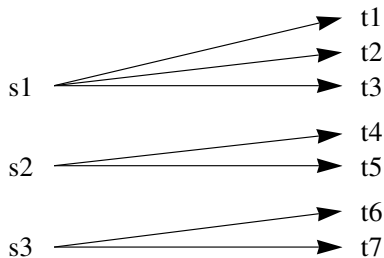
Example (1) is true in the sketched situation with three soldiers and seven targets, where soldier 1 hit only targets 1, 2, and 3, soldier 2 hit only targets 4 and 5, and soldier 3 hit only targets 6 and 7. This observation doesn't follow from the existence of the distributive interpretations of the two plural DPs. Thus the doubly distributive interpretation can be para-

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phrased as 'Every soldier hit every target', which is clearly false in the situation under consideration.

In this paper we use the term 'cumulative interpretation' for all cases where a sentence containing two plurals has truth conditions weaker than those of a doubly distributive paraphase.[1] Other terms have been used in the literature: Kroch (1974) uses the term 'serially distributive', Scha (1981) reserves the term 'cumulative' for weak interpretations available in sentences containing two indefinite plurals and doesn't actually use any term to refer the weak reading of (1), and Sauerland (1998) introduces the term 'codistributive reading' that Winter also makes use of. We use the term 'cumulative interpretation' without any theoretical commitment. A sentence containing more than one plural DP will be called a 'relational plural'.

In this paper, we discuss three possible analyses of the cumulative interpretation of (1): The **-analysis from Krifka (1986), the lexical analysis that is advocated by Scha (1981), and the dependent definites analysis that Winter (2000) develops to supplement the lexical analysis.

Both the **-operator analysis and the lexical analysis make use of an operation that assigns to a binary predicate a new cumulative meaning. The intuition is that (1) is true in the situation shown because the relation 'hit' holds for pairs of soldiers and targets and because every soldier and every target appear as a member in one of the pairs of the 'hit'-relation. Kroch (1974: 205) captures this by stating an interpretation rule very much like (2) for his 'serially distributive' interpretation:

(2) $P(X, Y) \Rightarrow \forall x \in X \exists y \in Y \ P(x, y)$ and
         $\forall y \in Y \exists x \in X \ P(x, y)$

Rather than adding cumulativity as an optionally applying interpretation rule, we follow Krifka (1986) and Sternefeld (1998) and assume that cumulativity is captured by an operator that is present in the structure and can take a binary predicate/relation as its argument. This is the **-operator. A

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[1] A phenomenon that at first might seem related to cumulative interpretations is the difference between total and partial predicates discussed by Krifka (1996) and Yoon (1996). But (i) and (ii) show that cumulative interpretations are an independent phenomenon: (i) shows that only the predicate *dirty* in (ib) allows a partial reading since only (ib) can be true if some of the cups are actually dirty while most are clean. But both (iia) and (iib) allow a cumulative reading. In the following, we avoid partial predicates when discussing cumulative interpretations.

(i)   a.   The cups are clean.
         b.   The cups are dirty.

(ii)   a.   The boys cleaned the cups.
         b.   The boys dirtied the cups.

number of equivalent definitions of the **-operator are available. We'll make use of the one in (3).[2]

(3) $[**R](X)(Y) = 1$ if and only if $\forall x \in X \exists y \in Y \ R(x)(y)$ and $\forall y \in Y \exists x \in X \ R(x)(y)$

A crucial claim of the syntactic operator analysis is that the cumulativity operator can apply to any binary predicate formed in the syntax.

The lexical analysis is originally due to Scha (1981).[3] It makes use of a meaning postulate, instead of the **-operator, to assign a cumulative interpretation to a predicate. In (4), we give the meaning postulate that Scha (1981: 497) proposes for the relation "parallel".

(4) $par(X, Y) = \forall x \in X \exists y \in Y \ par(x, y)$ and $\forall y \in Y \exists x \in X \ par(x, y)$ and $\#X \neq 0$ and $\#Y \neq 0$

The interpretation that the meaning postulate (4) makes available for the relation "parallel" is exactly the result of applying the **-operator. In principle, meaning postulates like (4) could be part of our semantic knowledge of some binary predicates, but not hold for others. However, at least Winter assumes that a meaning postulate like (4) exists for every lexical binary predicate. The difference, then, between this analysis and the **-analysis is that meaning postulates, at least at Scha and Winter see it, are only possible for lexical predicates. The **-analysis, however, assumes that ** can apply to any phrase that denotes a two-place predicate.

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[2]   One alternative definition of ** makes use of the notion of a pair-cover from Schwarzschild (1992). A pair-cover of a set of pairs Z is a subset C such that for any pair (x, y) in Z there are x′ and y′ such that (x′, y) $\in$ C and (x, y′) $\in$ C. The **-operator can then be defined as in (i).

(i) $[**R](X)(Y) = 1$ iff there is a pair-cover C of $X \times Y$ such that $R(x)(y)$ for all (x, y) $\in$ C

A second alternative definition is that of Krifka (1986) in terms of closure of a set under mereological sum formation. This definition assumes that the mereological sum of two pairs is defined as in (iia). ** of a relation R is then defined as the smallest superset closed under mereological sum formation.

(ii)   a. $(x_1, y_1) \oplus (x_2, y_2) = (x_1 \oplus x_2, y_1 \oplus y_2)$
         b. $**R = \min\{S \supset R \mid \forall x, y \in S \ x \oplus y \in S\}$

A third alternative is to view instances of **-application as special cases of branching quantification in the sense of Henkin (1961) and Hintikka (1974). The first to observe this reduction to branching quantification is, to our knowledge, van Benthem (1989: 441).

[3]   In fact, Scha (1981) proposes two analyses for cumulative interpretations. For examples with definites he proposes the meaning postulates discussed in the text. For examples with indefinite numerals, he proposes a syntactic rule forming a complex quantifier out of the two numerals. The latter analysis is closer to the **-analysis we are discussing. Winter (2000) uses the term "vagueness" for the lexical analysis.

A third explanation of the weak readings of (1) is developed by Winter (2000) (see also Sauerland 1994). This 'dependency analysis' assumes that one of the plurals contains an implicit variable bound by the other one. Consider the representation for (1) in (5).

(5)   The soldiers λx. x hit the targets (of x)

If the subject in (5) is interpreted as a distributive universal, and we assume that some relation R of targets to soldiers is contextually salient, we arrive at the interpretation in (6).

(6)   ∀x[x is one of the soldiers → x hit [the R(x) targets]]
        R(x)(y) = 1 iff y is a target assigned to x

This interpretation, which can be paraphrased as (7), is sufficiently weak for (1) to be true in the situation under discussion.

(7)   Each soldier hit the target(s) assigned to him.

Implicit variables are motivated by the work of Mitchell (1986), Partee (1989), Chierchia (1993), and others. Motivation for the dependency analysis for the particular phenomenon at hand comes from the observation that dependent definites are required independently of the issue of relational plurals: (8a) for example can also describe the situation in (1), i.e. (8a) can be understood as in (8b):

(8)   a. Every soldier hit the targets.
      b. Every soldier hit the targets assigned to him.

Which of the three possible accounts of (1) is actually required? The dependency account is independently attested; is this account sufficient for all examples of cumulativity? It's clearly not, as shown by (9), which also can be true in the situation sketched in (1).

(9)   These three soldiers hit those seven targets.

As we discuss in section 3 in more detail, the dependency analysis assigns to (9) an interpretation that can be paraphrased as in (10). However, (10) is false or a presupposition failure in the situation under consideration, because no soldier is assigned seven targets.

(10)   Each of these three soldiers hit the seven targets assigned to him.

So the question is which mechanism should be adopted in addition to the dependency account: the **-analysis or the lexical analysis. Both would explain the previous example. There seems to be no a priori preference for either account, as we know of no independent evidence for either

analysis. Winter's position is that the lexical analysis together with the dependency account explains all cases of weak readings with two plural noun phrases.

Our position is that both the dependency analysis and the **-analysis are required. We show that Winter's analysis is insufficient and that there are a number of examples which neither the dependency analysis nor the lexical analysis can account for.

The structure of this paper is as follows: In section 2 we discuss morphological and semantic plurality of the dependent NP. We show that the plural marking must generally be interpreted and that this causes a problem for a dependency analysis of cases where plural marking does not seem to affect interpretation. Section 3 shows that several kinds of plural NPs can participate in cumulative readings, not all of which are amenable to a dependency analysis. Winter is aware of such data, and we discuss his position. In section 4, we establish an independent argument for a uniform analysis of all the cumulative constructions in section 3 using the **-operator. We show that the constraints on the availability of cumulative readings (in cases that don't allow for a dependency analysis) follow from the familiar locality constraints on quantifier raising, and that the particular version of the **-analysis in Sauerland (1998) predicts exactly this. Section 5 concludes the paper.

2. INTERPRETATION OF THE DEPENDENT PLURAL

Consider example (1) again, but now in a situation where each soldier is assigned exactly one target. Can this example be subsumed under the dependency analysis in (11) (repeated from (5))?

(11)   The soldiers $\lambda x.x$ hit the $R(x)$ targets

$s1 \longrightarrow t1$
$s2 \longrightarrow t2$
$s3 \longrightarrow t3$
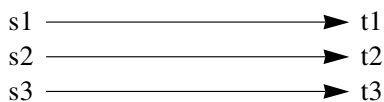
If the plural marking on the lower DP is interpreted, the prediction is that (1) is not true in this situation, because no soldier hit a plurality of targets associated with him. Rather, only (12), without plural marking, should be appropriate in a situation where in fact every soldier is associated with only one target.[4]

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[4] The example with the singular shows something else. Compare (11) (repeated in (ia)) with (ib). The interpretation of (ia) where the target is dependent on the soldier requires a context that establishes a relation of soldiers and targets to be licensed.

(12)   The soldiers hit the target.

Winter (2000: 56–58), however, suggests that "dependent plurality" is not interpreted. This is well known to be true for plural marking on bound plural pronouns, as shown by example (13).

(13)   The boys (each) think they will win.

Example (13) has an interpretation where each boy thinks that there will be one winner, namely himself. In this case, the bound variable *they* corresponds to is always assigned a singular individual. Nevertheless, the pronoun itself must be morphologically plural. We assume that this is an agreement phenomenon, and that the plural feature on *they* in (13) is not interpreted, just like other agreement features are not interpreted (Chomsky 1995 and others). The agreement requirement seems to be a general fact about bound variables, as there are well known parallels with person, tense, gender, and mood marking (Partee 1973; Kratzer 1998; Schlenker 1999).

Winter's suggestion, if we understand it correctly, implies that plural marking on any DP may be purely morphological if the plural DP contains a pronominal bound by another plural DP.[5] Winter doesn't offer any independent support for this conclusion, and it is hard to regard the phenomenon still as a pronominal agreement under his proposal.

The following examples show that there are cases of DP containing a bound pronominal where plural marking must be interpreted contrary to the suggestion of Winter.

(i)   a.   The soldiers hit the target.
        b.   The soldiers hit the targets.

This isn't the case for the weak interpretation of (ib). We would like to suggest that in empty contexts the dependency analysis is not available, and the weak interpretation of (ib) comes about by a different mechanism. In (ib) this may be the lexical or the **-analysis. Consider, however, example (ii), where the lexical analysis doesn't predict a weak interpretation.

(ii)   a.   The boys put a coin into the machine.
        b.   The boys put a coin into the machines.

In our intuition, only (iib) allows a cumulative interpretation in an empty context. If that judgment is correct, it argues for the **-analysis.

[5]   Winter (2000: 57) states: "As noted already by Chomsky (1975), syntactic plural number does not always entail 'semantic plurality'," and "What the origin of these effects may be is of course a question that begs an answer, [. . .]." We have chosen one plausible way to make this suggestion precise; we believe that alternative ways would make the same wrong predictions for the cases that follow.

(14) a. The soldiers get promoted if they hit the/their target.
    b. The soldiers get promoted if they hit the/their targets.

(15) a. The women will leave after the/their husbands arrived.
    b. The women will leave after the/their husband arrived.

(16) a. The seals like a person who caresses their noses.
    b. The seals like a person who caresses their nose.

Consider the examples in (15) in a situation where every woman has exactly
one husband. In that case (15a) only allows an interpretation that requires
all the husbands to arrive before the first woman leaves, while (15b) can
also be true if the first woman's departure takes place after only her own
husband's arrival. If plural marking on *the/their husbands* is interpreted
in (15a), this difference in interpretation is predicted because *the/their
husbands* cannot refer to the husband of just one woman, and therefore must
refer to the group of all husbands. But if plural marking on *the/their
husbands* isn't interpreted, no difference in interpretation is expected in
(15).

    We conclude therefore that dependent plurality is restricted to pronom-
inals – plural marking on a bound pronominal need not be interpreted as
plurality. Plural marking on non-pronominal DPs, however, must be inter-
preted. In particular, a consequence of interpreting plural marking is that
plural marking is only licensed in a situation where the singular marking
is inappropriate.

    If plural marking on non-pronominal DPs must be interpreted, there
are examples of cumulative readings that are explained by neither the
dependency nor the lexical analysis. Winter observes that this is the case
for example (17a), which can be true in a situation where, for each circle,
there is only one triangle that is connected to it by a dashed line. Similarly,
examples (17b) and (17c) show that the **-analysis is required, since these
examples can be true in situations where women have no more than one
husband, and where sea lions have no more than one nose.

(17) a. The circles are connected to the triangles by a dashed line.

                                               (Winter's (77))

    b. The women gave a kiss to the/their husbands.
    c. The sea lions balanced a ball on the/their noses.

Consider (17b) in detail. As we showed above, a dependency analysis
doesn't predict that (17b) can be true in a situation where each woman
has exactly one husband and gave a kiss to her one husband. But in fact
(17b) can be true in such a situation. A lexical analysis is also insuffi-

cient, since the cumulated predicate is 'λyλx. x give a kiss to y'. Only the **-analysis can predict that (17b) can be true in the situation under consideration. The reason is that syntactic processes, which are discussed extensively in section 4, can create the predicate 'λyλx. x give a kiss to y'. The application of the **-operator to this predicate then yields the result that (17b) can be true in the situation with one husband per woman. Representation (18) shows the account of (16b) on the **-analysis.

(18)   [the women] [the husbands] **[λyλx. x gave a kiss to y]

3. MORE CASES OF **-CUMULATIVITY

3.1. *Other Cases of Non-dependent, Non-lexical Cumulativity*

The cases discussed in the previous section aren't the only ones where the dependency analysis cannot derive cumulativity. Three further cases are cardinal definites, cardinal indefinites, and conjunctions.

Consider first the examples in (19) with cardinal definites as the lower plural:

(19) a. Many politicians have taken a bribe from the five companies.
     b. These five teachers gave a bad mark to those 20 protesting students.
     c. The two women wanted to marry the two men.

Each of the examples allows a cumulative reading. For example, (19a) could be true in a situation in which there is no politician who took a bribe from every one of the five companies, as long as there are many politicians who took a bribe from one of the five companies. Similarly, (19b) is true when each of the 20 students got a bad mark from only one of the five teachers. (19c), finally, is true when each woman decided to marry one of the two men under discussion. We will show that all three examples in (19) are only predicted to have a cumulative interpretation by the **-analysis.

None of the examples in (19) lends itself to an analysis in terms of dependent definites, because of the presence of the numeral in the lower plural. For example, consider the analysis in (20) for (19c).

(20)   ∀x[x is one of the two women → x wanted to marry [the R(x) two men]]]
        where R(x)(y) = 1 iff x dates y

Analysis (20) is false in a situation where, for each woman, there is only one man she decided to marry, but true in a situation where, for each woman,

there are two men she decided to marry. Therefore, analysis (20) correctly captures the interpretation of (21), but is insufficient for (19c).

(21)   Each of the two women wanted to marry the TWO men that she dated.

Of course, on the dependency analysis, the relation R could be any relationship between women and men. However, for any choice of R, we would expect that each woman has a desire to marry two men somehow associated with her. This is not the reading we are after and not a salient reading of (19c) altogether. Note that this problem can be seen as a different instantiation of the question, discussed in the previous section, whether the plural on the dependent NP may be vacuous. Here, the numeral is taking the place of the plural morpheme, and the numerals in (19) are interpreted.

The cumulative readings in (19) also cannot be accommodated to the view that the cumulation is restricted to lexical predicates simply because the cumulated predicate isn't a lexical one: In example (19a) 'λxλy. x took a bribe from y' is the cumulated predicate, and in (19c) 'λxλy. x wants to marry y' is cumulated.[6]

Cumulative readings also occur with plural indefinites and with conjunctions. Consider the examples in (22) and (23).

(22) a. Three boys gave a present to five girls.
     b. The two gardeners sold 2000 roses to a woman, and only 500 to a man.
     c. Jim and Frank want to marry two dentists.

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[6] That a lexical analysis for (19c) is impossible follows independently of the analysis of infinitival complementation chosen. Consider first an analysis of (19c) that assumes that the subject position of the infinitival clause is occupied by a silent pronominal which is coreferent with the subject of *want*. On this analysis, application of ** to *marry* yields (ia), which can be paraphrased as in (ib).

(i)   a. $\forall w \in W$: want(w)(**marry(M)(W))
       b. The two women each have the following desire: they marry the two men.

The result is not the interpretation of (19c) observed, since it is not intuitively required for (19a) to be true that the two women have the same desire.

Consider now an analysis of (19c) that assumes that the subject position of the infinitival clause is empty, so that the clausal argument of *want* is a predicate, not a proposition (Chierchia 1984). One possible instantiation of this analysis is shown in (iia) and paraphrased in (iib).

(ii)   a. want(W)(**marry(M))
       b. The two women together have the following desire: they marry the two men.

Clearly, (iia) also doesn't have the cumulative interpretation observed with (19c).

(23) a. Three boys gave a present to Ann, Jill, Sue, Nina, and Zoe.
     b. The two gardeners sold a rose to Sue, Mary, and Peter.
     c. Jim and Frank want to marry Sue and Amy (respectively).

A cumulative reading is straightforward in all cases. (22a), for example, can be true if each girl received only one present from a boy. Again, an analysis in terms of dependent definites is as impossible for indefinites and conjunctions as it was for numeral definites. For the numeral indefinite example (22a), a dependency analysis would only yield the interpretation paraphrased by (24).

(24)   Three boys each gave a present to five girls related to them.

For the coordinate DPs in (23) a dependency analysis is ruled out, because a coordination of proper names cannot contain an implicit variable. This is shown, for example, by the fact that (25) only allows an interpretation where each of the five girls received a present from each of the boys.

(25)   Every boy gave a present to Ann, Jill, Sue, Nina, and Zoe.

3.2. *Winter on Those Cases*

Winter is, of course, aware of data involving numerals and conjunctions, and discusses some relevant examples in his paper. His basic position seems to be (i) that cumulativity with cardinal definites is restricted to lexical predicates; (ii) that cumulativity with cardinal indefinites is to be analyzed by a mechanism of cumulative quantification in the spirit of Scha (1981), which is different from 'normal' cumulativity, and (iii) that cumulativity with conjunctions is to be analyzed by a coordination-specific mechanism. We will discuss these three cases in turn.

Regarding numeral definites, we believe that Winter's generalization that cumulativity is restricted to lexical predicates is incorrect. We have already seen three counterexamples in (19). Let's, however, consider the arguments Winter presents in favor of this restriction.

A crucial contrast for Winter is the difference between (26a) and (26b); when we evaluate these sentences against the situation sketched (27), with the additional contextual information that Ann and Ruth are Bill's children and Mary and Sue are John's children, (26a) can plausibly be judged true, but (26b) is false.

(26)   (Winter's (33b) and (47a))
     a. The fathers are separated from the children by a wall.
     b. The two fathers are separated from the four children by a wall.

(27)

	Ann		Mary
Bill		John	
	Ruth		Sue

Note that Winter chose a non-lexical predicate, '$\lambda x \lambda y$. x is separated from y by a wall'. Therefore, only the dependency analysis and the **-analysis predict a cumulative reading for (26). The dependency analysis predicts cumulativity to be possible in (26a), but not in (26b). Therefore, the dependency analysis is sufficient to account for (26a). Furthermore, the **-analysis actually seems to predict that (26b) should allow a cumulative interpretation, contrary to fact. Hence, Winter concludes based on the contrast in (26) that the dependency analysis is superior to the **-analysis.

The contrast in (26) is fairly clear, and this is therefore a good argument for distinguishing (26b) with its cardinal definites from (26a) with its plain definites. However, we disagree with the conclusion that the distinction be made by rejecting a **-analysis. We have shown that the **-analysis is possible in other examples with cardinal definites. Thus finding one example in which a cardinal definite does not allow a cumulative reading is no basis for the general conclusion that cardinal definites do not allow such readings. Could there be other factors blocking the **-analysis for (26b) in the situation described?

First, it should be pointed out that (26a) and (26b) are not semantically identical under our assumptions either. (26a) should permit a dependency analysis while (26b) doesn't. A dependency analysis is, in fact, very natural for (26b) given the inherently relational nouns *father* and *child*, and given that Winter considers the sentence in a situation where a parent-hood relation actually holds between the fathers and the children they are separated from. This is likely to affect judgments in (26a): A cumulative reading can come about by the **-analysis or by the dependency analysis, and should thus be easy to obtain. In (26b), on the other hand, cumulativity can arise only via the **-analysis.

Furthermore, we think the pragmatic factors weighing on judgments of (26) should be considered in more detail because it is plausible that pragmatic factors always affect the availability of a cumulative reading: all sentences which allow a cumulative reading have other readings as well, for example the doubly distributive one. Cumulative interpretations are not equally salient for all examples of relational plurals. We think that

there is a general tendency to favor the strongest possible interpretation, a doubly distributive reading (i.e., we think that the strongest meaning hypothesis of Dalrymple et al. (1998) probably has applications beyond reciprocals in plural predication). The doubly distributive interpretation is the reading that one intuitively gets in (26b), and can be paraphrased as "Each of the two fathers is separated from each of the four children by a wall." That is why (26b) is judged false in situation (27). Semantic and pragmatic factors can overcome this bias towards the strongest meaning. This is what happens in (19c), for example, since most people are unwilling to assume that a woman would have a desire to marry more than one man. No such considerations force a weaker reading in Winter's example (26b), and therefore only the doubly distributive interpretation is available.

We have identified two further factors that help overcome the pragmatic bias towards the doubly distributive interpretation. For one, it helps (for reasons we do not understand) to put the two numeral expressions into focus and the cumulated relation in the background. (28b) can be judged true more easily in the situation in (27) given the context in (28a):

(28) a. In the picture over there, the three women are separated from the four dogs by a wall.
     b. In this picture, the two men are separated from the four children by a wall.

Secondly, a cumulative reading is easier to get if the cardinalities of the two groups match. Accordingly, a cumulative reading is natural for both relational plural sentences in (29):

(29) The two semanticists gave the two consultants a flower, and the two lecturers gave the two TAs a bottle of wine.

Next, let's consider examples with indefinite numerals (case (ii) from above). Winter discusses and rejects the possibility that the same account should be given for cumulativity in examples like Scha's (30) and examples with definites.

(30) 600 Dutch companies use 5000 American computers.

(Scha 1981: 500)

As shown in (31), the cumulative interpretation of (30) is easily captured on our analysis by the **-operator.

(31) $\exists X$ (X is a plurality of 600 Dutch companies) $\exists Y$ (Y is a plurality of 6000 American computers) [X **use Y]

However, things aren't that simple. As Winter (p. 52) points out, an analysis like (31) is inappropriate for (32), which also has a cumulative interpretation.

(32)   Exactly 600 Dutch companies use exactly 6000 American computers.   (Winter's (61))

The problem is that representation (33) is incorrectly predicted to be true in a situation where 700 Dutch companies used 10000 American computers, since the existential quantifiers ∃X and ∃Y could select subsets of these two sets that have exactly the specified cardinalities 600 and 6000.

(33)   ∃X (X is a plurality of exactly 600 Dutch companies) ∃Y (Y is a plurality of exactly 6000 American computers) [X **use Y]

However, recent work by Hackl (2000, 2001) and Krifka (1999) develops a semantics for non-upward monotonic quantificational determiners such as *exactly 600* or *at most three* that allows an account of (32) and similar examples using the **-analysis of cumulativity. Hackl's proposal, in particular, is to apply what's known about the syntax and semantics of comparatives to this class of determiners. Hackl's proposal leads to the representation (34) for (32), where *exactly 600* was decomposed into [[exactly 600] many] and the 'exactly 600' part has moved to a position taking clausal scope, and analogously for *exactly 6000*.

(34)   600 is the maximal number n such that [6000 is the maximal number m such that [∃X (X is a plurality of n-many Dutch companies) ∃Y (Y is a plurality of m-many American computers) [X **use Y]

Hackl's analysis extends to all cases of non-monotonic indefinite determiners. Hence there is no need to postulate an additional analysis for cumulativity in examples like (30) involving indefinites. In the next section, we show that cumulativity with definite and indefinite numerals is subject to the same restrictions, and argue that they should be analyzed in the same way.

Finally, consider examples involving conjunctions of proper names (case (iii) from above). Winter claims that (35a), in contrast to (35b), cannot be true in a cumulative situation.

(35) a. John and Bill gave Mary, Sue, Ann, and Jane a flower.
                                                          (Winter's (42))
     b. John and Bill gave Mary and Jane a flower.

Our research with informants has shown that the contrast in (35) is less strong than that in (26). We attribute the remaining contrast to the fact, observed with (26) already, that cumulative interpretations are easier with two plurals of matching cardinality. Examples like (35a) allow a cumulative interpretation quite easily when some other factors biasing such sentences against a cumulative interpretation are controlled for. In particular, as noted above already, a cumulative construal is most easily available if the two plural NPs are in focus. The default focus placement for (35a), however, is to focus the final noun phrase *a flower*. (36) is a modified version of (35a) that takes these consideration into account, and a cumulative construal is available in (36).

(36)   Who gave a flower to whom?
         John and Bill gave a flower to Mary, Sue, Ann, and Jane.

Another way to make cumulative readings easily available with conjunctions is use of the word *respectively* as in (37).[7]

(37)   John and Bill gave a flower to Mary and Sue respectively.

We show in the next section that cumulative readings involving *respectively* are subject to the same locality restrictions that cumulative readings involving definite and indefinite numerals are subject to. This corroborates our claim that all three phenomena are to be analyzed in the same way using the **-operator.

4.   THE **-ANALYSIS AND QR LOCALITY

This section develops the **-analysis of cumulativity in more detail by investigating the restrictions on which binary predicates can be cumulated, and then shows that these restrictions apply uniformly to all cumulativity phenomena subsumed under the **-analysis in the previous section. Regarding the syntactic restrictions on cumulative interpretations, we show that binary predicates corresponding to complex syntactic constituents can be cumulated, and that quantifier raising as well can create binary predicates by readjusting the syntactic constituency. This, we show, follows

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[7]   Winter suggests that the data involving *respectively* should receive a different analysis from cumulativity phenomena, an analysis that has to cover examples like (i) as well. Our strategy is different: we try to push a **analysis as far as possible in the hope that it might generalize to (i) as well.

  (i)   John loves and hates Mary and Sue respectively. (Winter's (45))

easily from the analysis of movement suggested by Heim and Kratzer (1998).

Consider again the **-analysis of example (38a) (repeated from (19b)):

(38) a. These two teachers gave a bad mark to those 20 students.

     b. (these two teachers) (those 20 students) **λyλx[x gave a bad mark to y]

In (38b) the cumulative reading could potentially be derived by application of ** to an expression that is a syntactic constituent at S-structure. (39) shows what that structure could look like (assume that *to* is semantically vacuous). (See Larson 1990; Pesetsky 1995; Bruening 2000 for more detailed analyses of the constituent structure of ditransitives.)

(39)   [[these two teachers] [[**[gave a bad mark]] [to those 20 students]]]

However, there are other examples that clearly require a readjustment of syntactic constituency. Consider once more (40a) (repeated from (19c)) and the **-analysis of its cumulative reading in (40b):

(40) a. The two women want to marry the two men.

     b. (the two women) (the two men) **λyλx[x want to marry y]

The cumulated predicate in (40b) doesn't correspond to a syntactic constituent at S-structure, where *to marry the two men* is customarily assumed to be the complement of *want*.

Similar mismatches between surface constituency and the constituency indicated by interpretation are, of course, well known in the case of quantifier scope. One solution for the quantifier scope case is to assume that a quantifier moves from its surface position to its scope position (Chomsky 1976; May 1977, and many others) – this movement is commonly called QR. We propose that definite plurals can also undergo QR, and that this QR can create the binary predicate required for the application of the **-operator.

Sauerland (1998) points out that the possibility to form binary predicates via movement is predicted from the way syntactic movement is analyzed by Heim and Kratzer (1998: 186–188). They propose that the structures created by movement look like those shown in example (41a) for *Who left*. In contrast to the usually assumed structure in (41b), a variable abstractor λx is adjoined to the constituent targeted by movement in (41a) before the moved phrase is adjoined. Furthermore, Heim and Kratzer propose that the constituent consisting of λx and its sister is interpreted as a predicate.

(41) a.

    Who

       λx

          left   x

b.

    Who$_x$

       left   x
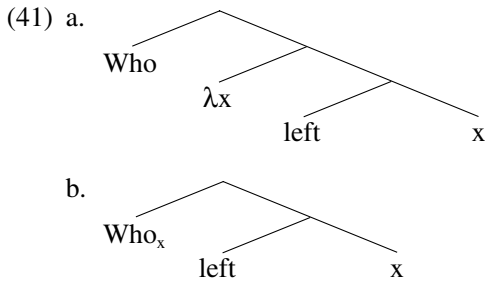
If movement creates constituents that are interpreted as predicates, it is also possible to create predicates that take more than one argument by movement. This happens if a second instance of movement targets a position between the predicate created by movement and the moved phrase. Sauerland (1998) proposes to create the cumulated predicate in examples like (40a) in this way. We illustrate this proposal for (40a) with a sketch of three steps of a derivation in (42).

(42) a. [the two women] λx [x want to marry the two men]
    b. QR: [the two women][the two men] $\lambda y \, \lambda x$ [x want to marry y]
    c. **-insertion: [the two women] [the two men] **$\lambda y \lambda x$ [x want to marry y]

The representation (42b) is derived from (42a) by applying QR to [the two men], targeting the position immediately above λx. This creates a binary predicate which the **-operator can be applied to in (42c).

    This analysis makes an interesting prediction: cumulative readings should be available just in case syntax, and especially QR, can create the relation that the **-operator has to apply to. We expect the familiar constraints on QR to show up in cumulative readings. This prediction is already made by Sternefeld's (1998) approach to cumulativity, but it has only been argued to be empirically correct by Sauerland (1998), and extensively by Beck (2000). We discuss a set of relevant examples in this section; we will avoid examples with plain definites throughout to exclude a dependency analysis.

    QR is much more easily possible out of infinitival clauses than finite clauses.[8] Accordingly, a cumulative reading is possible in (43a) but

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[8] Our point doesn't depend on whether the clause-boundedness restriction is exactly correct, but rather on whether there's a correlation between the scope of quantificational NPs and the availability of cumulative readings with plurals. Beck (2000: 17) observes the interesting exception to the clause-boundedness of cumulative readings in (i), where the matrix subject and the embedded object can cumulate if the embedded subject pronoun *they* is bound by the matrix subject.

not (43b). (43c) specifies the relation that would have to cumulate in (43b).

(43) a. The two lawyers have pronounced the two proposals to be against the law.

    b. # The two lawyers have pronounced that the two proposals are against the law.

    c. **λyλx.x has pronounced that y is against the law

Since we argue that numeral definites, numeral indefinites, and conjunctions are all to be analyzed in terms of the **-operator, we expect constraints on QR to affect cumulative readings with all of these types of plural NPs. The contrast between finite clauses and infinitival clauses is replicated in examples with numeral indefinites and conjunctions in (44) and (45):

(44) a. # Max and Peter said that Bill married two dentists.

    b. * Max and Peter said that Bill married Ann and Amy, respectively.

    c. **λyλx[x said that Bill married y]

(45) a. Max and Peter want to marry two dentists.

    b. Max and Peter want to marry Sue and Amy, respectively.

    c. **λyλx[x wants to marry y]

A similar constraint on QR is found in extraction out of NPs. While QR is in principle possible out of NPs (as so-called inverse linking data show, see May 1985), relative clauses are in general islands for QR. This is mirrored with cumulative readings in (46):

(46) a. Sue and Amy saw a premiere of the two new operas this week.

    b. # Sue and Amy talked to a man who likes the two countries.

    c. **λyλx.x talked to a man who likes y

Again, the contrast is replicated with indefinites and conjunctions. The relative clause cases in (47) lack cumulative readings while the NPs in (48) allow them.

(i)   The two women said that they would buy the two cars.

As (ii) shows, in this case the correlation between cumulative readings and wide scope doesn't obtain.

(ii)   A woman said that she would buy every car.

A detailed explanation of the contrast between (i) and (ii) is beyond the scope of this paper. We believe that the explanation should come from two things: (I) a better understanding of the syntax of *de se* pronouns (pronouns that refer to the speaker of an embedded speech act), and (II) the fact that for our account of the cumulativity of two NPs the lower NP doesn't need to move to a position taking scope above the higher NP (see example (59) below).

(47) a. # Sue and Amy talked to a man who likes two European countries.
 b. * Sue and Amy talked to a man who likes Northampton and Danbury, respectively.
 c.   **λyλx[x talked to a man who likes y]

(48) a.   Sue and Amy saw a premiere of two new operas this week.
 b.   Sue and Amy saw a premiere of 'Cats' and 'Oklahoma!', respectively.
 c.   **λyλx.x saw a premiere of y

In fact we find the contrast between specific vs. non-specific NPs familiar from Fiengo and Higginbotham (1991) on inverse linking:

(49) a.   Sue and Amy discussed a review of these two books in class.
 b. # Sue and Amy discussed Jill's review of these two books in class.
 c.   **λyλx.x discussed Jill's review of y in class

And again, the contrast also exists with an indefinite numeral in (50) and a coordination in (51):

(50) a.   Sue and Amy discussed a review of two new books.
 b. # Sue and Amy discussed Jill's review of two new books.

(51) a.   Sue and Amy discussed a review of 'Move Alpha' and 'Fried Green Tomatoes', respectively.
 b. ?? Sue and Amy discussed Jill's review of 'Move Alpha' and 'Fried Green Tomatoes', respectively.

As a final example of constraints on QR that affect cumulation, we show that cumulative readings in English double-object constructions also behave in a way parallel to standard QR. (52) shows that the second object cannot take scope over the first. The observation essentially goes back to Barss and Lasnik (1986) and is discussed by Larson (1990), Aoun and Li (1993), and Bruening (2000).

(52)   I gave a boy every cookie.
       * every cookie >> a boy

We adopt from Bruening (2000) the assumption that, while both quantifiers in (52) can undergo QR, there is a constraint that blocks the second object from moving to a position higher than the first. (Bruening explains this constraint by appeal to the shortest attract constraint on movement of Chomsky 1995.) In fact, we believe that the facts from cumulativity lend new support to Bruening's analysis.

Consider first (53) and (54). While cumulation in (53) can take scope over the indefinite second object, cumulation between the subject and the second object in (54) cannot take scope over an indefinite first object.

(53) a.   The two girls gave the two boys a cookie.
     b.   **λyλx[x gave y a cookie]

(54) a. # The two girls gave a boy the two cookies.
     b.   **λzλx[x gave a boy z]

Sentence (54) only has a cumulative reading in which the same boy is involved. The LF in (55) is impossible, which is expected since the LF-position of the second objects is higher than that of the first object:

(55)   * [[two girls][two cookies] **[λy λx[x gave a boy y]]]

At the same time, the representation (56) is possible for (54), since the hierarchical order of the two objects is maintained. This corresponds to an interpretation where the indefinite isn't part of the cumulated relation.

(56)   [a boy] λz [[two girls] [two cookies] **[λy λx[x gave z y]]]

The contrast between (57b) and the two *to*-variants of the ditransitive in (57a,c) shows the same effect:

(57) a.   Two employees showed the two reports to a friend.
     b. # Two employees showed a friend the two reports.
     c.   Two employees showed a report to the two spies.

In the structures with a prepositional object, (57a) and (57c), there is a cumulative reading in which cumulation takes scope over the singular indefinite. The corresponding double-object structure (57b) does not have such a reading.

Finally, Bruening's analysis predicts that both objects of a double object construction can scope over the subject as long the first object ends up in a higher position. This assumption is needed to account for the cumulative interpretation of (58), where the cumulated relation includes the indefinite subject.

(58)   Today, a gardener sold 1000 customers 1200 flowers and a florist sold 800 customers 1300 flowers.

Structure (59) is the LF-representation we assume for the first conjunct of (58).

(59)   [1000 customers] [1200 flowers] **λy λx[a gardener sold x y]

For completeness, we show in (60) and (61) that conjunctions and indefinites behave just like numeral definites in the double-object construction.

(60) a.   Two girls gave two boys a cookie.
     b.   Two girls gave Sue and Amy a cookie.
     c.   **λyλx[x gave y a cookie]

(61) a. # Two girls gave a boy two books.
     b. # Sue and Amy gave a boy 'Peter Pan' and 'Fried Green Tomatoes', respectively.
     c.   **λzλx[x gave a boy z]

We draw three immediate conclusions from the data discussed in this section. The first is that our findings support an analysis in terms of the **-operator. The **-operator applies to a relation-denoting constituent. Hence we expect that it can apply to any relation-denoting constituent that syntax can create – overtly or covertly – but also that no other relation should be able to cumulate. This is what we find. Syntactic constraints affect the availability of cumulative readings in the way the **-analysis predicts.

The second conclusion is that cumulative readings with all types of plural NPs discussed in this section (numeral definites, numeral indefinites, and conjunctions) should be analyzed in the same way. The availability of cumulative readings is subject to the same syntactic constraints for all of them. These empirical parallels would appear accidental in a theory that derived cumulativity in fundamentally different ways for the three cases.

Thirdly, our data in this section speak against an analysis in terms of dependent definites. Even if we found a way to adapt the dependent definite analysis to apply to numerals, for example, a dependent definite analysis would not predict locality conditions to affect the availability of the cumulative reading. In fact, Winter notes that cumulative readings in this sense can cross island boundaries. He gives example (62) below, which indeed allows for a dependent reading:

(62) a.   The companies will go bankrupt if the computers are not powerful enough.
     b.   Each company will go bankrupt if their computers are not powerful enough.

We are happy to follow him in the conclusion that (62a) should receive an analysis in terms of dependent NPs. (62a) confirms that an analysis in terms of dependent NPs exists. Winter also notes that a parallel example with numeral indefinites, as in (63), allows no such interpretation (his

example uses *exactly*, but leaving *exactly* out does not change the judgment). This is what we would expect.

(63)   600 companies will go bankrupt if 5000 computers are not powerful enough.

Our conclusions jointly imply that all cumulative readings discussed in this section should be derived by the **-analysis. None of the data in this section are amenable to an analysis in terms of either dependent definites (because of numerals and conjunctions) or a lexical analysis (because the relation that obtains between the two plural NPs is not lexical). Not only is an analysis in terms of ** straightforward; it can also straightforwardly account for the fact that cumulative readings exhibit all the familiar locality effects of QR.

5.   SUMMARY AND CONCLUSION

We conclude that both a dependent NP analysis and a **-analysis exist. We are convinced by Winter's arguments in favor of dependency; we take issue only with Winter's claim that ** does not exist. We have brought forth the following arguments in support of **:

There is evidence that the NP that would be dependent in Winter's analysis is a genuine plural. The dependency analysis runs into trouble when the dependent NP would have to refer to a singular individual (section 2). A related point is that in the place of a plain plural definite, numeral definites, numeral indefinites, and conjunctions also allow cumulative readings. Those cannot be subsumed under a dependency analysis (section 3).

We have explored the circumstances under which cumulative readings are possible, and we have shown that a cumulative reading is permitted just in case syntax can create a constituent that denotes the argument relation of the **-operator. In particular, the familiar locality constraints on QR show up with all relevant data (numeral definites, indefinites, and conjunctions) (section 4). Locality effects are expected under a **-analysis, but not a dependency analysis. This shows that one would not want to extend a dependency analysis to other types of NPs, even if it were semantically possible. It also shows that cumulative readings with these data are one and the same phenomenon, and not a random assortment of pseudo-cumulative effects. Winter's position seems to be that the conjunctions should be analyzed as a coordination-specific phenomenon, the definite numerals (presumably) are restricted to lexical predicates, and the numeral indefinites are to be subsumed under cumulative quantification. We disagree with the claim

that numeral definites only show cumulative readings with lexical predicates (see data above). We have shown that it is desirable to assume a parallel analysis for all these data, and we think that the **-operator should be the crucial ingredient in that analysis.

A final issue we would like to address is that of lexical predicates. Once we have the **-operator at our disposal, this operator can be held responsible for cumulative readings with lexical predicates, too. We have throughout the paper kept open the possibility that there is an independent mechanism that cumulates lexical predicates (the meaning postulates approach from Scha); this was done for the purpose of establishing the need for ** independently of assumptions about lexical predicates. Given our theoretical conclusions, however, we see no need to keep an independent lexical mechanism, and we suggest to use ** on lexical relations instead.

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