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# RECIPROCALS ARE DEFINITES*

This paper proposes that elementary reciprocal sentences have four semantic readings: a strongly reciprocal interpretation, a weakly reciprocal interpretation, a situation-based weakly reciprocal reading, and a collective reading. Interpretational possibilities of reciprocal sentences that have been discussed in the literature are identified as one of these four. A compositional semantic analysis of all of these readings is provided in which the reciprocal expression is uniformly represented as 'the other ones among them' (recasting Heim, Lasnik and May 1991a, b). A reciprocal sentence is thus a special kind of relational plural. Interpretational variability comes about by the same mechanisms of plural predication at work in relational plurals: pluralization operators, LF operations like QR, and addition of contextual information.

## 1. INTRODUCTION

The topic of this paper is the compositional derivation of the numerous readings of elementary reciprocal sentences. My goal is to assume only one analysis of the reciprocal and to exploit the properties of plural predication to get the variation in interpretation that we observe. The analysis of the reciprocal that I use is a variant of Heim, Lasnik and May's (1991a, b) analysis, in which the reciprocal expression *each other* means 'the other ones among them'. The obvious challenge for this theory is the variety of readings that elementary reciprocal sentences permit. An impressive recent survey of these readings is found in Dalrymple et al. (1998). My aim is to show that the source for this variety is not ambiguity of the reciprocal, but the usual indeterminacy we find in relational plural sentences. The multiplicity of interpretations in reciprocal sentences should therefore follow from the mechanisms of plural predication that

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we need independently for relational plurals. My strategy is different in this respect from that of Dalrymple et al., who ascribe a range of meanings to the reciprocal itself, and in a sense this paper is a response to that aspect of their theory.

The structure of the paper is as follows: In section 2 I introduce Heim, Lasnik and May's (1991a, b) (henceforth: HLM) analysis. I then collect from the literature the range of interpretations of reciprocal sentences that this analysis does not account for and that I will be concerned with.

In section 3 I explain why I will pursue the analogy to relational plural sentences, a theoretical perspective developed as early as Langendoen (1978). I introduce the theory of plural predication I assume. Straightforward application of this theory to HLM's basic idea gives us a first set of reciprocal readings, including strong reciprocity and partitioned strong reciprocity.

Section 4 is dedicated to weak reciprocity. I discuss a recent proposal by Sternefeld (1998) to derive weak reciprocity, which is entirely compatible with my theoretical outlook but not with my use of a HLM semantics for the reciprocal. I suggest a way to derive weakly reciprocal readings that combines insights by Sternefeld with HLM and, I argue, improves on Sternefeld's original suggestions.

The topic of section 5 is intermediate reciprocity, as discussed in Dalrymple et al. (1998). I argue that this should not be viewed as an independent reading. Rather, the interpretational effect should be subsumed under a more general context dependency. Sauerland (1998) and (in a somewhat different form) Schwarzschild (1996) propose a contextually salient relation to derive such effects. I further speculate that the analysis of relational plurals in Beck (1999b) for apparent salient relation effects in terms of salient subsituations can be extended to reciprocals.

I summarize the paper in section 6 and relate my general perspective to Dalrymple et al.'s. I discuss what I consider the only true leftover from their paper that remains unaccounted for – inclusive alternative ordering interpretations of reciprocal sentences – and I explain how their Strongest Meaning Hypothesis can apply under my view of reciprocals.

## 2. HLM and Its Challenges

### 2.1. *Heim, Lasnik & May (1991a)*

Let's look at the simplest possible case of a reciprocal sentence – something like (1). I will call *Mary and John* the antecedent of the reciprocal, and the group denoted by that NP the antecedent group; *know* will be referred

to as the reciprocal relation. (1) is an elementary reciprocal sentence (terminology from Langendoen); I will use this label for sentences whose semantic ingredients can be schematized as in (2) (where A is the antecedent group and R the reciprocal relation, some expression of type ⟨e, ⟨e, t⟩⟩).

(1) Mary and John know each other.

(2) A R each other

HLM take as their starting point the fact that (1) means the same as (3a) – both amount to the truth conditions in (3b).

(3) a. Mary and John each know the other.
b. Mary knows John and John knows Mary.

They propose that *other* in *each other* makes the same contribution that it does on data like (4) – namely, distinctness.

(4) a. John came out, and no other doctor came in.
b. I don't like this picture, show me another.

To this they add the anaphoric nature of the reciprocal: whatever 'other' individual we are looking at, it must still be a member of the antecedent group. They propose that the LF of (1) looks like (5), where *each* has adjoined to the reciprocal antecedent. With the assumption that the reciprocal has the denotation in (6) and *each* the one in (7), the truth conditions come out as in (8).[1, 2]

(5) [[Mary and John]$_3$ each] [1 [[[$t_1$ other] Pro$_3$] [2 [$t_1$ know $t_2$]]]

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[1] I use 'group' as an informal term to talk about pluralities of individuals and '&' to indicate group formation, so 'M&J' stands for the denotation of *Mary and John*. I will talk about groups as if they were sets of singular individuals, but still of type ⟨e⟩. Singular individuals are identified with the singleton sets that contain them. See Schwarzschild (1996) for a suitable ontology. Also, I use '≤' for the part-of relation. Given my ontological assumptions, '≤' is interpreted as the subset relation and '&' as set union. If nothing more is said about the parts of a given group, assume that they are individual parts of that group, i.e. singularities. This will be made more precise in section 3.

I present truth conditions as translations into a λ-categorial language with these symbols, except that I will often represent predications like 'know(x, y)' as 'x knows y' for readability.

[2] I generally use Pro$_3$ to stand for the silent element in the reciprocal pronoun that is anaphoric to the antecedent group. I express the anaphoric relation by coindexation. Since Pro$_3$ is obligatorily related to the antecedent, it would be more adequate to express the anaphoric relation via (obligatory) variable binding. This can be done by another QR movement of the antecedent. I will generally omit this additional step for simplicity.

(6) each other = every other one among them
[[[$t_1$ other (of) $Pro_3$]]] =
$\lambda Q \forall z[z \neq x_1 \ \& \ z \leq x_3 \ \& \ person(z) \rightarrow Q(z)]$

(7) a. [[each]] = $\lambda x \lambda P \forall y[y \leq x \ \& \ singularity(y) \rightarrow P(y)]$
b. [[Mary and John each]] =
$\lambda P \forall y[y \leq M\&J \ \& \ singularity(y) \rightarrow P(y)]$

(8) $\forall y[y \leq M\&J \ \& \ singularity(y) \rightarrow$
$\forall z[z \neq y \ \& \ z \leq M\&J \ \& \ person(z) \rightarrow z \text{ knows } y]]$

The reciprocal is doubly anaphoric: to the antecedent group itself (the range argument, in the terminology of HLM – here, the variable $x_3$), and to the bound variable that is the argument of *other* (the contrast argument – the variable $x_1$ in the example). With a two-membered antecedent group, the universal quantifier associated with the reciprocal does not seem to do much work; but consider (9a). HLM predict that the sentence means (9b), whatever the number of men is, which seems right (although it should be noted that HLM explicitly restrict their attention of two-membered groups).

(9) a. The men know each other.
b. Each man knows every other man.

This analysis involves a twofold universal quantification over members of the antecedent group. The resulting reading is known in the literature as a strongly reciprocal interpretation (Langendoen's (1978) name for Fiengo and Lasnik's (1973) *each-the-other* relation). I give the abstract schema for strong reciprocity in (10).

(10) *Strong Reciprocity (SR):*
$\forall x \leq A$: $\forall y \leq A$ [$y \neq x \rightarrow xRy$]

This is certainly a possible reading of reciprocal sentences and a plausible one for the example. Not all reciprocal sentences receive such strong truth conditions, however. Their truth conditions can be weaker than SR in various ways. Below I discuss several weaker interpretations of reciprocal data that have been argued in the literature to be independent readings. I introduce first the relevant data and formalizations. Theoretical discussion including the question of the status of these interpretations as semantic readings will be the topic of the following sections.

## 2.2. *Reciprocal Interpretations Unaccounted For*

### 2.2.1. *Partitioned Strong Reciprocity (PartSR)*

Fiengo and Lasnik (1973) are perhaps the first ones to discuss the difference in meaning between quantificational (11a) and reciprocal (11b):

(11) a. The men are each hitting the others.
b. The men are hitting each other.

In (11b) it is not the case that each man has to hit every other man. It is possible, for example, for the men to team up in pairs that stand in the hit-relation. Fiengo and Lasnik characterize this reading as follows: there is a partition of the subject group *the men* (here, a partition into pairs) such that in each cell of the partition, SR holds. This is the concept of partitioned strong reciprocity:

(12) *Partitioned Strong Reciprocity (PartSR):*
There is a partition PART of A such that $\forall X \in$ PART:
$\forall x \leq X$: $\forall y \leq X$ [$y \neq x \rightarrow xRy$]

A perhaps clearer example is Dalrymple et al.'s (13):

(13) To muddy the ballot waters further, at least four sets of propositions compete with each other.

They report that the context in which the sentence occurs makes it clear that the intended reading is one in which each member of the first set of propositions competes with every other individual proposition in that set, and similarly for the other three sets.

### 2.2.2. *Intermediate Reciprocity (IR)*

Fiengo and Lasnik correctly concluded that it is not always possible to interpret a reciprocal sentence according to SR. However, partitioning of the set denoted by the antecedent is not the only way in which the truth conditions of a reciprocal can be weaker than SR. The next example comes from Dalrymple et al.

(14) Five Boston pitchers sat alongside each other.

SR is factually impossible. Yet this is not a contradictory statement. The sentence is considered true in the situation depicted below (the arrow symbolizes the reciprocal relation – here, *sit alongside*).

(15) $1 \leftrightarrow 2 \leftrightarrow 3 \leftrightarrow 4 \leftrightarrow 5$

Dalrymple et al. suggest the following truth conditions:

(16) $\forall x \leq P$: $\forall y \leq P$ [$y \neq x \rightarrow$
$\exists z_1 \ldots z_n \leq P[x = z_1$ & $y = z_n$ & $z_1$ sat alongside $z_2$ & . . .
& $z_{n-1}$ sat alongside $z_n$]]

That is, any two members of the antecedent group are connected by a chain of elements that stand in the reciprocal relation. This is stated more generally below as Intermediate Reciprocity (IR).

(17) *Intermediate Reciprocity (IR):*
$\forall x \leq A$: $\forall y \leq A[y \neq x \rightarrow$
$\exists z_1 \ldots z_n \leq A[x = z_1$ & $y=z_n$ & $z_1 R z_2$ & . . . & $z_{n-1} R z_n]]$

Similar data include the following (both from Dalrymple et al.):

(18) a. The telephone poles are spaced five hundred feet from each other.
b. The exits on the Hollywood Freeway are within one mile of each other.

### 2.2.3. *Weak Reciprocity (WR)*

There are data that force us to assume that the truth conditions of the reciprocal statements involved are still weaker. Consider (19) from Langendoen.

(19) The prisoners released each other.

Let us (in contrast to Langendoen in his discussion of this example) ignore group releasings and assume that each prisoner acted and suffered individually. For the sentence to be true, each prisoner must have released another prisoner, and must have been released by another prisoner. Neither SR nor IR need to hold.

Langendoen characterizes this reading as weakly reciprocal; this is formalized in (20).

(20) *Weak Reciprocity (WR):*
$\forall x \leq A$: $\exists y \leq A$ [$xRy$ & $x \neq y$] &
$\forall y \leq A$: $\exists x \leq A$ [$xRy$ & $x \neq y$]

Sentence (21) is another example that also has (or can have) weakly reciprocal truth conditions.

(21) The children give each other a present.

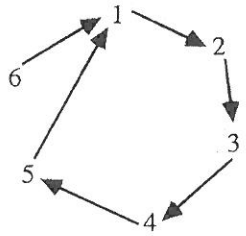
Take the sentence to be about a Santa Claus party. Those happen on the 6th of December and typically involve cookies, Christmas songs, and bad poems. Also, people give each other presents. One way to do the presents is that everybody brings a present and drops it into a big bag. Later you get to close your eyes and choose a present from the bag. Alternatively, you write your name on a piece of paper, the papers go into a bag, and you have to bring a present for the person whose name you draw. In either case, (21) can truthfully describe the procedure because every child gives and receives a present.

### 2.2.4. *One-way Weak Reciprocity (OWR)*

This reading and the next one are weaker than WR. Both have been suggested by Dalrymple et al. Sentences like (22) show, according to Dalrymple et al., that WR needs to hold only in one direction. We accept the sentence as true in the situation depicted in (23). Pirate 6 is not stared at by anybody.

(22) The pirates are staring at each other.

(23)




Dalrymple et al. propose the following truth conditions for the example:

(24) $\forall x[x \leq P \rightarrow \exists y[y \leq P \ \& \ x \neq y \ \& \ x \text{ stared at } y]]$

The general case is given in (25).

(25) *One-way Weak Reciprocity (OWR):*
$\forall x[x \leq A \rightarrow \exists y[y \leq A \ \& \ x \neq y \ \& \ xRy]]$

One of the important contributions of Dalrymple et al. is the observation that semantic properties of the reciprocal relation are crucial for distinguishing between the readings. Notice that if the reciprocal relation is symmetric, WR and OWR are equivalent. So if we contrast WR with OWR, only examples with a non-symmetric relation are relevant.

2.2.5. *Inclusive Alternative Ordering (IAO)*

A final set of data involves asymmetric relations. Consider the following examples (taken from Dalrymple et al. 1998 and Langendoen 1978, respectively):

(26) a. The third-graders gave each other measles.
b. The plates are stacked on top of each other.

These sentences may be true, even though there must be at least one third-grader who did not give the measles to any other third-grader (since you can only have measles once), and there must be one plate that is not on top of any other plate (the bottom-most one). Thus, even WR and OWR are too strong. Dalrymple et al. suggest that for (26b) to be true it is only required that each plate is either on top of one other plate, or has one other plate on top of itself. The abstract truth conditions of this interpretation are given in (27).[3]

(27) *Inclusive Alternative Ordering (IAO):*
$\forall x[x \leq A \rightarrow \exists y[y \leq A \ \& \ x \neq y \ \& \ (xRy \vee yRx)]]$

The suggestion that this is a reciprocal reading is attributed to Kanski (1987) by Dalrymple et al.

2.2.6. *Relations between the Readings*

This concludes my survey of possible interpretations for reciprocal sentences. It is obvious that I have been guided to some extent by Dalrymple et al. in selecting the set of relevant interpretations. I therefore should mention that compared to Dalrymple et al., two readings that they introduce are missing in my survey: Strong Alternative Reciprocity (SAR) and Intermediate Alternative Reciprocity (IAR). I am not convinced from the evidence brought forth in Dalrymple et al. that these should be analyzed

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[3] Actually, Dalrymple et al. account for the two examples in this subsection with two different sets of truth conditions. (26a) receives truth conditions in terms of Intermediate Alternative Reciprocity (IAR), defined below:

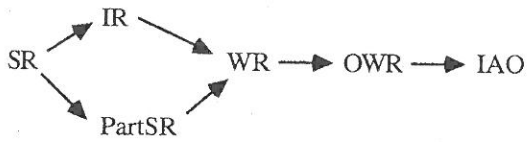
(i) Intermediate Alternative Reciprocity (IAR):
$\forall x \leq A$: $\forall y \leq A$ [$y \neq y \rightarrow$
$\exists z_1 \ldots z_n \leq A[x = z_1 \ \& \ y = z_n \ \& \ (z_1Rz_2 \vee z_2Rz_1) \ \& \ \ldots$
$\& \ (z_{n-1}Rz_n \vee z_nRz_{n-1})]]$

I do not discuss IAR as a separate reading because I think that IAO is sufficient to illustrate the problem with those examples. IAR is a mixture between IR and IAO.

as independent readings of reciprocal sentences and will disregard them.[4] On the other hand, I have mentioned and will discuss PartSR and WR, which fall outside their theory. Dalrymple et al. are not concerned with partitional interpretations in general – I do not think we would have an argument as to whether PartSR interpretations exist. I do disagree w.r.t. WR; see section 4 for discussion.

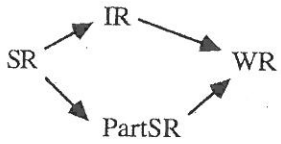
It has been mentioned in the above discussion that the readings I have introduced are not logically independent, and become progressively weaker in the order presented. The entailment relations between them have been studied by Dalrymple et al. For the six readings discussed here, the relations are as diagrammed below:

(28)




If the reciprocal relation is symmetric, WR, OWR, and IAO collapse into one reading. The simplified diagram for symmetric relations is given in (29).

(29)




Even though there seem to be all these different possible readings for reciprocal sentences in general, any individual sentence is not perceived as multiply ambiguous. Dalrymple et al. suggest that any given sentence will have the strongest meaning it could express (logically and factually) as its only interpretation. They call this the Strongest Meaning Hypothesis (SMH). The SMH will be applied to my analysis in section 6.4.

Getting back to the main topic of this paper: the basic HLM analysis does not account for the weaker reciprocal readings we discussed in this subsection. The plot of the rest of the paper is to find an explanation for the remaining five readings on the basis of some version of HLM. The method adopted is to analyze reciprocal sentences as a special kind of relational plural, as laid out in the next section. Looking ahead at the results I will come up with: we will find an analysis of SR, PartSR, WR, and OWR interpretations within a relational plural story; I will argue that

[4] It should be noted that SAR falls out from Dalrymple et al.'s theoretical system; they do not argue for it on an empirical basis. Therefore the only reading that I'm really ignoring is IAR.

we should change our minds about what goes on in IR interpretations, and then suggest a relational plural story; and we will be quite stuck with IAO interpretations.

## 3. Mechanisms of Plural Predication

### 3.1. *Langendoen's Claim*

Langendoen (1978) observes that the interpretations of reciprocal sentences mirror the interpretations of relational plurals. A relational plural is a sentence like (30b) with two group denoting expressions (*the three children* and *the two books*) and something that denotes a relation (*know* in the example). Compare (30a, b): they have prominent interpretations paraphrased in (31a, b).

(30) a. The three children know each other.
b. The three children know the two books.

(31) a. Each of the three children knows each other one of the three children.
b. Each of the three children knows each of the two books.

More abstractly, a relational plural sentence has an interpretation involving universal quantification over both groups in the sentence. In terms of quantification over group members, this mirrors SR. The difference comes from the anaphoric nature of the reciprocal: the same group (the antecedent group) is quantified over twice in the case of the reciprocal sentence.

(32) a. ARB iff $\forall x \leq A: \forall y \leq B: xRy$
b. AR each other iff $\forall x \leq A: \forall y \leq A\ [y \neq x \rightarrow xRy]$

Just as SR is not the only reciprocal interpretation, the reading schematized in (32) is not the only interpretation that a relational plural can receive. (33a, b) have the interpretations in (34a, b):

(33) a. The children can touch the horses.
b. The children can touch each other.

(34) a. Each child can touch one of the horses, and each horse can be touched by one of the children.
b. Each child can touch, and be touched by, one other child.

(34a) is called a cumulative interpretation (terminology used by Sternefeld (1998) going back to Scha (1984)). Generally, weakly reciprocal readings are mirrored by cumulative interpretations.

(35) a. ARB iff $\forall x \leq A: \exists y \leq B: xRy$ &
$\forall y \leq B: \exists x \leq A: xRy$

b. AR each other iff $\forall x \leq A: \exists y \leq A\ [xRy \ \& \ x \neq y]$ &
$\forall y \leq A: \exists x \leq A\ [xRy \ \& \ x \neq y]$

Once more, the parallel in terms of quantification over group members is obvious.

These observations lead Langendoen to suggest that whatever mechanism gives us the required interpretations of relational plurals should account for reciprocal sentences also. In the next subsection, I will introduce the theory of plural predication I want to use.

## 3.2. *Plural Predication*

### 3.2.1. *Distribution*

Let's first discuss how a property applies to a group. Consider (36).

(36) a. The children weigh 50 lbs.
b. Each of the children weighs 50 lbs.
c. The children together weigh 50 lbs.

Sentence (36a) has a reading paraphrased in (36b), in which the group denoted by 'the children' does not per se have the property of weighing 50 lbs. Rather, each member of that group has the property. This is the distributive reading. (36a) also has a collective reading, in which the children together weigh 50 lbs. The collective reading can be represented simply as predication of the group denoted by 'the children':

(37) weigh_50_lb(C)

I will use the * operator familiar from Link's (1983) work to capture distributivity.

(38) *Distribution:*
* is that function: $D\langle e, t\rangle \rightarrow D\langle e, t\rangle$ such that for any f in $D\langle e, t\rangle$ and any x in D:

$[*f](x) = 1$ iff $f(x) = 1$ or
$\exists u, v[x = (u \& v) \ \& \ [*f](u) \ \& \ [*f](v)]$

Sentence (36a) has a Logical Form as given in (39a), which can be straightforwardly translated to (39b). If each child weighs 50 lbs, then it is certainly true that the group referred to by 'the children' can be divided into subgroups that weigh 50 lbs. Thus (39b) will be true in a situation that makes

(39c) true. However, (39b) will also be true if the children together weigh 50 lbs (or non-individual subgroups of the children do), hence the distributive interpretation is not captured unambiguously as a reading of (39a) on this analysis. I will come back to this soon (section 3.2.4.).

(39) a. [[the children] [*[weigh 50 lbs]]]
b. $C \in {}^*\lambda x$[x weights 50 lbs]
c. $\forall x[x \leq C \rightarrow$ x weighs 50 lbs]

### 3.2.2. *Cumulation*

Let's see what we can say about the interpretation of relational plural sentences like (40) so far.

(40) Sue and Amy read 'Fried Green Tomatoes' and 'The L-Shaped Room'.

Theoretically we have four possibilities for pluralization of the two arguments of a transitive verb: we could have a collective-collective reading, a collective-distributive, a distributive-collective, and a doubly distributive one (not all of which make sense for this particular example with *read*). In particular, distribution allows us to assign to (40) the interpretation paraphrased in (41a). This can be derived via the LF (41b), where both plural NPs have undergone QR (I comment on my assumptions about LF in section 3.2.3 below). (41b) is interpreted in (41c, d).

(41) a. Each of Sue and Amy read each of FGT and L.
b. [[Sue and Amy] [*[[1 [FGT and L] [*[2 [$t_1$ read $t_2$]]]]
c. S&A $\in {}^*\lambda x$[FGT&L $\in {}^*\lambda y$[x read y]]
d. $\forall x \leq$ S&A: $\forall y$FGT&L: x read y

Let's assume once more that x and y range over singularities. (41c) says that Sue and Amy can be divided into individual parts each of which has read the individual parts of FGT and L. In other words, (41c) means (41d). This is a plausible reading of the sentence. Hence, double distribution (applying the * operator twice, once for the object argument slot of the relation and once for the subject argument slot), will lead to an interpretation that universally quantifies over the members of both groups in the relational plural sentence.

However, even if we ignore all kinds of collective interpretations, this is not the only intuitively available reading for this sentence. There is another way to relate the individual members of our two groups to individual reading events than to universally quantify over both groups. The weaker cumulative reading is paraphrased in (42).

(42) a. Each of Sue and Amy read one of FGT and L, and each of the books was read by one of the women.
b. $\forall x \leq S\&A$: $\exists y \leq FGT\&L$: x read y &
$\forall y \leq FGT\&L$: $\exists x \leq S\&A$: x read y

Sternefeld (1998) following Krifka (1986) suggests a second pluralization operator ** to capture cumulative readings, which pluralizes a relation rather than a property.

(43) *Cumulation:*
** is that function: $D\langle e, \langle e, t\rangle\rangle \rightarrow D\langle e, \langle e, t\rangle\rangle$ such that for any R, y, x: [**R](y)(x) = 1 iff
R(y)(x) or
$\exists x_1 x_2 y_1 y_2[x = (x_1 \& x_2) \& y = (y_1 \& y_2) \& **R(y_1)(x_1) \& **R(y_2)(x_2)]$

Cumulation allows us to assign another LF to the sentence, (44b), which I will translate as in (44c) (notation following Sternefeld 1998).

(44) a. Sue and Amy read 'Fried Green Tomatoes' and 'The L-Shaped Room'.
b. [[S & A] [[**read] [FGT & L]]]
c. $\langle S\&A, FGT\&L\rangle \in **\lambda y \lambda x$[x read y]
d. $\forall x \leq S\&A$: $\exists y \leq FGT\&L$: x read y &
$\forall y \leq FGT\&L$: $\exists x \leq S\&A$: x read y

Cumulation pluralizes the two argument slots of a relation simultaneously. Here is an informal explanation of how it works: You gather into a group things from the domain of the relation. Then you gather into a second group things from the range of the relation which stand in the relation to the things in the first group. The cumulated relation holds between the two groups. In our example (44), you gather readers into one group, and then you gather into a second group things read by those people. The cumulated *read* relation holds between the resulting groups. The claim made by the sentence is that Sue and Amy and FGT and L are such groups. Now think about how a particular book could get to be in the object group: it can only be in there by virtue of having been read by some member of the subject group. Similarly, something can be a member of the subject group only by virtue of having read one of the books in the object group. Hence cumulation will have the effect that we seem to quantify over the members of the two groups in the '$\forall\exists$ . . . $\forall\exists$' way described in (44d).

3.2.3. *Logical Form of Plural Predication*

I assume that the mechanisms of pluralization (* and ** so far) combine freely with the usual mechanisms of Logical Form. Relevant for our purposes are in particular variable binding and QR. I make the usual assumptions about variables: pronouns and traces are variables; binding configurations are created by movement. I represent this in the framework from Heim and Kratzer (1998) – an example is given in (45) (LF in (45b), translation in (45c)).

(45) a. Sally likes herself.
b. [Sally [1 [$t_1$ [likes herself$_1$]]]]
c. Sally $\in$ $\lambda$x[x likes x]

The * and ** operators can apply to lexical predicates as well as to predicates created by movement (example (46)) and in particular QR (example (47)).

(46) a. The children like themselves.
b. Each child likes herself/himself.
c. [[the children] [* [1 [$t_1$ [like themselves$_1$]]]]]
d. C $\in$ *$\lambda$x[x likes x]

(47) a. A student taught these classes.
b. Each of these classes was taught by a (possibly different) student.
c. [[these classes] [* [1 [[a student] [taught $t_1$]]]]]
d. C $\in$ *$\lambda$y[$\exists$x[student(x) & taught(y)(x)]]

This is true of cumulation as well as distribution; (48) and (49) provide examples in which the relation that ** applies to is the interpretation of a constituent created by QR. (48a) can be true if for each of Jim and Frank, there is one dentist that he wants to marry – an interpretation that requires us to cumulate the non-lexical relation 'x want to marry y', as indicated in (48b, c). Similarly, (49a) can be true if Sue wrote a dissertation on her generals paper topic and so did Amy, requiring us to cumulate 'x wrote a dissertation on y' ((49b, c)).

(48) a. Jim and Frank want to marry two dentists.
b. [[Jim and Frank] [[two dentists] [**[2 [1 [$t_1$ want to marry $t_2$]]]]]]
c. $\exists$Z[dentists(Z) & two(Z) & $\langle$J&F, Z$\rangle$ $\in$
**$\lambda$y$\lambda$x[x wants to marry y]]

(49) a. Sue and Amy wrote a dissertation on their generals paper topics.
b. [[Sue and Amy]$_3$ [[their$_3$ generals topics]
[**[2 [1 [$t_1$ wrote a dissertation on $t_2$]]]]]]
c. ⟨S&A, S′sGT&A′sGT⟩ ∈
**λyλx[x wrote a dissertation on y]]

I assume the usual properties of and constraints on QR. See Sauerland (1998), Beck (2000a), and Beck and Sauerland (2001) for an extensive discussion of the Logical Form of cumulation.

### 3.2.4. *Covers and Subgroup Effects*

Schwarzschild (1996) (following previous work primarily by Landman 1989a) notes that the pair (50a, b) poses a problem for standard analyses of distributivity. (50a) can be understood to mean (50′a). Now imagine that the NP 'the cows and the pigs' refers to all the animals that there are in the context, and that the NP 'the young animals and the old animals' refers to those same animals (i.e., assume (51)). Still, (50b) cannot be interpreted as (50′a). A straightforward reading for (50b) is given in (50′b).

(50) a. The cows and the pigs filled the barn to capacity.
b. The young animals and the old animals filled the barn to capacity.

(50′) a. The cows filled the barn to capacity and the pigs filled the barn to capacity.
b. The young animals filled the barn to capacity and the old animals filled the barn to capacity.

(51) [[the cows and the pigs]] = [[the young animals and the old animals]] = [[the animals]]

Notice that we are interested in the plausible distributive readings of (50a, b). Under the present analysis of distributivity, the difference in interpretation between the two sentences is unexpected. The distributive reading of (50a) will be represented as in (50″a), that of (50b) in (50″b).

(50″) a. [[The cows and the pigs] [*[filled the barn to capacity]]]]
b. [[The young animals and the old animals] [*[filled the barn to capacity]]]]

Given (51), the denotations of the two subject NPs are the same. Obviously, the two predicates are also the same. So there is no way we could derive

an interpretational difference between the two sentences on their respective distributive readings.

The difference is in which subgroups we distribute down to. If the animals are referred to in terms of the cows and the pigs, it is those two subgroups that we attribute the property 'fill the barn to capacity' to. If the same animals are mentioned in terms of the young animals vs. the old animals, we take those subgroups to be the ones that distribution is down to. The way we mention the animals makes different subgroups relevant for distribution: we distribute to the subgroups that are explicitly mentioned.

Schwarzschild suggests that plural predication is in general sensitive to a contextually provided division of the universe of discourse into salient subgroups. Explicit mention of certain subgroups is one way to make them salient, and distribution will divide groups into those subgroups. To formally capture this idea, he introduces the notion of the cover of a set, defined in (52).

(52) C is a *cover* of P iff:

C is a set of subsets of P
Every member of P belongs to some set in C
{ } is not in C

Remember that sets of individuals are what we call groups. So a cover can be seen as a set of subgroups of the group that it covers. A particular kind of cover is a partition (a cover that contains only non-overlapping subgroups).

(53) A cover C of a set P is a partition iff for any X, Y $\in$ C: $X \cap Y = \{ \}$

Now we have to make distribution sensitive to those covers. Schwarzschild suggests that LFs of plural predications contain free variables, which will be assigned a value by the variable assignment. That value is going to be the cover of the universe of discourse made salient by the context. Combining Schwarzschild's idea with the * operator leads to an LF like (54a) for (50a), which will be interpreted as in (54b). This implementation of Schwarzschild's idea is taken from Heim (1994). If the cover is a minimal cover, (54b) is equivalent to (54c) (and (54c) is what Schwarzschild actually suggests).[5]

[5] Intuitively, a cover is minimal if we couldn't take a cell out of the cover the original group. More precisely:

Let C be cover of P. C is a minimal cover of P iff there is no proper subset X of C such that X is a cover of P.

(54) a. [[the cows and the pigs] [*[Cov[filled the barn to capacity]]]]
b. [[the cows and the pigs]] ∈ *λx[Cov(x) & x filled the barn to capacity]
c. ∀x[x ≤ [[the cows and the pigs]] & Cov(x) → x filled the barn to capacity]

What exactly (54) means depends of course on the value assigned to the variable Cov. For any plurality Y, we will want to talk about the covered part of Y as defined in (55).

(55) $Cov[Y] \coloneqq \{X: X \in Cov \ \& \ X \leq Y\}$

The covered part of Y is the collection of all those cells in the cover that consist exclusively of members of Y. Now, imagine that the context makes salient the partition of the animals into the cows on the one hand and the pigs on the other, i.e. the partition given in (56a). Then (54) will have the same meaning as the paraphrase (50′a), hence it captures the desired distributive reading. On the other hand, mentioning the animals as the young animals and the old animals as in (50b) will make the partition in (56b) salient, and this will lead to the meaning paraphrased in (50′b).

(56) a. Cov[the animals] = {[[the cows]], [[the pigs]]}
b. Cov[the animals] = {[[the young animals]], [[the old animals]]}

I refer the reader to Schwarzschild (1996) for more examples and discussion. To summarize, distribution is context sensitive. This is implemented via a free variable ranging over covers in the distributive LFs. This variable will be assigned the salient division into subgroups, and the effect is that distribution is down to the subgroups that are the cells in the cover.

We might ask what happens if the context gives us no indication of salient subgroups. Schwarzschild suggests that in those cases, the salient cover is one whose cells are singular individuals. This is the case in the reading of (36a) repeated here as (57a) that we were interested in above. If nothing in the context suggests an interesting division of the children into subgroups, then the free variable Cov will be assigned a partition into individual children. With that cover assignment, (57c) is equivalent to (57d), hence expresses distribution to singularities.

(57) a. The children weigh 50 lbs.
b. [[the children] [*[Cov[1 [$t_1$ weigh 50 lbs]]]]]
c. C ∈ *λx[Cov(x) & x weighs 50 lbs]
d. ∀x[x ∈ C → weighs 50 lbs]

Cover effects are not restricted to distributive readings. Consider the

relational plural (58) (similar examples can be found in Schwarzschild (1996)):

(58) a. The cows and the pigs outnumber the girls and the boys.
b. The young animals and the old animals outnumber the girls and the boys.

Sentence (58a) naturally has a reading which amounts to the claim that the cows outnumber the girls and the pigs outnumber the boys. This is a cumulative reading between non-individual subgroups. The corresponding reading of (58b) makes use of different subgroups, namely the young animals and the old animals instead of the cows and the pigs. Intuitively, we split the animals into those subgroups that are explicitly mentioned. The two sentences exhibit an effect quite parallel to the salient subgroups effect in distribution. The only difference is that this is a cumulative reading, not a distributive one. Hence contextual information in terms of salient subgroups seems to enter into the interpretation of cumulative statements as well.

I suggest to formalize the most plausible reading of (58a) as in (59a). The relevant cover is given in (59b).

(59) a. $\langle$C&P, G&B$\rangle \in$ **$\lambda y \lambda x$[Cov(x) & Cov(y) & x outnumber y]
b. Cov $\supseteq$ {[[the cows]], [[the pigs]], [[the girls]], [[the boys]]}
c. $\forall$x[x $\leq$ C&P & Cov(x) $\rightarrow$
$\exists$y[y $\leq$ G&B & Cov(y) & x outnumber y]] &
$\forall$y[y $\leq$ G&B & Cov(y) $\rightarrow$
$\exists$x[x $\leq$ C&P & Cov(x) & x outnumber y]]

This reading can be derived via the LF in (60):

(60) [[the cows and the pigs] [[the girls and the boys] [**[1 [Cov[2 [$t_1$ [Cov [outnumber $t_2$]]]]]]]

I adopt the following hypothesis (from Beck 1999c) as an extension of Schwarzschild's theory:

(61) *Contextual Restrictions on Plural Operators:*
Plural Predication is uniformly restricted to salient subgroups. Both * and ** are sensitive to covers.

### 3.2.5. *Exceptions*

Brisson (1998) puts covers to a second use. She is concerned with data like (62a) vs. (62b).

(62) a. The children built a raft.
b. The children all built a raft.

Sentence (62a) has a collective reading (there is one raft that the children built together) and a distributive reading (there are several rafts built by individual children). Both are compatible with a child that is not involved in raft building; that is, we would still be willing to accept the sentence as true if there was a child that for some reason did not participate. (62b) also has a collective and a distributive reading. However, both are incompatible with an uninvolved child. (62b) does not tolerate exceptions. I concentrate in my discussion on the distributive reading, for convenience. An old-fashioned representation of that reading is given in (62′).

(62′) $\forall x[x \leq C \rightarrow x \text{ built a raft}]$

Let's assume as before that the default parts of the children-group are the individual children. (62′) says that each of the children built a raft; the standard representation thus does not allow for uninvolved children. Why then are we prepared to tolerate them in (62a) but not in (62b)? To answer this question, Brisson builds on Schwarzschild's (1996) theory of distributivity. A more adequate representation of (62a, b) is (62″) with the added restriction that the parts of the children-group be members of the cover. (62″) says that those subparts of the children that are members of the cover built a raft.

(62″) $\forall x[x \leq C \ \& \ Cov(x) \rightarrow x \text{ built a raft}]$

How does the cover help us with the problem of (62a) vs. (62b)? Since this does not seem to be a problem with subgroups, let's ignore subgroups and continue to assume that distribution is to individual children. We made an important assumption in our discussion of the examples above, namely that the cover exhausts the groups distributed over; or in the other words, that a subset of the cover of the universe of discourse is in fact a cover of the group we are looking at. Let's make this explicit – we had assumed (63):

(63) $\cup Cov[Y] = Y$
(where $Cov[Y] \coloneqq \{X: X \in Cov \ \& \ X \leq Y\}$ cf. (55))

Looking at the representation of the distributive reading in (62″), the covered part of C is that part of the children-group that is quantified over. Imagine that the cover has the property in (64a): if we form the union of all cells in the cover that consist of children only, we get back the original group. Then, each child will be affected by the universal quantification in (62″),

and all children without exception will be involved in raft building. This is what Brisson calls a good fit: the cover has a subset that covers the plurality under consideration. Imagine on the other hand that the covered part of the children is actually smaller than the original group (this could happen if a child was lumped together in a group with non-children). Whatever is not included in the covered part of C will not be affected by the universal quantification in (62″). Those children will be exceptions permitted by (62″): children not involved in raft building. This is what Brisson calls an ill-fitting cover.

(64) a. $\cup Cov[C] = C$ no exceptions
b. $\cup Cov[C] < C$ exceptions

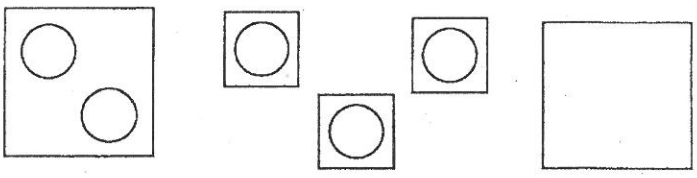
The semantic contribution of *all* is that it forces the cover to be a good fit. This accounts for the contrast in (62).

Brisson identifies various factors that affect tolerance of exceptions (properties of the group denoting NPs as well as overall contextual effects); I refer the reader to Brisson (1998) for discussion.

My proposal in the previous subsection that all plural predication (cumulation as well as distribution) is sensitive to covers predicts that we find exception effects in cumulative readings of relational plurals. I argue in Beck (2000b) that this is indeed the case, and that tolerance of exceptions in relational plurals is affected by the same factors as in distribution. A pertinent example is (65) from Scha (1984), which is judged true in the situation depicted in (65′).

(65) The squares contain the circles.

(65′)



My analysis of the cumulative reading of the example in (66) together with the assumptions about the cover stated in (67) predicts this. See Beck (2000b) for more discussion.

(66) $\forall x[x \leq S \ \& \ Cov(x) \rightarrow \exists y[y \leq C \ \& \ Cov(y) \ \& \ x \text{ contains } y] \ \&$
$\forall y[y \leq C \ \& \ Cov(y) \rightarrow \exists x[x \leq S \ \& \ Cov(x) \ \& \ x \text{ contains } y]$

(67) $\cup Cov[S] < S$ $\cup Cov[C] = C$

To sum up, we now have a partially pragmatic theory of plural predica-

tion. The context contributes a cover of the universe of discourse, which serves two functions: it accounts for subgroup effects, and it provides a mechanism by which we can accept exceptions to a plural predication.

### 3.2.6. *Subgroup and Exception Data for Reciprocals*

My reasons for introducing this contextual element into my story on plural predication is that the empirical motivation for covers – subgroup effects and exceptions – exists in reciprocal sentences as well. Consider (68) from Roberts (1987):

(68) a. The leaves touched each other.
b. The leaves are all on one tree. Most of them touch one or more other leaves.

Just as we didn't require every single child to be involved in raft building, we don't require every single leaf to participate in the *touch*-relation.

Regarding subgroup effects, (69) provides a pertinent example:

(69) The syntacticians of the two departments and the semanticists of the two departments meet with each other.

Let's concentrate on group meetings. The sentence makes salient four subgroups of linguists, the ones in (71). It would be made true by various scenarios of meetings between those groups, for example the syntacticians of department 1 meeting with the syntacticians of department 2, and the same for the semanticists. The weakly reciprocal interpretation for subgroups that is a salient interpretation for this sentence is given in (70) (I use L 'the linguists' to stand for the referent of 'the syntacticians of the two departments and the semanticists of the two departments').[6]

(70) $\forall x[x \leq L \;\&\; Cov(x) \rightarrow$
$\exists y[y \leq L \;\&\; Cov(y) \;\&\; x \neq y \;\&\; x \text{ meet with } y]] \;\&$
$\forall y[y \leq L \;\&\; Cov(y) \rightarrow$
$\exists x[x \leq L \;\&\; Cov(x) \;\&\; x \neq y \;\&\; x \text{ meet with } y]]$

(71) $Cov[\text{the linguists}] = \{SemD_1, SemD_2, SynD_1, SynD_2\}$

Let's therefore assume (following Beck 2000b) that a more complete formalization of WR should look like (72).

---

[6] Our analysis at the present stage requires that the cover be minimal, as defined in footnote 5. Otherwise, the interaction of the cover with the non-identity statement might lead to truth conditions that are too weak. The non-identity condition will be replaced by a condition of non-overlap presently (section 3.3.).

(72) *Weak Reciprocity (WR):*
$\forall x[x \leq A \ \& \ Cov(x) \rightarrow \exists y[y \leq A \ \& \ Cov(y) \ \& \ x \neq y \ \& \ xRy]] \ \&$
$\forall y[y \leq A \ \& \ Cov(y) \rightarrow \exists x[x \leq A \ \& \ Cov(x) \ \& \ x \neq y \ \& \ xRy]]$

This means that subgroup effects as well as exception effects show up in reciprocal data in the same way as in ordinary plural predication. Langendoen's claim is confirmed by these observations, and our strategy should be to extend the theory of plural predication developed in this section to reciprocals. We will take a first step in the next subsection, and we will find an analysis for the reciprocal data discussed in this subsection in the course of the paper.

### 3.3. *A Y2K Compliant Version of HLM's Derivation of SR*

#### 3.3.1. *SR*

The version of an HLM analysis I will introduce here departs from HLM (1991a) in that it doesn't associate either the antecedent or the reciprocal with any quantificational force. Rather, general mechanisms of plural predication are held responsible for the two-way universal quantification we observe in SR. In this, the analysis I will introduce is closer to HLM (1991b), and also to Heim (1994) and in particular Sauerland (1998).

Look at the pair in (73) again:

(73) a. The three children know each other.
b. The three children know the two books.

(73′) a. Each of the three children knows each other one of the three children.
b. Each of the three knows each of the two books.

We now know that the interpretation in (73′b) is compositionally derived as indicated in (74) ((74) is simplified in that it does not represent covers; in cases of this kind, the assumption should be that the relevant cover consists of singularities):

(74) a. [[the three children] [*[[1 [the two books] [*[2 [$t_1$ know $t_2$]]]]
b. 3C ∈ [*λx. 2B ∈ [*λy.x know y]]
c. ∀x ≤ 3C: ∀y ≤ 2B: x knows y

Here is what's wrong with HLM's original proposal then: we don't want to associate the universal quantification in SR with the NPs; instead, we should blame distribution for it, following Langendoen's idea. In partic-

ular, the reciprocal should be a group-denoting expression rather than a quantifier.[7]

The reciprocal must denote a group in dependence on the antecedent. The HLM analysis suggests that this group is 'the other ones among them', where *them* is coreferential with the antecedent (cf. (75b)). If we add to this the effects of double distribution, the paraphrase amounts to (75c, d), strong reciprocity.

(75) a. Mary, Sue, and Bill saw each other.
b. Mary, Sue, and Bill saw the other ones among Mary, Sue, and Bill.
c. Each of Mary, Sue, and Bill saw every other one of Mary, Sue, and Bill.
d. $\forall x\ [x \leq \text{MSB} \rightarrow \forall y[y \leq \text{MSB} \ \&\ y \neq x \rightarrow x \text{ saw } y]]$

The idea is, then, that the reciprocal denotes a group that contains all the members of the antecedent, minus the individual we are looking at in terms of distribution. This will be represented as in (76). The definition of the maximality operator is repeated in (77). This operator is the contribution of the definite determiner (cf. Sharvy 1980).

(76) a. each other = the other one(s) among them
$= \max(*\lambda z[\neg z \circ x_1 \ \&\ z \leq x_3 \ \&\ \text{Cov}(z)])$
b. $[\max\ [*\ [\text{Cov}[[\text{other } x_1]\ (\text{of})\ \text{Pro}_3]]]]$

(77) Let S be a set ordered by $\leq$.
Then $\max(S) = \iota s[s \in S \ \&\ \forall s' \in S[s \leq s']]$

A minor change from HLM is that the contribution of *other* is assumed to be non-overlap (defined in (78)) rather than non-identity. Sauerland (1998) argues that this is necessary once it is no longer guaranteed that the contrast argument is a singularity (as it was in the original HLM analysis due to the denotation of *each*, cf. section 2). Motivation independent of reciprocals comes from examples like his (79):

(78) $x \circ y$ iff $\exists z[z \leq x \ \&\ z \leq y]$

---

[7] Sauerland argues for this on the basis of reciprocal sentences with three-place relations, like (i):

(i) The three boys wrote these six letters to each other.

I won't be concerned with these data in this paper; I believe that essentially both Sauerland's (1998) and Sternefeld's (1998) analyses are compatible with what I say.

(79) Two of the three students live in Cambridge. The other student lives in Somerville.

I will talk about this as the distinctness condition. In the case of singularities, non-overlap amounts to non-identity, so this change does not affect the reciprocal readings discussed in section 2. The change matters when we involve subgroups, as suggested by the data in section 3.2.6.[8] When it is clear that subgroups play no role, I will use non-identity in my representations of truth conditions. Given all this, the LF for (75a) will be (75′):

(75′) [[Mary, Sue and Bill]$_3$
[*[Cov[1 [[max [*[Cov[[other $x_1$] (of) $Pro_3$]]
[*[Cov[2 [$t_1$ saw $t_2$]]]]]]

This LF straightforwardly translates to (80a). Assume that the cover contains singular individuals. The maximum operator takes as its argument the set of all individual parts of Mary, Sue, and Bill that are not identical to x. That set itself would have two members who are individual people, hence it would not have a maximum. The * operator corresponds to closure under group formation, hence the *-ed set will also contain the group that has those two people as its members. This is the maximum. I will write that group as MSB-x in (80b), which is also simplified in that it presupposes that we look at singular parts only. Then (80b) will amount to (80c), the desired strongly reciprocal interpretation of the sentence.

(80) a. $MSB \in *\lambda x[Cov(x) \;\&\; max(*\lambda z[\neg z \circ x_1 \;\&\; z \leq MSB \;\&\; Cov(z)]) \in *\lambda y[Cov(y) \;\&\; x \text{ saw } y]]$
b. $MSB \in *\lambda x[MSB\text{-}x \in *\lambda y[x \text{ saw } y]]$
c. $\forall x[x \in MSB \rightarrow \forall y[y \in MSB \;\&\; y \neq x \rightarrow x \text{ saw } y]]$

This analysis reduces SR as far as possible to properties of plural predication. The only aspect specific to reciprocal interpretation comes from the semantic contribution of the reciprocal itself.

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[8] As pointed out to me by Roger Schwarzschild (p.c), replacing non-identity by non-overlap also prevents us from co-binding the range argument of *other* and the contrast argument of *other*. This might be desirable to help exclude derivations like (ii) for the unacceptable (i):

(i) a. *The children are as numerous as each other.

(ii) a. [C[1 [$t_1$ are as numerous as [max[*[Cov[other $x_1$ of $Pro_1$]]]]]]]
b. $C \in \lambda x.x$ are as numerous as $max(*\lambda z.Cov(z) \;\&\; z \leq x \;\&\; z \neq x)$
C are as numerous as $max(*\lambda z.Cov(z) \;\&\; z \leq C \;\&\; z \neq C)$
C are as numerous as C
c. The children are as numerous as the children.

This is the slightly updated HLM story I want to tell about SR. We will return to more interesting covers in section 3.3.3. The logical structure of strong reciprocity as I state it is given in (81a). If we presuppose that x and y are singularities, this is the same as (81b), and the same as SR as stated in section 2.

(81) a. $A \in *\lambda x[Cov(x) \ \& \ A\text{-}x \in *\lambda y(Cov(y) \ \& \ xRy]]$
b. $A \in *\lambda x[A\text{-}x \in *\lambda y[xRy]]$
c. $\forall x \leq A: \forall y \leq A[y \neq x \rightarrow xRy]$

### 3.3.2. *Collective Readings*

Note that the whole NP *each other* denotes the group we informally called A-x above. While distribution over the antecedent group is necessary to bind the variable x, the distribution over A-x that we assumed to get SR is actually not required. It is conceivable that we might find data that are collective with respect to that group, and I think such data exist. Consider (82):

(82) a. Our committees are made up of each other.
b. For each x, x is one of us: x's committee consists of the other ones among us.
c. [our$_3$ [*[Cov[3 [t$_4$'s committee is made up of [max[*[Cov[other $x_4$ (of) Pro$_3$]]]]]
d. $\forall x \in$ [[we]]: x's committee is made up of [[we]]-x

Sentence (82a) exhibits a reading that is collective with respect to the group denoted by the reciprocal. That reading is paraphrased in (82b) and derived via the LF in (82c). There is no distribution over the object argument slot here at all; the reciprocal enters composition as a group directly. That group must be, essentially, 'the rest of us', in this example. Other data that illustrate this collective reading of reciprocals, taken from Dalrymple et al. (1998), are given in (83).

(83) a. The satellite, called Windsock, would be launched from under the wing of a B-52 bomber and fly to a 'liberation point' where the gravitational fields of the Earth, the Sun and the Moon cancel each other out.
b. The forks are propped against each other.

For (83b), for instance, imagine three forks. Each one is jointly supported by the other two, but not by any single other fork. (84) presents the abstract truth conditions for this collective reading of the reciprocal.

(84) *Collective reading:*
a. $A \in {}^*\lambda x[xR(A\text{-}x)]$
b. $\forall x \leq A$: $xR(A\text{-}x)$

I believe that these data show conclusively that the group that I call A-x is needed and must be a meaning of the reciprocal (and the plot is of course that it is the only meaning). Thus they support an analysis of reciprocals as plural definites.

### 3.3.3. *SR and Cover Effects*

The first thing we use covers for is to divide up a plurality into salient parts. PartSR seems an obvious case where we do just that: in example (85) we divide up the group of men into subgroups. The resulting subgroups then meet the truth conditions of SR. So perhaps we imagine that there is a salient cover partitioning the men into pairs.

(85) The men are hitting each other.

(86) a. $\forall X[X \leq [[\text{the men}]] \ \& \ Cov(X) \rightarrow X \text{ are hitting each other}]$
b. $\forall X[X \leq [[\text{the men}]] \ \& \ Cov(X) \rightarrow$
$\forall x \in X$: $\forall y \in X[x \neq y \rightarrow x \text{ is hitting } y]]$

This analysis requires iterative pluralization: we first distribute over the subject group to get the cover effect, and then we have SR = double distribution below that.

(87) [[the men] [$^*Cov_1$ [1 [$t_1$ [$^*Cov_2$ [2 [[each other$_2$ of $Pro_1$] [$^*Cov_2$ [3 [$t_2$ is hitting $t_3$]]]]]]]

(88) $M \in [{}^*\lambda X.Cov_1(X) \ \& \ X \in [{}^*\lambda x.Cov_2(x) \ \& \ X\text{-}x \in [{}^*\lambda y.Cov_2(y) \ \& \ x \text{ is hitting } y]]]$

$Cov_1$ is supposed to divide the men into pairs of men, and $Cov_2$ consists of singularities and enforces distribution down to individuals. There is a difference between this analysis and Fiengo and Lasnik's definition of PartSR in that for them there has to be a partition, whereas we use the salient partition of the antecedent group. I agree with Schwarzschild's (1996) arguments that simply requiring there to be a partition is too weak. See also Dalrymple et al.'s discussion of this point, in which they come to the same conclusion. We will see another possible derivation of PartSR in section 5.

PartSR (or more generally partitioned reciprocity) is actually not the most obvious way in which covers can enter reciprocal interpretation. Notice that

the schema for SR, when we take into account covers, actually looks like (89), as opposed to the simplified (90) that we have used so far.

(89) $\forall x \leq A[Cov(x) \rightarrow \forall y \leq A[Cov(y) \ \& \ \neg y \circ x \rightarrow xRy]$

(90) $\forall x \leq A: \forall y \leq A\ [y \neq x \rightarrow xRy]$

Hence, we expect to find SR for subgroups. A relevant example is (91) from Schwarzschild (1996).

(91) The prisoners on the two sides of the room can see each other.

The sentence is judged false (or at least, has a prominent reading which is false) if the two sides of the room are separated by an opaque barrier. It is false because then the two salient subgroups of the prisoners cannot see each other. (91) is actually not a good illustration of *strong* reciprocity among subgroups because it only involves two groups. (92) below takes care of that.

(92) The prisoners in the four corners of the room can see each other.

These interpretations (collective, SR, PartSR, and SR for subgroups), then, fall out from combining the assumption that the reciprocal is a plural definite with the theory of plural predication in section 3.2. Let's see how far this strategy will carry w.r.t. the other readings introduced in section 2.

## 4. Weak Reciprocity

### 4.1. *Sternefeld (1998)*

Sternefeld (1998), following Langendoen (1978), observes that deriving an SR interpretation for reciprocal statements is not sufficient. His paper provides a compositional derivation of the truth conditions of WR discussed in section 2 for data like (93).

(93) a. The children are touching each other.

b. $\forall x \leq C: \exists y \leq C\ [x \text{ touches } y \ \& \ x \neq y] \ \&$
$\forall y \leq C\ \exists x \leq C\ [x \text{ touches } y \ \& \ x \neq y]$

The key observation for Sternefeld's analysis of WR is Langendoen's insight that similarly to SR being parallel to double distribution, WR is analogous to cumulative readings of relational plurals. The cumulative reading of (94a) is given in (94b) and derived via (94c). The definition of ** is repeated in (95).

(94) a. Sue and Amy read 'Fried Green Tomatoes' and 'The L-Shaped Room'.
b. $\forall x \leq$ S&A: $\exists y \leq$ FGT&L: x read y & $\forall y \leq$ FGT&L: $\exists x \leq$ S&A: x read y
c. [[S & A] [[**read] [FGT & L]]]

(95) *Cumulation:*
** is that function $D\langle e, \langle e, t\rangle\rangle \rightarrow D\langle e, \langle e, t\rangle\rangle$ such that for any R: [**R](y)(x) = 1 iff
R(y)(x) or
$\exists x_1 x_2 y_1 y_2[x = (x_1 \& x_2)$ & $y = (y_1 \& y_2)$ & $**R(y_1)(x_1)$ & $**R(y_2)(x_2)]$

We hold pluralization operations responsible for the quantifiers that occur in such paraphrases. Hence, Sternefeld suggests, we ought to derive WR via the workings of **.

Unfortunately, this idea seems incompatible with our HLM analysis of reciprocals. We want to cumulate *touch*. But an LF like (96a) below would contain a free variable (the contrast argument of *other*). The meaning of (96b) is assignment dependent and does not represent a meaning of (93a). This is why we said above that distribution over the antecedent group was necessary.

(96) a. [[the children] [[each other] [**[2 [1 [$t_1$ touch $t_2$]]]]]]
b. $\langle C, C\text{-}x\rangle \in$ $**\lambda y \lambda z$[z touches y]

Accordingly, Sternefeld's compositional analysis does not make use of the HLM meaning for the reciprocal. He proposes an LF for (93a) that looks essentially like (97a) and is interpreted to mean (97b).

(97) a. [[the children$_3$] [**[other touch]] [$Pro_3$ ($t_{other}$)]]
b. $\langle C, C\rangle \in$ $**\lambda y \lambda x$[x touches y & $x \neq y$]

Expression (97) incorporates a particular view of the role of the reciprocal besides using **. Notice that the cumulated relation holds, not between two independent groups, but between the antecedent group and that same group. This reflects the anaphoric nature of the reciprocal. Let us now look more closely at the reciprocal relation, the relation that cumulates. Obviously, this must include *touch*; however, we want to cut out the reflexive part of the *touch*-relation. That is, the reciprocal statement is not made true by every child touching herself or himself. Hence we combine a distinctness statement with the original relation and get something like 'other-touch'. (97b) says that the children can be divided pairwise into non-identical subgroups that stand in a *touch*-relation. This will be the case iff for each child, we find at least one other child touched by the

first one, and for each child, there is at least one other child that touches her/him. Those are the truth conditions of WR, the reading we are after.

On this view, then, the reciprocal makes two independent semantic contributions. One is anaphoricity, and the other is a distinctness condition which must be combined with the reciprocal relation by way of some kind of generalized predicate modification that allows 'intersection' of two relations (notice that the trace of the movement that split *other* off is meaningless). Accordingly, the reciprocal is split up at LF into these two components, which are interpreted independently. Compare this to the HLM view of the role of the reciprocal: there, too, the reciprocal contributed distinctness and anaphoricity, but those two contributions were combined within one constituent and led to the description of a particular group.

Expression (98) schematizes the Sternefeld analysis of WR:

(98) $\langle A, A\rangle \in {}^{**}\lambda y \lambda x[x \neq y \ \& \ xRy]$

Next, we will look at some problems for this approach.

### 4.2. *Problems for Sternefeld*

While reducing WR to ** seems just the right thing to do according to the discussion in section 3, I see two kinds of problems for this particular way of doing it. One problem is the relation to the HLM meaning of the reciprocal, and the other has to do with the interaction of the distinctness condition with other operators. Both in effect concern the treatment of the distinctness statement proposed by Sternefeld. We will examine the two cases in turn.

Notice first that the whole NP *each other* does not receive a denotation here – there is no such thing as a group denoted by the reciprocal (the group we call A-x). Sternefeld's analysis of the reciprocal does not provide us with a natural way of getting that group. He does make a suggestion for how to derive such a meaning, which I do not want to discuss in any detail. I think it amounts to an ambiguity hypothesis: the reciprocal can either be treated in Sternefeld's fashion or as a HLM reciprocal, with various representational and semantic differences between the two. I find this a little unsatisfactory. There ought to be a natural relation between all readings that reciprocals allow for.

Sternefeld, on the other hand, is not overly concerned by this: he speculates, with Langendoen, that it might be sufficient to generate WR as the weaker reading and that an independent SR reading, and hence the HLM meaning A-x, is not needed.

Since I am criticizing Sternefeld on the grounds of not giving us a good

way to derive A-x, let me make the case stronger that we actually need A-x. One reason I have for assuming there must be this meaning for the reciprocal are the collective readings discussed above. These are independent of the issue of whether or not we need SR in addition to WR and provide evidence in favor of A-x. Secondly, I think the case can be made that SR is needed in addition to WR. Consider the following dialog.

(99) a. Context: Susanne and Ed want to go backpacking. They will take along a group of other people. There are several requirements on the group that is to join them, e.g.: everybody needs to be reasonably fit, and people must get along.
b. Susanne: We could take Amy, Bertha, Celia, and Dave. They like each other.
c. Ed: You're kidding! Bertha can't stand Dave!

Clearly, this is one rare occasion on which Ed disagrees with Susanne. He contradicts her statement that Amy, Bertha, Celia, and Dave like each other. It is sufficient reason for him to disagree that Bertha does not like Dave – everybody else may get along fine. Hence, his statement does not contradict the WR truth conditions of Susanne's claim. If his statement is to be reasonable, it must be a contradiction to SR. I will maintain the position that SR is a reading of reciprocals: it can't be the case that WR is the only semantics that reciprocal statements ever allow for.

The second kind of problem for Sternefeld's analysis concerns the interaction of reciprocity with scope-bearing elements like negation and quantifiers. The simplest type of example that illustrates the problem is (100).

(100) They don't like each other.

Sternefeld would presumably predict that negation can take either wide or narrow scope relative to cumulation. The wide scope reading of negation is given in (101a). For the narrow scope reading, two LFs are conceivable: (101b) and (101c).

(101) a. $\neg[\langle[[\text{they}]], [[\text{they}]]\rangle \in {}^{**}\lambda y \lambda x[x \neq y \ \& \ x \text{ likes } y]]$
b. $\langle[[\text{they}]], [[\text{they}]]\rangle \in {}^{**}\lambda y \lambda x \neg[x \neq y \ \& \ x \text{ likes } y]$
c. $\langle[[\text{they}]], [[\text{they}]]\rangle \in {}^{**}\lambda y \lambda x[x \neq y \ \& \ \neg[x \text{ likes } y]]$

Suppose we just have a two-membered group, for simplicity. Then (101a) is compatible with one person liking the other, but denies that this is mutual. The narrow scope reading is stronger; it describes mutual dislike. I think the latter reading is the more prominent (and perhaps the only) interpretation of (100). The formula that accurately represents the stronger reading

is (101c). (101b), actually, is a tautology. It says that the referent of *they* can be divided up into subgroups x and y that make the formula $\neg$[x $\neq$ y & x likes y] true; or equivalently: the referent of *they* can be divided up into subgroups x and y that make the formula 'x = y' true or 'x likes y' false. For this it is enough to choose identical subgroups of [[they]]. This is always possible. Notice that in (101b) the distinctness condition is interpreted in its overt position. This is what we assumed above when we discussed Sternefeld's analysis: we first create a relation 'other-like' and then combine that with the rest. While he could presumably raise the distinctness statement out of the scope of negation to derive (101c), we would in addition need some stipulation that excludes an LF corresponding to (101b).

Notice that it is not the case that the reciprocal necessarily takes wide scope. (102a) is ambiguous: It might mean either (102b) or (102c).

(102) a. Mary and Sue introduced no one to each other.
b. There is nobody such that Mary introduced him to Sue and Sue introduced him to Mary.
c. Mary didn't introduce anybody to Sue and Sue didn't introduce anybody to Mary.

Expression (103a) and (103b) are the semantic representations associated with these two readings on the Sternefeld analysis:

(103) a. $\neg\exists$z[$\langle$M&S, M&S$\rangle$ $\in$ **$\lambda$y$\lambda$x[x $\neq$ y & x introduced z to y]]
b. $\langle$M&S, M&S$\rangle$ $\in$ **$\lambda$y$\lambda$x[x $\neq$ y & $\neg\exists$z[x introduced z to y]]
c. $\langle$M&S, M&S$\rangle$ $\in$ **$\lambda$y$\lambda$x$\neg\exists$z[x $\neq$ y & x introduced z to y]

Formula (103c) is once more a tautological reading that we mistakenly predict if the distinctness condition is in the scope of the negation. The point of the example is that there is interaction between the interpretation of the reciprocal and the quantifier. (A claim to the contrary is found in Moltmann (1992), but I think that it does not hold, in the light of data like (102); in this I am in agreement with Dalrymple et al. (1998), cf. the discussion in section 5.1 of their paper.) In particular, the reciprocal can end up inside or outside the scope of a negative operator. But the distinctness statement by itself doesn't seem to be able to be inside the scope of negation while the rest of the reciprocal is outside.

The same ambiguity is found in (104).

(104) a. Mary and Sue only introduced BILL to each other.
b. There is no x other than Bill such that Mary introduced x to Sue and Sue introduced x to Mary (Bill's was the only mutual introduction).

c. Mary introduced Bill and no-one else to Sue, and Sue introduced Bill and no-one else to Mary (Bill's was the only introduction).

Example (104) also presents the same problem to the current analysis of WR. Other downward monotonic operators will have a similar effect. This should make us question Sternefeld's treatment of the distinctness condition. Just looking at downward monotonic expression, though, leaves the possibility open that it is simply so implausible to interpret an utterance as a tautology when there are other possibilities that one will always disregard the tautological interpretation in favor of less trivial readings. Therefore, let me provide a slightly less obvious example in which the truth conditions wrongly predicted by leaving the distinctness condition in situ are not tautological – (105a) below:

(105) a. The four professors introduced exactly two students to each other.

b. $\langle P, P\rangle \in$
$^{**}\lambda y \lambda x[\text{card}(\lambda z[x \neq y \ \& \ \text{student}(z) \ \& \ x \text{ introduced } z \text{ to } y]) = 2]$

Expression (105b) is a formalization of the truth conditions that result from interpreting the distinctness condition in its overt position. (105b) says that there must be a division of P (the group referred to by 'the four professors') into subgroups x, y that makes (106) true:

(106) $\text{card}(\lambda z[x \neq y \ \& \ \text{student}(z) \ \& \ x \text{ introduced } z \text{ to } y]) = 2$

That is, there must be a division of P into subgroups such that exactly two objects z make (107) true:

(107) $x \neq y \ \& \ \text{student}(z) \ \& \ x \text{ introduced } z \text{ to } y$

Imagine the following situation: the four professors are a, b, c, and d; a introduced exactly one student to b and vice versa; c introduced exactly one student to d and vice versa. (105a) is intuitively false. Yet, we can find a division of a&b&c&d such that there are exactly two z that make (107) true. Here is how: we divide $\langle P, P\rangle$ into $\langle a\&b, a\&b\rangle$ and into $\langle c\&d, c\&d\rangle$, and then further into $\langle a, a\rangle$, $\langle b, b\rangle$, $\langle c, d\rangle$, and $\langle d, c\rangle$. Only the c,d-pairs will make (107) true, hence exactly two students z fit the description in (106).

This shows that the truth conditions assigned in this way are too weak. Yet the statement expressed in (105b) is not tautological: it is false, for example, if fewer than two students were introduced. A correct formalization in Sternefeld's framework once more puts the distinctness statement outside the scope of the other operator:

(108) $\langle P, P\rangle \in {}^{**}\lambda y \lambda x[x \neq y \ \&\ \text{card}(\lambda z[\text{student}(z) \ \&\ x \text{ introduced } z \text{ to } y]) = 2]$

Obviously, similar problems arise with other operators that require us to count. The generalization over these data seems to be the following: the distinctness condition 'x ≠ y' must be in the immediate scope of the binders of x and y; that is, there must be no other intervening operator between the abstraction over x and y and cumulation, and the distinctness condition. Thus, we observe the semantic effects of the distinctness condition being tied to cumulation. Intuitively, we always want to divide up the antecedent of the reciprocal into distinct subgroups that make the reciprocal relation true. I will refer to this as the 'distinct subgroups effect'. Sternefeld's analysis does not seem to provide a natural explanation for the distinct subgroups effect, given that the relation of distinctness could be interpreted in various places.

Let me summarize the discussion in this section so far. We saw a very smooth analysis of the phenomenon of WR, which reduces it to cumulation. The semantics of reciprocity is largely derived from the semantics of pluralization – exactly in line with the perspective I argue for in this paper. On the other hand, on this particular implementation of this idea, there are problems with the analysis of the reciprocal: the relation to the HLM meaning of the reciprocal is unclear, and splitting off the distinctness condition leads to wrong predictions. The question arises whether we could not save the idea that WR is cumulation, but still use HLM. The next section proposes an analysis of WR in terms of cumulation on the basis of HLM (following Beck 1999a). We will see that the distinct subgroups effect finds a natural explanation that way.

## 4.3. *An Alternative Based on HLM*

### 4.3.1. *WR by QR*

Remember that the problem for the HLM reciprocal when we try to use it for WR is that we want a cumulated relation to hold between the group denoted by the antecedent, and that same group. The reciprocal on the HLM story denotes, not the antecedent group A, but a group we called A-x. Obviously, we can't have a cumulated relation between A and A-x because the variable x would remain unbound. So this doesn't make sense.

However, notice that we do have a second expression referring to the antecedent group on the HLM proposal. In (109), it is the hidden pronoun $Pro_3$ that shows up as *them* in the paraphrase 'the other ones among them'.

So perhaps we could cumulate between this *them* and the antecedent? This idea is implemented in (110).

(109) a. The children like each other.
b. The children$_3$ like [max [*[Cov[[other $x_1$] (of) $Pro_3$]]]]

(110) a. [$Pro_3$ [[the children]$_3$
[**[1 [Cov[2 [$t_2$ [Cov [like [max [* [[other $x_1$] (of) $t_2$]]]]]
b. $\langle C, C\rangle \in$ **λxλy[Cov(x) & Cov(y) &
x likes max(*λz[Cov(z) & z ≠ x & z ≤ y])]
c. $\langle C, C\rangle \in$ **λxλy[x likes max(*λz[z ≠ x & z ≤ y])]

Imagine we assign to (109) the LF in (110a). We QR both the subject and the covert pronoun that is anaphoric with it. We cumulate the resulting relation. This will yield the translation in (110b), which is simplified to (110c) assuming that x, y, and z all range over singularities only. This is guaranteed by the cover.

It is by no means obvious that (110c) denotes anything useful. Let's approach the problem of figuring out what it means by comparing the relation we cumulate to the relation that Sternefeld would want to cumulate for this example. Since Sternefeld predicted the right truth conditions for this type of example, we want to know whether the relation he cumulates is the same as ours. If it is, then we predict the same truth conditions. The two relations are given in (111).

(111) a. λyλx[y ≠ x & L(x, y)] (b) (a)
b. λyλx[L(x, max(*λz[z ≠ x & z ≤ y])] (b) (a)

Suppose we choose a and b such that a = b. What is the set of all singularities that are not identical to a and are a part of b? Since both a and b are singularities, if they are the same singularity, this is the empty set. Closure under group formation (that is, application of the * operator) will still result in the empty set. The maximum of the empty set is undefined. Hence, (111b) presupposes that a ≠ b. What if that is the case, i.e. if we choose a and b such that a ≠ b? Then the maximum of the set of things that are a part of b and not identical to a will be b. Hence, (111b) presupposes that b ≠ a and asserts that L(a, b). (111a) asserts that b ≠ a and L(a, b). Thus (111a, b) are true of the same pairs ⟨a, b⟩. The only difference is that (111b) may be undefined when (111a) is false. This looks promising.

Let me rewrite (112a) as (112b), which I find somewhat more readable:

(112) a. λyλx[L(x, max(λz[z ≠ x & z ≤ y])]
b. λyλx[L(x, y) & @(x ≠ y)]
c. λyλx[L(x, y) & x ≠ y]

The notation means that the argument of the @ is a presupposition rather than part of the assertion. A similar notation for presuppositions is found in Beaver (1995). What we are really interested in is (113a) compared to (113b):

(113) a. $**\lambda y\lambda x[L(x, y) \& @(x \neq y)] (A)(A)$
b. $**\lambda y\lambda x[L(x, y) \& x \neq y] (A)(A)$

Expression (113a) poses an interesting question about presupposition projection. Notice that we would like to know what happens to the distinctness presupposition $x \neq y$ when x and y get bound. For this, recall once more the definition of **:

(114) **is that function $D\langle e, \langle e, t\rangle\rangle \rightarrow D\langle e, \langle e, t\rangle\rangle$ such that for any R: $[**R](y)(x) = 1$ iff
$R(y)(x)$ or
$\exists x_1x_2y_1y_2[x = (x_1 \& x_2) \& y = (y_1 \& y_2) \& **R(y_1)(x_1) \& **R(y_2)(x_2)]$

A pair $\langle A, A\rangle$ can never get into such a reciprocal cumulated relation via the first clause of the disjunction since $A = A$, but the basic relation presupposes distinctness. Hence $\langle A, A\rangle$ must get in there via the second clause. Thus we must be able to divide up A into distinct parts $y_1$ and $x_1$ for this to come out true. For A to be divisible into distinct parts means that A is a plurality. I want the distinctness condition to project as a presupposition of plurality.

It is not clear, however, that it will project as a presupposition in that way. Suppose we choose as A a singularity, say, Fred. Now choose as 'parts' something like Fred (as $x_1$ and $y_2$) and Amy (as $x_2$ and $y_1$). This will of course make the first conjunct in the second clause of (114) false, since it is not the case that Fred = Fred&Amy; however, the whole expression will be perfectly well defined. It could only be true if the antecedent had more than one part, but as far as I can see, it does not carry any presupposition. So this would be identical to Sternefeld's truth conditions.

However, I think it is straightforward to improve on that a little, with the present analysis. I will make the following assumption:

(115) *Pluralized partial functions:*
$[**(f)](y)(x)$ is undefined if $f(y)(x)$ is undefined and x and y cannot be divided into parts for which f is defined.
$[*g](x)$ is undefined if $g(x)$ is undefined and x cannot be divided into parts for which is g defined.

Independent motivation for this assumption comes from data like (116):

(116) a. Agatha and Gwendolyn stopped smoking.
*λx[x stopped smoking] (A&G)

b. Agatha and Gwendolyn won the award for math and physics (respectively).
**λyλx[x won the award for y] (M&P)(A&G)

Imagine that Agatha has never smoked. Then (116a) should be a presupposition violation just like 'Agatha stopped smoking'. This will only come out right if we prevent that the group Agatha and Gwendolyn is divided up into, say, Gwendolyn and Tom, both of whom used to smoke. In other words: you do not escape a presupposition failure by choosing non-parts of the groups you are looking at. Analogous reasoning holds for (116b) and cumulation.

If we adopt the assumption in (115), (113a) is only defined if A has two distinct parts. This is the presupposition that the antecedent is a group. I think this presupposition is a good thing. Consider (117).

(117) These pants resemble each other.

The interpretations assigned to (117) under Sternefeld's analysis and under my analysis are given in (118a) and (118b) respectively.

(118) a. **λyλx[resemble(x, y) & $y \neq x$] (p)(p)
$\forall x[x \leq p \rightarrow \exists y[y \neq p$ & resemble (x, y) & $x \neq y]]$

b. **λyλx[resemble(x, y) & @$(y \neq x)$] (p)(p)
$\forall x[x \leq p \rightarrow \exists y[y \leq p$ & resemble (x, y) & @$(x \neq y)]]$

Suppose there is only one pair of pants. Then (118a) will be false, and (118b) will be undefined. I think an undefined outcome is better, because (119) is still inappropriate, rather than true:

(119) These pants do not resemble each other (because there is only one of them).

Hence, this analysis predicts that reciprocals introduce a presupposition that their antecedent is a plurality. Notice that we already made this prediction for SR: The HLM representation of the reciprocal 'the other one(s) among them' will only be defined if the antecedent contains at least two distinct subparts. We now predict that there is always such a presupposition, in cases of a WR interpretation as well as SR.

To summarize the discussion of this subsection: In these simple cases, the HLM + QR analysis I suggest is very similar to the Sternefeld analysis, except that it gives us a straightforward way to capture a presupposition

of plurality. Hence I think that the semantic result of the funny QR operation in (110) is, actually, slightly better than the original Sternefeld analysis. (120) states the abstract truth conditions of a weakly reciprocal statement under this analysis.

(120) *Weak reciprocity (WR):*
a. $\langle A, A\rangle \in {**}\lambda y \lambda x[Cov(x) \,\&\, Cov(y) \,\&\, R(x, \max({*}\lambda z[Cov(z) \,\&\, \neg z \circ x \,\&\, z \leq y]))]$
b. $\langle A, A\rangle \in {**}\lambda y \lambda x[R(x, \max(\lambda z[z \neq x \,\&\, z \leq y]))]$
c. $\langle A, A\rangle \in {**}\lambda y \lambda x[R(x, y) \,\&\, @(y \neq x)]$

### 4.3.2. *Distinctness as Presupposition*

Let us now look at the distinct subgroups effect and what a presuppositional analysis has to say about it. Remember that the effect seemed to be that the distinctness condition 'x ≠ y' must be in the immediate scope of the binders of x and y; that is, there must be no other intervening operator between the abstraction over x and y and cumulation, and the distinctness condition. In (121) below, I repeat some of the problematic data as well as their new semantic analyses. The distinctness condition is marked as a presupposition.

(121) a. They don't like each other.
b. $\neg[\langle[[they]], [[they]]\rangle \in {**}\lambda y \lambda x[@(x \neq y \,\&\, x \text{ likes } y]]$
c. $\langle[[they]], [[they]]\rangle \in {**}\lambda y \lambda x \neg[@(x \neq y \,\&\, x \text{ likes } y]$
d. $\langle[[they]], [[they]]\rangle \in {**}\lambda y \lambda x.x \neq y \,\&\, \neg[x \text{ likes } y]$

Since the distinctness condition is a presupposition, it will project up to the point where the two variables contained in it get bound. If we ignore the plurality presupposition (which is how the presuppositionality of the reciprocal projects after that), (121c) amounts to (121d), which was the desired interpretation. Hence, on this analysis, we do not need to exclude LFs that leave the remnant of the reciprocal in situ. Presuppositionality suffices to derive the distinct subgroups effect.

Example (122) is parallel. The interesting case is reading (122c) and representation (123b). Once more, (123b) is the same as the desired (123c) modulo plurality presupposition.

(122) a. Mary and Sue introduced no-one to each other.
b. There is nobody such that Mary introduced him to Sue and Sue introduced him to Mary.
c. Mary didn't introduce anybody to Sue and Sue didn't introduce anybody to Mary.

(123) a. $\neg\exists z[\langle M\&S, M\&S\rangle \in {**}\lambda y\lambda x[@(x \neq y)$ & x introduced z to y]]
b. $\langle M\&S, M\&S\rangle \in {**}\lambda y\lambda x\neg\exists z[@(x \neq y)$ & x introduced z to y]
c. $\langle M\&S, M\&S\rangle \in {**}\lambda y\lambda x[(x \neq y)$ & $\neg\exists z[$x introduced z to y]]

I provide (124) below for completeness – it does not add anything new at this point.

(124) a. The four professors introduced exactly two students to each other.
b. $\langle P, P\rangle \in {**}\lambda y\lambda x[$card$(\lambda z[@(x \neq y)$ & student(z) & x introduced z to y]) = 2]
c. $\langle P, P\rangle \in {**}\lambda y\lambda x[(x \neq y$ & card$(\lambda z[$student(z) & x introduced z to y]) = 2]

The distinct subgroups effect, on this analysis, has nothing to with scope, or with the LF position of the distinctness condition, but rather with its presuppositional nature. The presupposition is projected up to the point where the variables get bound. Hence the tie between the distinctness requirement on subgroups and cumulation finds a logical explanation. The presupposition is something we inherit from the HLM analysis by virtue of the definiteness of the reciprocal. I conclude that there is additional motivation for taking the definite paraphrase 'the other ones among them' as a guideline.

### 4.3.3. *Cumulation and QR*

The discussion in this section and my analysis of WR presuppose that the argument relation of the ** operator can be syntactically complex and may be the denotation of a constituent that comes into existence only at LF. This is argued for in Sauerland (1998), Beck (2000a), and Beck and Sauerland (2001); compare section 3. What is relevant for our present purposes is in particular the question whether QR can plausibly create the relation I need to derive WR: can we generally cumulate out of a complex NP with a structure like the one proposed for the reciprocal? I argue that we can. Some pertinent data as well as the required cumulated relations are given below ((125) repeated from section 3; *respectively* helps to indicate what the relevant reading is).

(125) a. Sue and Amy wrote a dissertation on their generals paper topics.
b. ${**}\lambda y\lambda x[$x wrote a dissertation on y]

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

(127) a. Sue and Amy drank most of the beer and the wine (respectively).
b. **λyλx[x drank most of y]

(128) a. Sue and Amy hate the other ones in their two girl scout groups.
b. **λyλx[x hates the other(x) ones in y]

(129) a. Sue and Amy compared many of the children from the two groups (and both said that the developments of the children in their group had been fairly homogeneous).
b. **λyλx[x compared many of the children from y]

I conclude that the structures I need to generate for my account of WR are expected to exist independently of reciprocals. Cumulation must be able to find these LF constituents. Hence there is no theoretical problem with the analysis proposed in this section, provided that we accept a HLM analysis in which the reciprocal has a complex internal structure similar to the NPs in the examples above. That structure is visible to syntax and in particular to movement operations – a position already established in HLM.

### 4.4. *WR and Cover Effects*

Recall that the analysis of WR proposed here really looks like (130), including the cover variables.

(130) a. $\langle A, A\rangle \in$ **λyλx[Cov(x) & Cov(y) & R(x, max(*λz[Cov(z) & ¬z∘x & z ≤ y])]
b. $\langle A, A\rangle \in$ **λyλx[Cov(x) & Cov(y) & R(x, y) & @(¬y∘x)])]

Thus we predict that there will be subgroup and exception effects in WR readings. I actually used subgroup effects as part of my motivation for pursuing the relational plural analogy – remember (131).

(131) The syntacticians of the two departments and the semanticists of the two departments meet with each other.

(132) a. $\forall x[x \leq L \ \& \ Cov(x) \rightarrow$
$\exists y[y \leq L \ \& \ Cov(y) \ \& \ \neg y \circ x \ \& \ x$ meet with $y]] \ \&$
$\forall y[y \leq L \ \& \ Cov(y) \rightarrow \exists x[x \leq L \ \& \ Cov(x) \ \&$
$\neg y \circ x \ \& \ x$ meet with $y]]$

b. $Cov[\text{the linguists}] = \{SemD_1, SemD_2, SynD_1, SynD_2\}$

The analysis of (131) is given in (133).

(133) a. $[[\text{the syntacticians} \ldots]_3 [Pro_3 [[**[1 [Cov[2 [t}_1 [Cov [\text{meet with [max [*[[other } x_1] \text{ (of) } t_2]]]]]]$

b. $\langle L, L\rangle \in **\lambda y \lambda x[Cov(x) \ \& \ Cov(y) \ \&$
$\text{meet}(x, \max(*\lambda z(Cov(z) \ \& \ \neg z \circ x \ \& \ z \leq y))]$

Exception effects prove more interesting. Let's think about what it means to be an exception to a weakly reciprocal reading. The two possibilities are given in (134) (the general case) or (134′) (assuming once more division of A into singularities). Either you are a member of A that does not stand in relation R to any other member of A; or you are a member of A that no other member of A stands in relation R to.

(134) a. $\exists x[x \leq A \ \& \ Cov(x) \ \& \ \sim\exists y[y \leq A \ \& \ Cov(y) \ \& \ \neg z \circ x \ \& \ xRy]]$

b. $\exists y[y \leq A \ \& \ Cov(y) \ \& \ \sim\exists x[x \leq A \ \& \ Cov(x) \ \& \ \neg z \circ x \ \& \ xRy]]$

(134′)a. $\exists x[x \leq A \ \& \ \sim\exists y[y \leq A \ \& \ x \neq y \ \& \ xRy]]$

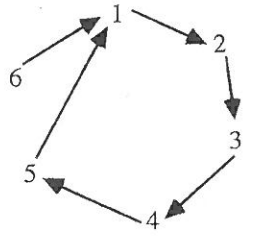
b. $\exists y[y \leq A \ \& \ \sim\exists x[x \leq A \ \& \ x \neq y \ \& \ xRy]]$

In view of this, consider once more Dalrymple et al.'s example in (135):

(135) The pirates stared at each other.

Remember that Dalrymple et al. observe that the sentence is judged true in the situation depicted in (136).

(136)




They propose that the sentence is true just so long as each pirate stared at one other pirate, i.e. they propose the truth conditions in (137). These truth conditions amount to OWR repeated below.

(137) $\forall x[x \leq P \rightarrow \exists y[y \leq P \ \& \ x \neq y \ \& \ x$ stared at $y]]$

(138) *One-way Weak Reciprocity (OWR):*
$\forall x[x \leq A \rightarrow \exists y[y \leq A \ \& \ x \neq y \ \& \ xRy]]$

Here is an alternative way of looking at (135) in the context of (136): perhaps what happens in (136) is that, for some reason, we are willing to tolerate an exception to an interpretation that is basically weakly reciprocal (an unstared-at pirate). This is what I propose in Beck (2000b). According to what we just said, the correct representation of the weakly reciprocal reading of (135) is (139) with the cover variables.

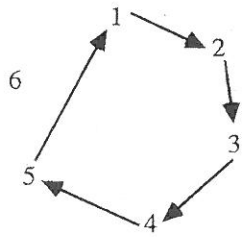
(139) $\forall x[x \leq P \ \& \ Cov(x) \rightarrow$
$\exists y[y \leq P \ \& \ Cov(y) \ \& \ x \neq y \ \& \ x$ stared at $y]] \ \&$
$\forall y[y \leq P \ \& \ Cov(y) \rightarrow$
$\exists x[x \leq P \ \& \ Cov(x) \ \& \ x \neq y \ \& \ x$ stared at $y]]$

Imagine that the cover has the property in (140) – e.g., it does not contain pirate 6. That pirate will not be affected by the quantification over group members in (139), i.e. will be an exception permitted by (139). In other words, pirate 6 is not required to be stared at by any other pirate. The sentence can thus be true in the situation in (136).

(140) $\cup Cov[P] < P$

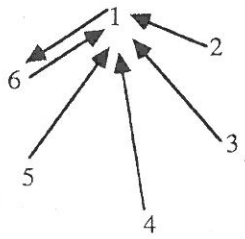
Actually, if pirate 6 is not covered, then he will be disregarded not only as a stared-at individual but also as a starer. The two ways in which one can be an exception to a weakly reciprocal interpretation are not distinguished by the story as we are telling it here. The sentence should be equally acceptable if we reverse the arrow from 6 to 1 in (136), or in a situation like (141) with a completely uninvolved pirate. This seems fine, and is not predicted by an OWR analysis.

(141)




Note also that OWR predicts that the sentence is true in the situation in (142), where everybody stares at one pirate (who stares at somebody else) – the extreme case of OWR.

(142)




However, it is at best unclear to me whether or not the sentence is true in this situation. According to the truth conditions proposed for the sentence by OWR I should not have such doubts. It seems to be too weak to require that only one member of the pirate group needs to be stared at. This suggests that the second direction or WR is not really missing, and that it is more accurate to think about the example in terms of an exception to an interpretation that is basically weakly reciprocal. (142) would require a cover that is too ill-fitting to be acceptable in a normal context.

Given Brisson's analysis of *all*, we expect the presence of *all* to preclude exceptions: (143) in contrast to (135) should be false in situation (141), and it is.

(143) The pirates all stared at each other.

Some further evidence in favor of this analysis of apparent OWR in terms of WR plus exceptions is provided in Beck (2000b), where I argue that the availability of (apparent) OWR correlates with the factors that generally govern acceptability of exceptions. I conclude that there is no need to assume OWR as a separate reading, since exceptions to WR are better accounted for as cover effects, which are needed independently.

A final remark on exceptions: a member of the antecedent group can be ignored by the cover no matter whether we have a weakly or a strongly reciprocal interpretation. Hence we predict that exceptions may be possible with basic SR interpretation, too. I think this is correct; an example like (144), which favors SR, may still be judged true if there is one disconnected computer around that we are willing to accept as exceptional for one reason or another.

(144) The computers are linked to each other.

Let me briefly summarized section 4. We have seen that it is possible to extend the HLM analysis (which seemed designed for SR type interpretations) to WR type interpretations. I suggest to combine cumulation and QR with the HLM representation of the reciprocal to derive WR. This

captures presupposition effects, and allows us to attribute subgroup and exception effects as usual to plural predication.

Of the six readings we started out with in section 2 (SR, PartSR, IR, WR, OWR, and IAO), we have now analyzed four – SR, PartSR, WR, and OWR. Only IR and IAO remain to be accounted for. IR is the topic of the next section.

## 5. Intermediate Reciprocity

### 5.1. *IR Is Not about Transitive Closure*

Intermediate Reciprocity is the last remaining reading from section 2 that I promised to account for. Remember IR as suggested by Dalrymple et al., and examples like (146):

(145) *Intermediate Reciprocity (IR):*
$\forall x \leq A$: $\forall y \leq A$ [$y \neq x \rightarrow \exists z_1 \ldots z_n \leq A[x = z_1 \ \& \ y = z_n \ \& \ z_1 R z_2 \ \& \ \ldots \ \& \ z_{n-1} R z_n]$]

(146) a. The telephone poles are spaced five hundred feet from each other.
b. The exits are 5 miles apart from each other.

Dalrymple et al. say that the meaning of this sentence is that every telephone pole is related to every other one by a chain of poles spaced five hundred feet apart. They suggest that with such examples, instead of looking at the plain relation 'x is spaced five hundred feet from y' as our reciprocal relation, we look at the transitive closure of that relation. Transitive closure is defined below.

(147) For any relation R, R+ (the transitive closure of R) is:
$R \cup \{\langle x, y\rangle$: $\exists z_1 \ldots z_n[x = z_1 \ \& \ y = z_n \ \& \ z_1 R z_2 \ \& \ \ldots \ \& \ z_{n-1} R z_n\}$

Then, SR holds, not looking at A and R, but looking at A and R+:

(148) A R each other iff
$\forall x \leq A$: $\forall y \leq A$ [$y \neq x \rightarrow$ [R+](x, y)]]

There is no doubt that this correctly describes the situation we find with the telephone poles and the highway exits. Nonetheless, I don't think that we want to say that transitive closure of the reciprocal relation amounts to an independent reading of reciprocal sentences. I propose that the fact that (145) seems a plausible interpretation of the example stems from our

knowledge that telephone poles tend to be set up in a line. If we change the plausible physical setup associated with a sentence, transitive closure turns out to give unsatisfactory results. To see this, consider the following example:

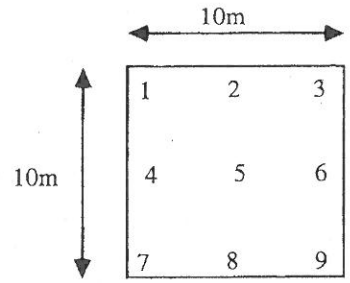
(149) a. Context: You are describing a dress to a friend. It is short sleeved with a wide skirt and made from a white cloth with red dots.
b. The dots are 3″ apart from each other.

You will imagine that the cloth is covered more or less homogenously with dots. That is, each dot is 3″ apart from its neighbors. You will not imagine a situation that suffices to make IR true – a cloth through which we can lay a line of dots such that the dots in this line meet IR. Yet (149) with the two-dimensional cloth seems no less natural than (146) with the one-dimensional line: both times you look at an object and its immediate neighbors. (150) is analogous:

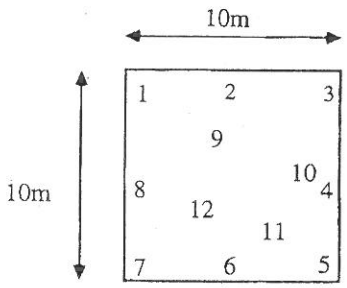
(150) a. Context: You are planting an apple orchard. You want to maximize the number of trees you can plant, but realize that the individual trees need some space. The expert you consult tells you:
b. The trees should be about 5m apart from each other.

If your plot is 100 square meters, you will probably plant 9 trees (if you plant them in rows); this is depicted in (151). IR would allow you to plant more – for instance in the way depicted in (152) (imagine that tree2 is 5m from both tree1 and tree3, etc.).

(151)



(152)




Note that in both examples, SR is impossible, hence the strongest meaning that the sentence could have (according to Dalrymple et al.'s hierarchy) is IR. Yet, we take it to make a claim stronger than IR.

Finally, consider (153).

(153) a. Context: The girls are standing in a circle.
b. The girls can all just touch each other.

I judge this sentence false if there is one gap between the girls that is too large. IR would permit this.

These examples show us that the mathematical notion of transitive closure of a relation seems useful in a line setup; but as soon as we change the context (here, go from a line to a two-dimensional plane or a circle) we see that what's going on can't be something as mathematically well defined as that. I think that these data indicate that we are looking at a phenomenon more flexible and variable than transitive closure.

## 5.2. *Salient Relations*

### 5.2.1. *Sauerland and Schwarzschild*

Below is a formalization of the truth conditions of (154a) that takes seriously the neighbor-idea:

(154) a. The telephone poles are spaced five hundred feet from each other.
b. $\forall x \leq P$: $\forall y \leq P$ [$x \neq y$ & x is next to y $\rightarrow$ x is 500′ apart from y]

We have added a relational restriction 'x is next to y', which would work for the telephone poles as well as the polka dots and the apple trees. The double universal quantification makes this look like an instance of SR.

The restriction could be added to the reciprocal itself. This suggestion amounts to an LF like (154′) for this reading:

(154′) [[the telephone poles]$_3$ [*[1 [[max ($R_C$ other$_1$ of Pro$_3$)] [*[2 [t$_1$ is 3″ apart from t$_2$]]]]]]]

(155) a. [max ($R_C$ other$_1$ of Pro$_3$)] = max(*λz.x ≠ z & $R_C$(x, z) & z ≤ P)
= the other ones among P next to x

b. $R_C$ = λxλy.x is next to y

Thus the reciprocal would have to contain a hidden, contextually contributed relation. It could be viewed like a dependent definite in that sense. A non-reciprocal example is given in (156) (see Winter (2000) for a recent discussion of dependent definites).

(156) a. Each student presented the paper.
b. Each student presented the paper assigned to her/him.

This suggestion has been made by Sauerland (1998) to account for readings of reciprocals weaker than SR, including WR. We will come back to the question of how far one would want to carry this strategy below. For now let's focus on IR-like interpretations.

If this is the right strategy, then we expect a much wider variety of contextual restrictions to be possible than just a restriction to neighbors. The idea is that the reciprocal means 'the relevant other ones among them', where what counts as relevant is dependent on context. This is very similar to Schwarzschild's (1996) analysis of reciprocals. Let's first look at the data he brings forth to support his idea, and an analysis in the terms just introduced. Then I will relate this analysis to Schwarzschild's. The following examples are all taken from Schwarzschild (1996).

(157) a. The books in the chart complement each other.
b. The husbands and wives in the room are similar to each other.
c. Those twins who were born before 1960 were separated from each other in school.
d. The people who shared their summer appartments spent most of the winter arguing with each other about entry times.

Sentence (157a) comes with the chart in (158).

(158)

| Fiction | Non-fiction |
|---|---|
| Alice in Wonderland | Aspects; Language (Bloomfield) |
| Fantastic Voyage | Gray's Anatomy |
| David Copperfield, Hard Times | Das Kapital, The Wealth of Nations |
| Oedipus Rex, Agamemnon | Freud's Intro to Psychology |
| Richard III | Machiavelli's The Prince |

All of these have plausible readings analyzed as SR plus relation in the reciprocal below:[9]

(159) a. $\forall x \leq A$: $\forall y \leq A$ [$x \neq y$ & $R_C(x, y) \rightarrow$ x complements y]
b. $R_C = \lambda x \lambda y.x$ is in the same row in the chart as y
A = the books in the chart

(160) a. $\forall x \leq A$: $\forall y \leq A$ [$x \neq y$ & $R_C(x, y) \rightarrow$ x is similar to y]
b. $R_C = \lambda x \lambda y.x$ is married to y
A = the husbands and wives in the room

(161) a. $\forall x \leq A$ : $\forall y \leq A$ [$x \neq y$ & $R_C(x, y) \rightarrow$ x was separated from y]
b. $R_C = \lambda x \lambda y.x$ is y's twin
A = those twins who were born before 1960

(162) a. $\forall x \leq A$: $\forall y \leq A$ [$x \neq y$ & $R_C(x, y) \rightarrow$ x argues with y]
b. $R_C = \lambda x \lambda y.x$ and y share the same summer apartment
A = the people who shared their summer apartments

So we do indeed find a range of possibilities for what the context contributes when we get 'intermediate' reciprocal readings.

While Schwarzschild also uses these data to argue that the contribution of context is essential in the interpretation of reciprocals, the details of his analysis look a bit different from what I have introduced above. He argues that the denotation of the reciprocal pronoun is a free function variable that is assigned a value by context. An example for his analysis is given below.

(163) a. The children like each other.
b. $\forall y$[$y \leq$ [[the_children]] & Cov(y) $\rightarrow$
like(y)(EachOther([[the_children]])(y))]

*EachOther* is a variable over functions from pairs of individuals to indi-

[9] The book chart example could also plausibly be collective plus relation in the reciprocal.

viduals. The value for this variable is contextually determined. Thus, (163b) means that all salient subgroups of the children y like whatever the function EachOther assigns to the children and y. Obviously, we need some restrictions on what EachOther can assign to such pairs ⟨[[the children]], y⟩: it has to be subgroup of the children, and it has to be different from y (we don't want the reflexive part of the relation to be able to make the reciprocal statement true). These restrictions are given in (164i, ii)

(164) For all M, g:
(i) $\forall a \forall b[\ [[\text{EachOther}]]^{M,g}(a)(b) \leq a$
(ii) $\forall a \forall b[\ [[\text{EachOther}]]^{M,g}(a)(b) \neq b$
(iii) ∀a: the domain and range of $[[\text{EachOther}]]^{M,g}(a)$ are identical to Cov

In addition, I will assume (164iii) (discussed by Schwarzschild also). Let's assume that the cover is the individual children. (163b) means something like:

(163′) Each child likes whatever other child EachOther picks from the children for that child.

While this proposal looks quite different from what we have been saying so far, note that several of the ingredients are familiar: (i) is anaphoricity (x is a part of the antecedent group); (ii) is distinctness. Suppose that in addition we separate the functional nature of EachOther from its contextual nature by splitting it up into a definite determiner and a salient relation:

(165) $\text{EachOther} = \lambda A \lambda x.\max(\lambda y.y \leq A \ \&\ y \neq x \ \&\ \text{Cov}(y) \ \&\ R_C(x, y))$

Expressed this way, it becomes clear that Schwarzschild's idea is quite similar to the idea going back to Sauerland that I present here. (A difference is that we make different assumptions about pluralization than Schwarzschild – let's not worry about that right now.)

This analysis of IR can be summarized as follows: the reciprocal, being a definite, can be like a dependent definite in the sense that it can contain a contextually provided relation. Context dependency in this sense accounts for "intermediate" readings. IR is just one example of such a context-dependent reading.

### 5.2.2. *How Many 'Weak' Readings?*

Schwarzschild proposes his analysis as the only semantics for reciprocals, i.e. unlike us does not distinguish SR, WR, and this intermediate reading.

This step is possible for Sauerland too, and he does indeed suggest that quantificationally weaker reciprocal readings arise via the addition of pragmatic restrictors. So in particular, the fact that in a WR interpretation every member of the antecedent group A needs to stand in the reciprocal relation R to only one other member of A would be derived via a strong relational restriction plus definiteness.

I would like to argue that we want a basic WR reading in addition to the contextual relation reading. The reason is that while reciprocal sentences can be understood very specifically with reference to the context, they don't have to be. Consider (166):

(166) Because our department consists of only six faculty, the non-tenured faculty have to evaluate each other.

Imagine that A, B, and C are the non-tenured faculty. The claim made by the reciprocal sentence is correctly represented in (167) in terms of WR.

(167) a. $\langle ABC, ABC\rangle \in {**}\lambda x\lambda y.@(x \neq y)$ & x evaluate y
b. $\forall x \leq ABC$: $\exists y \leq ABC$ [$x \neq y$ & x evaluates y] &
$\forall y \leq ABC$: $\exists x \leq ABC$ [$x \neq y$ & x evaluates y]
c. Each of ABC evaluates at least one other member of ABC and each of ABC is evaluated by another one of ABC.

What is necessary by virtue of the size of our department is no more than that – in particular, the reciprocal sentence does not make a claim like (168):

(168) $\forall x[x \leq ABC \rightarrow$
x evaluates $\max(\lambda y.y \leq ABC \;\&\; x \neq y \;\&\; R_C(x, y)]$

That is, it is not necessary that each of us evaluate a particular other one of us. (169a) is an accurate paraphrase of (166), whereas (169b) is not ((169b) is too weak since the interpretation of the reciprocal sentence is too strong).[10]

(169) a. If our department didn't have only six faculty, it would not be necessary that each of ABC evaluates another one of ABC and is evaluated by another one of ABC.
b. If our department didn't have only six faculty, it would not be necessary that each of ABC evaluates the other one of ABC assigned to her/him.

---

[10] I have left the paraphrase vague between having an $R_C$ of type $\langle e, \langle e, t\rangle\rangle$ or one of type $\langle s, \langle e, \langle e, t\rangle\rangle\rangle$; either would make the reciprocal statement too strong.

A similar point is made by (170).

(170) a. This year we won't have to evaluate each other.
b. This year it won't be necessary that each of us evaluates another one of us and is evaluated by another one of us.
c. This year it won't be necessary that each of us evaluates the other one of us assigned to her/him.

I conclude that we do not always have a salient relation, and that we want to keep the option of simple existential quantification over group members provided by WR. Quantificational weakness cannot generally be reduced to contextual specificity.

Note also another difference between the WR-style paraphrases and the contextual relation idea: the latter does not require every member of the antecedent group to be in the range of the reciprocal relation. For example, in (166) the direction '. . . and each of us is evaluated by another one of us' is missing. This is another respect in which the WR formalization is more accurate (and in this respect stronger); I think that modulo exceptions the second direction of WR is required (cf. also the discussion in section 4.3.4.).

Let's therefore distinguish WR from 'intermediate' contextual readings and look at the salient relation proposal as an addition to WR.

### 5.3. *Situation-based Cumulation instead of Salient Relations*

The Sauerland/Schwarzschild story in the preceding section would be sufficient for me to maintain the first general point argued for in this paper: that a HLM-style representation of the reciprocal accounts for all reciprocal readings. However, since I also pursue the idea that reciprocal sentences are just like relational plurals, I would like to carry this one step further and relate the intermediate readings from the previous subsection to a phenomenon in relational plurals.[11]

[11] An analysis as dependent definites actually resembles very closely a proposal for the semantics of relational plurals made by Winter (2000). He suggests to reduce apparent cumulation to dependent definites. Beck (2000a) and Beck and Sauerland (2001) argue that dependent definites are not sufficient, i.e. cannot replace polyadic pluralization. Beyond that, my comments on Schwarzschild's analysis of relational plurals in this section should largely carry over to a dependent definites analysis.

5.3.1. *Salient Relations in Relational Plurals*

Our relational restriction strategy can easily be rephrased in terms of an analysis Schwarzschild proposes for relational plurals. Below is an example that motivates a relational restriction for relational plurals, and Schwarzschild's analysis.

(171) The fiction books in the chart complement the non-fiction books.

(172)

| Fiction | Non-fiction |
|---|---|
| Alice in Wonderland | Aspects; Language (Bloomfield) |
| Fantasic Voyage | Gray's Anatomy |
| David Copperfield, Hard Time | Das Kapital, The Wealth of Nations |
| Oedipus Rex, Agamemnon | Freud's Intro to Psychology |
| Richard III | Machiavelli's The Prince |

When confronted with this chart, one tends to take the sentence to claim that the fiction books in a given line of the chart complement the non-fiction books in the same line. This is weaker than a doubly distributive reading; yet it is a stronger claim than a cumulative reading, where for each fiction book we would only have to find a complementing non-fiction book (and the reverse also). The context (here: the chart) suggests a pairing of fiction and non-fiction books, and it is those pairs that we look at in order to evaluate the sentence.

Schwarzschild suggests that two-place pluralization is restricted by a set of pairs of individuals – a contextually salient relation. Here is how he analyzes the salient interpretation of (171):

(173) a. $\forall\langle x, y\rangle[\langle x, y\rangle \in R_C \,\&\, x \leq [[\text{the fiction books}]] \,\&\, y \leq [[\text{the non-fiction books}]] \rightarrow x \text{ complements } y]$

b. $R_C = \{\langle x, y\rangle: x \text{ and } y \text{ are in the same line of the chart}\}$

We can view the proposal for reciprocals from the last subsection analogously to the relational plural:

(174) a. The telephone poles are spaced five hundred feet from each other.

b. $\forall\langle x, y\rangle\ [x \leq P \,\&\, y \leq P \,\&\, x \neq y \,\&\, \langle x, y\rangle \in R_C \rightarrow x \text{ is 500 feet apart from } y]$

c. $R_C = \{\langle x, y\rangle: x \text{ is next to } y\}$

The resulting semantics is obviously the same as when we incorporate the salient relation into the reciprocal and assume SR. The idea is only different

w.r.t. how the salient relation gets into the semantics. Schwarzschild proposes that salient relations are generally present in the semantics of relational plurals. So this reinterpretation of the salient relation strategy is in accordance with our general plot to reduce reciprocal semantics to relational plural semantics as far as possible.

### 5.3.2. *Salient Subsituations in Relational Plurals*

Regarding Schwarzschild's salient relation analysis of (171) and related data, I argue in Beck (1999b) that the corresponding readings are actually indicative of a subsituation context, not a salient relation. An important argument is that the salient relation analysis overgenerates: interpretations are expected to be possible that we do not actually find. For example, in (175) I try to make the relation in (175b) salient by mentioning it in the preceding discourse. The reading that would result is unavailable.

(175) a.#The people who live in this house are all graduate students. They moved in one after another within a period of two years. The women like the men.
b. $R = \{\langle x, y\rangle: x \text{ moved in after } y\}$
c. $\langle[[\text{the women}]], [[\text{the men}]]\rangle \in$
$^{**}\lambda y \lambda x[x \text{ moved in after } y \ \& \ x \text{ likes } y]$
d. If a woman moved in after a man, the woman likes the man.

I argue that what goes wrong in this example as opposed to the examples Schwarzschild brings forth to argue for a salient relation restriction is that the context is not suitable to set up a division into subsituations. The examples that work all have this property: the context gives us a way to perceive the situation we are talking about as falling apart into natural subsituations. Therefore, I propose to capture the apparent salient relation effect in terms of a division into subsituations instead. The subsituation analysis of the book chart example is given below. It assumes that pluralization can affect the situation/event argument of a relation as well as individual arguments, and that situations (or events) can come apart into salient subsituations. I will refer to this as situation-based cumulation.

(176) *Situation-based Cumulation:*
$^{***}$ is that function: $D\langle e, \langle e, \langle s, t\rangle\rangle\rangle \rightarrow \langle e, \langle e, \langle s, t\rangle\rangle\rangle$ such that for any R:

$$[^{***}R](y)(x)(s) = 1 \quad \text{iff} \quad R(y)(x)(s)$$
$$\text{or} \quad \exists x_1 x_2 y_1 y_2 s_1 s_2[(s = s_1 \ \& \ s_2) \ \&$$
$$(x = x_1 \ \& \ x_2) \ \& \ (y = y_1 \ \& \ y_2) \ \&$$
$$^{***}R(y_1)(x_1)(s_1) \ \& \ ^{***}R(y_2)(x_2)(s_2)]$$

(177) a. The fiction books in the chart complement the non-fiction books.

b. ⟨FB, NFB, s⟩ ∈ ***λyλxλs′[C(s′) & C(x) & C(y) & complement(y)(x)(s′)]

The correct truth conditions for our data can be captured by the schema in (178a), which boils down to (178b) by reasoning analogous to cumulation.

(178) a. ⟨A, B, s⟩ ∈ ***λyλxλs′[C(s′) & C(x) & C(y) & R(x)(y)(s′)] iff

b. ∀s′[s′ ≤ s & C(s′) → ∃xy[C(x) & C(y) & x ≤ A & y ≤ B & R(y)(x)(s′)] &
∀x[x ≤ A & C(x) → ∃s′y[C(s′) & C(y) & s′ ≤ s & y ≤ B & R(y)(x)(s′)] &
∀y[y ≤ B & C(y) → ∃s′x[C(s′) & C(x) & s′ ≤ s & x ≤ A & R(y)(x)(s′)]

Let s be the chart, the situation we evaluate (171) against, and let's assume that the context provides (179):

(179) C(s′) iff s′ consists of a line in the chart in (172).

The interpretation of our example will then amount to the following truth conditions: each line of the chart contains a pair of complementing fiction and non-fiction books, and each fiction book is part of such a situation, and so is each non-fiction book. This seems correct. The subsituation analysis is more restrictive in that interpretations like (175) are expected to be impossible. Let's adopt the subsituation analysis instead of the relation analysis for relational plurals then (the interested reader is referred to Beck (1999b) for more arguments and discussion).

### 5.3.3. *Salient Subsituations for Reciprocals*

Could we extend a subsituation analysis to the reciprocal data? Below is the analysis of the telephone poles in those terms:

(180) a. [[the telephone poles]$_3$ [Pro$_3$ [***[2 [1 [λs′ [t$_1$ is 500′ apart from [max [other$_1$ of t$_2$]]]]]]]]]

b. ⟨P, P, s⟩ ∈ [***λxλyλs′.@(x ≠ y) & C(x) & C(y) & C(s′) & x is 500′ apart from y in s′]

(181) C(s′) iff s′ is a minimal situation containing two neighboring poles.

(182) $\forall s'[s' \leq s \ \& \ C(s') \rightarrow \exists xy[x \leq P \ \& \ C(x) \ \& \ y \leq P \ \& \ C(y) \ \& \ x \neq y \ \& \ x \ 500' \text{ apart from } y \text{ in } s'] \ \&$
$\forall x[x \leq P \ \& \ C(x) \rightarrow \exists s'y[C(s') \ \& \ C(y) \ \& \ s' \leq s \ \& \ y \leq P \ \& \ x \neq y \ \& \ x \ 500' \text{ apart from } y \text{ in } s'] \ \&$
$\forall y[y \leq P \ \& \ C(y) \rightarrow \exists s'x[C(s') \ \& \ C(x) \ \& \ s' \leq s \ \& \ x \leq P \ \& \ x \neq y \ \& \ x \ 500' \text{ apart from } y \text{ in } s'] \ \&$

(183) Any two neighboring telephone poles are 500′ apart from each other.

This says that each pole+neighbor – situation contains two poles spaced 500 feet from each other, and each pole is part of such a situation. Together with our knowledge that telephone poles come in a line, IR will follow. If we apply this analysis to the trees in the orchard, our knowledge of orchards will make it a statement stronger than IR. So this looks promising, just so long as we can assume that the context is suited to making a division into subsituations salient as indicated in (181). Putting it differently, we argued that this analysis captures a subsituation view of a situation. Is it plausible to say that the telephone poles context imposes a divisional perspective on our interpretation of the sentence?

One argument in favor of this is the following German sentence, which can be equivalent to the original one in this context:

(184) Die 50 Pfähle sind immer/jeweils 500′
the 50 poles are always/each (time) 500′
voneinander entfernt.
from-each-other apart.
'The 50 poles are always 500′ apart from each other.'

(185) For each relevant situation s: the 50 poles are 500′ apart from each other in s.

Sentence (184) contains an adverb, *always* or *each time*. On the relevant reading the adverb cannot be taken to quantify over times or situations independently since we are talking about only one situation. Thus (185), while describing one possible meaning of (184), is not a good paraphrase of the reading of (184) that we are after. I suggest that the adverb indicates division into subsituations. That is, its role is analogous to that of *all* for individual argument slots. *All* puts a restriction on the cover, hence indicates pluralization (cf. Brisson 1998) of the argument slot it is associated with. *Always* (so my hypothesis) does the same for the situation argument slot. Therefore, (184) shows that it must be possible to take a divisional perspective on the poles situation.

Compare the predictions of the salient relation view vs. the situation-based view of the reciprocal data: just as in relational plurals, anything ought to be possible as a salient relation. The other analysis limits us to subsituation contexts, i.e., contexts that impose a division into salient subsituations on the situation we are considering. If you look back at the data that motivated a contextual analysis ((157) in section 5.2.1.), a subsituation perspective is extremely natural for all of them (the original IR data like the telephone poles are actually the least obvious ones). I don't think that this is an accident. Arbitrary restricting relations are no more possible in reciprocal sentences than they are in relational plurals. Consider for example (186):

(186) a. Our offices are assigned according to the length of time people have worked in the department. Therefore my colleagues grow older as you go down the hallway.
b. Luckily they respect each other.

Despite the context set up by the previous sentence, an interpretation like (187) is not possible. Thus the effect context can have is more limited than one would expect according to the relation analysis. I suggest that the interpretation is impossible because there is no subsituation perspective provided by the context. This distinguishes the example from the ones that work.

(187) a. $\forall\langle x, y\rangle\ [x \leq C\ \&\ y \leq C\ \&\ x \neq y\ \&\ R_C(x, y) \rightarrow x \text{ respects } y]$
b. $R_C = \lambda x \lambda y.\ x \text{ is older than } y$

The example leads us to another difference between the two analyses. Note that the relation I tried to make salient is non-symmetric. By contrast, good paraphrases for the contextual examples that work all involve symmetric contextual relations (for example 'be in the same line as'). This corresponds to the observation that a subsituation view is possible: the subsituation consists of just those entities that stand in the contextual relation (e.g. all the things that are in the same line of the chart), so the relation can be seen as identifying the subsituations.

Now, if we choose a non-symmetric contextual relation as well as a non-symmetric reciprocal relation, the relational analysis does not imply WR. That is, there could be members of the antecedent group with no other member standing in the reciprocal relation R to them. This contrasts with the situation-based analysis. There is an inherent symmetry in the situation-based ***-analysis that makes it imply regular WR: everyone in the antecedent group both R's and is R'ed (and this claim is made stronger by the situation requirement). The example below is constructed with two non-symmetric relations.

(188) a. My colleagues often recycle the others' class notes. They (all) respect each other.
b. $\forall\langle x, y\rangle$ [$x \leq C$ & $y \leq C$ & $x \neq y$ & $R_C(x, y) \rightarrow$ x respects y]
c. $R_C$-$\lambda x \lambda y$. x uses y's class notes
d. Everyone respects those other colleagues whose class notes she/he uses.

The interpretation indicated is compatible with unrespected colleagues. It is not available for this sentence. We intuitively assign a stronger interpretation to the reciprocal sentence, in which it provides a reason for the frequent exchange of class notes. Modulo exceptions, I have not been able to construct examples that do not intuitively imply WR (with the exception of IAO interpretations which are irrelevant here; see section 6.3.).

A final remark: note that an analysis in terms of subsituations can also apply to PartSR interpretations:

(189) The men are hitting each other.

(190) $\langle M, M, s\rangle \in$ ***$\lambda x \lambda y \lambda s'$.Cov(x) & Cov(y) & Cov(s′) & @($x \neq y$) & x is hitting y in s′

(191) Cov(s′) iff s is a minimal situation containing two men.
Cov(x) iff x is a singularity.

(192) $\forall s'[s' \leq s$ & Cov(s′) $\rightarrow \exists x, y[x \in M$ & $y \in M$ & $x \neq y$ & x is hitting y in s′]] &
$\forall x[x \in M \rightarrow \exists y, s[y \in M$ & $s' \leq s$ & Cov(s′) & $x \neq y$ & x is hitting y in s′]] &
$\forall y[y \in M \rightarrow \exists x, s[x \in M$ & $s' \leq s$ & Cov(s′) & $x \neq y$ & x is hitting y in s′]]

That is, each minimal situation with two men contains a hitter and a hittee, and each man is part of such a situation both as a hitter and a hittee. If we assume that each man is only part of one situation (which seems plausible in this example), then this amounts to PartSR. This analysis makes PartSR one possibility in a range of 'divisional' interpretations which are not necessarily strongly reciprocal in any sense.

(193) sums up the analysis I propose for context-dependent intermediate readings including IR, then: they are indicative of a division of the situation into subsituations, and are captured by generalized cumulation that involves the situation argument of a relation. We get a 'situation-based WR' interpretation.

(193) *Situation-based WR:*

a. $\langle A, A, s\rangle \in [***\lambda x\lambda y\lambda s'.\ @(\neg y \circ x)\ \&\ Cov(x)\ \&\ Cov(y)\ \&\ Cov(s')\ \&\ R(x, y, s')]$

b. $\forall s'[s' \leq s\ \&\ Cov(s') \rightarrow \exists xy[x \leq A\ \&\ y \leq A\ \&\ Cov(x)\ \&\ Cov(y)\ \&\ \neg y \circ x\ \&\ R(x, y, s')]\ \&$
$\forall x[x \leq A\ \&\ Cov(x) \rightarrow \exists s'y[Cov(s')\ \&\ Cov(y)\ \&\ s' \leq s\ \&\ y \leq A\ \&\ \neg y \circ x\ \&\ R(x, y, s')]\ \&$
$\forall y[y \leq A\ \&\ Cov(y) \rightarrow \exists s'x[Cov(s')\ \&\ Cov(x)\ \&\ s' \leq s\ \&\ x \leq A\ \&\ \neg y \circ x\ \&\ R(x, y, s')]$

To summarize this section: I argue that IR as defined by Dalrymple et al. is not an independent reading of reciprocal sentences. The interpretational effect is one that comes about when we add contextual information, and is subject to more variation than a transitivity account predicts. It is once more an interpretational effect that we find in relational plurals as well as in reciprocal sentences, and it receives the same analysis: cumulation involving the situation argument of a relation. In that sense, there is an 'intermediate' reading, or additional semantic reading, to SR and WR. I agree with Sauerland and in particular Schwarzschild on the relevance of contextual information, but I propose a different and in some ways more restrictive implementation of context effects.

## 6. Conclusion

### 6.1. *Summary*

This paper develops a compositional analysis of elementary reciprocal sentences. I propose that reciprocal sentences are a kind of relational plural, the reciprocal being an anaphoric definite. I try to get as much mileage as possible out of the analogy to relational plurals. On my analysis there are four semantic readings of reciprocal sentences (where by a semantic reading I mean one that is distinguished by its logical form): collective, SR, WR, and situation-based WR. They track the readings available for relational plurals: object collective, doubly distributive, cumulative, and situation-based cumulative (the other collective readings of relational plurals have no corresponding reciprocal reading for semantic reasons: they would leave the contrast argument of *other* unbound). The only assumption specific to reciprocals is the analysis of the reciprocal itself in terms of an anaphoric plural definite – an updated HLM analysis where it corresponds to 'the other ones among them'. The variability in interpretation that we observe is due to the various options for the Logical Form of a relational plural. Context

in the form of covers gives us additional pragmatic interpretations – subgroup readings as well as exception readings (including PartSR and OWR). Again they track subgroup and exception effects in relational plurals.

### 6.2. *Theoretical Perspective*

Let me relate my proposal to previous analyses of reciprocals. I get my general view of how reciprocals fit into the bigger scheme of things from Langendoen, Sternefeld, and Sauerland. I have pushed their ideas further in terms of empirical coverage, but I have retained the view that a theory of plural predication should handle most of what's peculiar about reciprocal sentences. The reciprocal therefore ends up semantically fairly pale. The trade-off is a relatively rich theory of plural predication (Logical Form plus QR, a set of star operators, and Covers). The idea is that all of that is needed independently of reciprocals.

This is where my story differs most from Dalrymple et al.'s. On their analysis the reciprocal is an operator and systematically ambiguous, responsible for six semantic readings of reciprocal sentences. On my view this neglects the parallels to plural predication: mechanisms of pluralization and the role of context. This is why I have basically treated their results as a challenge for the Langendoen/Sternefeld/Sauerland-type perspective in this paper. The reader may judge how successful I have been so far. I will end the paper with IAO interpretations (section 6.3), which do not fit into the semantic system developed here.

Compared to Schwarzschild (1996), the main difference is that my reciprocal semantics is determined to a larger extent compositionally as opposed to contextually. I also admit several semantic readings of reciprocal sentences; some arguments for this have been brought forth in sections 4 and 5. This means that we still need to clarify when we get which reading, a question that Dalrymple et al.'s Strongest Meaning Hypothesis (SMH) addresses. The SMH is discussed in section 6.4.

### 6.3. *A Remark on IAO*

Remember that IAO is about the type of data and interpretation below:

(194) *Inclusive Alternative Ordering (IAO):*
$\forall x[x \leq A \rightarrow \exists y[y \leq A \ \& \ x \neq y \ \& \ (xRy \vee yRx)]]$

(195) The plates are stacked on top of each other.

Dalrymple et al. propose to derive this reading by considering, not the

original reciprocal relation R, but the union of R and its inverse $R^{-1}$. Then WR obtains for A and $R \cup R^{-1}$.[12]

(196) $R^{-1} = \{\langle x, y\rangle: \langle y, x\rangle \in R\}$

(197) $\forall x[x \leq A \rightarrow \exists y[y \leq A \ \& \ x \neq y \ \& \ R \cup R^{-1}(x, y)]] \ \&$
$\forall y[y \leq A \rightarrow \exists x[x \leq A \ \& \ x \neq y \ \& \ R \cup R^{-1}(x, y)]]$

This simplifies to (198) since $R \cup R^{-1}$ is symmetric and is the same as IAO in (199).

(198) $\forall x[x \leq A \rightarrow \exists y[y \leq A \ \& \ x \neq y \ \& \ R \cup R^{-1}(x, y)]]$

(199) $\forall x[x \leq A \rightarrow \exists y[y \leq A \ \& \ x \neq y \ \& \ xRy \vee yRx)]]$

Notice that we could, in principle, do the same as Dalrymple et al., and assume that we really have LFs like (200) in such data:

(200) $\langle A, A\rangle \in [^{**}\lambda x\lambda y.@(x \neq y) \ \& \ R \cup R^{-1}(x, y)]$

Dalrymple et al. blame the lexical semantics of the reciprocal itself for the disjunctive effect (i.e., the introduction of $R \cup R^{-1}$) – the reciprocal is multiply ambiguous and this is one of the semantic contributions it can make. On our approach, it is technically unclear how and why the disjunction should get into the semantics. Let's approach this problem by asking *when* we might want this to happen.

Dalrymple et al. suggest that IAO only arises with asymmetric relations. Below are a few relevant examples each of which involves an asymmetric reciprocal relation. The judgment refers to the availability of an IAO interpretation.

(201) a. #The two trees are taller than each other.
b. #The two sets outnumber each other.

(202) a. #The skyscrapers are taller than each other for miles.
b. #These sets outnumber each other.

(203) a.??These three people inherited the shop from each other.
b.??The three men buried each other on this hillside.
c. #My mother and I procreated each other.

[from Sauerland (1998)]

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[12] Actually, Dalrymple et al. take OWR to be the basis of IAO and not WR, but the result is identical, since WR = OWR if we look at $R \cup R^{-1}$, $R \cup R^{-1}$ being symmetric.

(204) a. The members of this family have inherited the shop from each other for generations.
b. The settlers have buried each other on this hillside for centuries.

(205) a. The two books are lying on top of each other.
b. The two students followed each other into the elevator.
c. You put these two bowls inside each other.
d. The books are all stacked on top of each other.

I have found basically three types of asymmetric relations. The first type is comparisons (either verbal or with an explicit comparative). These are always unacceptable; in particular, the only reasonable reading IAO is unavailable ((201) and (202)).

The second type is "normal" relations that are asymmetric by nature (I assume here that 'inherit' means 'inherit after death' and similarly for 'bury'). These tend to be unacceptable with small groups and get better with large groups ((203) and (204)). There is some uncertainty and variation, but as a tendency I think my characterization is correct.

The third type are spatial, temporal, and derived spatio-temporal relations (examples in (205)). These have already been singled out by Langendoen (1978) as the ones that allow for an IAO-type interpretation. They are the only ones I could find that are acceptable with small groups including even two-membered groups. Also, Langendoen observes that there is a preferred direction for how to express reciprocal relations with such asymmetric spatial relations:

(206) a.#They preceded each other into the elevator.
b.#The plates are stacked underneath each other.

Given these data, it seems clear to me that we do not want to allow (200) as a general interpretational strategy, not even for just asymmetrical relations. This would predict that all of the above data are equally acceptable on an IAO reading. We want a more limited device which captures the differences in acceptability we observe.

I will exclude the second type of data (examples (203) and (204)) from consideration, since it is possible to tell some kind of an exception story about them. The fact that size matters indicates that this is the right way to think about them, and distinguishes them from the true IAO interpretations in (205), for which an exception story is extremely implausible. This means that IAO is limited to the relations *on top of*, *above*, *follow*, *after*, *behind*, *inside*. (These are the ones I found; it is possible that there are some more. Compare also Langendoen's list.)

To this I would like to add the observation that IAO reciprocals don't

seem to be able to take scope. We saw in section 4 that reciprocals scopally interact with other operators (which on my analysis is reduced to the fact that pluralization operators scopally interact with other operators). Another example is (207), which has the interpretation in (208a), associated with the LF (208b) in which cumulation takes scope over *want*.

(207) Tracy and Joe want to marry each other.

(208) a. Tracy wants to marry and Joe wants to marry Tracy.
b. $\langle T\&J, T\&J\rangle \in **\lambda x\lambda y.\ @(x \neq y)\ \&$ x wants to marry y

A corresponding interpretation with a complex reciprocal relation is unavailable for (209); the sentence can only mean (210).

(209) Tracy and Joe want to die after each other.

(210) Tracy and Joe both have the following (trivial) desire: they die after each other.

It cannot mean either (211a) (a complex WR interpretation) or (211b) (a complex IAO interpretation, true e.g. if Tracy wants to die after Joe).

(211) a. Tracy wants to die after Joe and Joe wants to die after Tracy.
b. For each x, x one of Tracy and Joe: either x wants to die after the other one of Tracy and Joe, or the other one of Tracy and Joe wants to die after x.

Only a lexical IAO interpretation is possible. A similar point is made by (212a) vs. (212b).

(212) a. These people were introduced to each other by a linguist.
b. The glasses were lined up behind each other by an apprentice magician.

Sentence (212a) has a non-lexical WR interpretation as indicated in (213): different linguists can be involved. (212b) on the other hand does not have either a non-lexical WR or a non-lexical IAO interpretation ((214a) and (214b)). The only possible interpretation seems to be (214c) with the same apprentice magician, a lexical IAO interpretation.

(213) $\langle P, P\rangle \in [**\lambda x\lambda y.\ @(x \neq y)\ \&$ x was introduced to y by a linguist]

(214) a. $\langle G, G\rangle \in [**\lambda x\lambda y.\ @(x \neq y)\ \&$ x was lined up behind y by an apprentice]

b. $\langle G, G\rangle \in [**\lambda x\lambda y.\ @(x \neq y)\ \&$ ((x was lined up behind y by an apprentice)
or (y was lined up behind x by an apprentice))]

c. $\exists z[\text{apprentice}(z) \;\&\; \langle G, G\rangle \in [{**}\lambda x\lambda y.\ @(x \neq y)$
$\&\ ((x \text{ was lined up behind } y \text{ by } z)$
$\text{or}\ (y \text{ was lined up behind } x \text{ by } z))]$

I leave the analysis of (215a, b) to the reader.

(215) a. These three bowls can be put inside each other.
b. These three children can lift each other.

I conclude that it is impossible to construct a non-lexical reciprocal relation with IAO data – IAO reciprocals do not seem to participate in the regular interactions of plural predication and LF. Given this observation plus the limitations noted above, I speculate that IAO reciprocals come about by a lexical process different from ordinary reciprocity and limited to the list of relations mentioned above. The result of that process is as Dalrymple et al. describe it. For example:

(216) a. inside each other =
$\lambda X.\langle X,X\rangle \in [{**}\lambda x\lambda y.\ x \text{ inside } y \text{ or } y \text{ inside } x]$

b. behind each other =
$\lambda X.\langle X,X\rangle \in [{**}\lambda x\lambda y.\ x \text{ behind } y \text{ or } y \text{ behind } x]$

And this is as far as I got.

### 6.4. *The Strongest Meaning Hypothesis*

Besides the systematic analysis of various readings of reciprocal sentences, the second important theoretical contribution of Dalrymple et al. (1998) is to provide a theory of which meaning any given reciprocal sentence actually has. This is the Strongest Meaning Hypothesis (SMH). The SMH says that a reciprocal sentence will have the logically strongest reciprocal interpretation that is compatible with the context in which the sentence is uttered. To illustrate, consider once more (217):

(217) The exits are within one mile of each other.

Even though we have identified several reciprocal interpretations, the sentence is not perceived as ambiguous. The SMH tells us why it receives the interpretation that it intuitively has, and no other. Given our background knowledge regarding highways and highway exits, SR is factually impossible. The remaining possibilities are intermediate reciprocity (IR in Dalrymple et al.'s case, situation-based WR in my case) and reciprocal interpretations weaker than that (WR for me, OWR etc. for Dalrymple et al.). The only available interpretation is the strongest remaining one, intermediate reciprocity.

The SMH as a principle of grammar relies on a well-defined set of alternative reciprocal interpretations, and on an entailment relation between those interpretations. As such, it is largely independent of the question investigated in this paper: how are the readings of reciprocal sentences derived compositionally, and of Dalrymple et al.'s answer to that question. Note that it is easy to find a formulation of the SMH in which no mention is made of how the propositions to be compared are derived:[13]

(218) *Strongest Meaning Hypothesis (SMH):*
Let $S_r$ be the set of theoretically possible reciprocal interpretations for a sentence S. Then S can be uttered felicitously in a context c, which supplies non-linguistic information I relevant to the reciprocal's interpretation, provided that the set $S_c$ has a member that entails every other one.

$S_c = \{p: p \text{ is consistent with I and } p \in S_r\}$

In that case, the use of S in c expresses the logically strongest proposition in $S_c$.

As long as a theory of reciprocals makes available a well-defined set of reciprocal interpretations, then, the SMH can operate on that set. The SMH, in other words, is essentially orthogonal to my project in this paper. Putting it differently, the difference between Dalrymple et al. and my theory would lie in what the members of the set $S_r$ are. I fully agree with Dalrymple et al. that reciprocal sentences are not perceived to be multiply ambiguous as a rule, and that they do indeed tend to be interpreted in the strongest possible way, given the relevant background information. Thus I consider it desirable to be able to include a version of the SMH in a theory of reciprocity. I propose to replace the six reciprocal readings in Dalrymple

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[13] Dalrymple et al.'s actual formulation is given below:

(i) Strongest Meaning Hypothesis (SMH):
A reciprocal sentence S can be uttered felicitously in a context c, which supplies non-linguistic information I relevant to the reciprocal's interpretation, provided that the set $S_c$ has a member that entails every other one.

$S_c = \{p: p \text{ is consistent with I and p is an interpretation of S obtained by interpreting the reciprocal as one of the six quantifiers in (91)}\}$
[Dalrymple et al.'s example number]

In that case, the use of S in c expresses the logically strongest proposition in $S_c$.

The six quantifiers referred to are meanings for the reciprocal that lead to SR, IR, OWR, SAR, IAR, and IAO interpretations for the reciprocal sentence. I have tried to change the definition of the SMH as little as possible in the text. See Dalrymple et al. for more discussion.

et al. by the set of semantic readings I argued for as members of the set of propositions $S_r$ that the SMH compares.[14] The entailment relations between my readings are as in (219):[15]

(219) SR → sitWR → WR

There is one potential problem for my claim that the SMH can apply in my system of reciprocal interpretations just like it applies in Dalrymple et al.'s: IAO interpretations in negative contexts. Roger Schwarzschild (p.c.) points out to me that examples like (220) imply that there is no knowing among the group referred to by 'them' at all. This interpretation amounts to (221): an IAO interpretation in the scope of a downward monotonic quantifier.

(220) None of them knew each other.

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[14] Note that the collective interpretation does not participate in an entailment relation with the other candidate meanings. We could consider it outside of the realm of the SMH. This would lead us to expect an ambiguity in cases where the collective reading makes sense. Alternatively, we could loosen the entailment condition.

[15] To show that sitWR entails WR, we have to show that (i) is a subset of (ii):

(i) $\lambda s.\forall s'[s' \leq s \,\&\, Cov(s') \rightarrow \exists xy[x \leq A \,\&\, y \leq A \,\&\, Cov(x) \,\&\, Cov(y) \,\&\, x \neq y \,\&\, R(x, y, s')] \,\&\, \forall x[x \leq A \,\&\, Cov(x) \rightarrow \exists s'y[Cov(s') \,\&\, Cov(y) \,\&\, s' \leq s \,\&\, y \leq A \,\&\, x \neq y \,\&\, R(x, y, s')] \,\&\, \forall y[y \leq A \,\&\, Cov(y) \rightarrow \exists s'x[Cov(s') \,\&\, Cov(x) \,\&\, s' \leq s \,\&\, x \leq A \,\&\, x \neq y \,\&\, R(x, y, s')]$

(ii) $\lambda s.\forall x[x \leq A \,\&\, Cov(x) \rightarrow \exists y[Cov(y) \,\&\, y \leq A \,\&\, x \neq y \,\&\, R(x, y, s)] \,\&\, \forall y[y \leq A \,\&\, Cov(y) \rightarrow \exists x[Cov(x) \,\&\, x \leq A \,\&\, x \neq y \,\&\, R(x, y, s)]$

This is the case if we can assume persistence (cf. Kratzer 1989). For our case, if R(x, y, s') and s' ≤ s, then R(x, y, s). To see that SR entails sitWR, (iii) has to be a subset of (i):

(iii) $\lambda s.\forall x[x \leq A \,\&\, Cov(x) \rightarrow \forall y[y \leq A \,\&\, Cov(y) \,\&\, x \neq y \rightarrow R(x, y, s)]$

So could a situation s be a member of (iii) and yet one of (a–c) be true?

(a) $\neg\forall s'[s' \leq s \,\&\, Cov(s') \rightarrow \exists xy[x \leq A \,\&\, y \leq A \,\&\, Cov(x) \,\&\, Cov(y) \,\&\, x \neq y \,\&\, R(x, y, s')]$

(b) $\neg\forall x[x \leq A \,\&\, Cov(x) \rightarrow \exists s'y[Cov(s') \,\&\, Cov(y) \,\&\, s' \leq s \,\&\, y \leq A \,\&\, x \neq y \,\&\, R(x, y, s')]$

(c) $\neg\forall y[y \leq A \,\&\, Cov(y) \rightarrow \exists s'x[Cov(s') \,\&\, Cov(x) \,\&\, s' \leq s \,\&\, x \leq A \,\&\, x \neq y \,\&\, R(x, y, s')]$

That depends on what Cov is w.r.t. the subsituations. If we make the assumption in (iv), (iii) will be a subset of (i).

(iv) $Cov(s') \rightarrow \exists xy[x \leq A \,\&\, y \leq A \,\&\, Cov(x) \,\&\, Cov(y) \,\&\, x \neq y \,\&\, R(x, y, s')]$

Formula (iv) says that s' cannot be a relevant subsituation of s unless it includes some R'ing between two distinct parts of the antecedent group. It seems reasonable to require this for the evaluation of a reciprocal statement 'A R each other'.

(221) $\sim\exists X[X \leq \text{them} \ \& \ \forall x[x \leq X \rightarrow \exists y[y \leq X \ \& \ x \neq y \ \& \ (x \text{ know } y \vee y \text{ know } x)]]]$

To see that (221) requires that there be no knowing at all, consider in particular two-membered subgroups of the group [[them]]. (221) implies that for any two-membered group, one member neither knows nor is known by the other. If any two people in our group are strangers to each other, then there is no knowing in that group at all.

Dalrymple et al.'s system of reciprocal readings together with the SMH lead us to expect this to be the interpretation of (220): IAO is their weakest reciprocal reading. In the scope of a downward entailing expression, it leads to the strongest possible interpretation for the sentence as a whole. The problem for me is that I claimed above that IAO interpretations fall outside the system of regular reciprocal interpretations and occur only with a certain set of lexical relations, all of them asymmetric and spatio-temporal. The *know*-relation is not among those relations, hence could not receive an IAO interpretation. The weakest reciprocal interpretation for me is WR. Thus we expect (222):

(222) $\sim\exists X[X \leq \text{them} \ \& \ \forall x \leq X\colon \exists y \leq X\ [xRy \ \& \ x \neq y] \ \& \ \forall y \leq X\colon \exists x \leq X\ [xRy \ \& \ x \neq y]$

Expression (222) says that there is no subgroup the members of which stand in a mutual *know*-relation. This is compatible with a situation in which some knowing is going on (for example a situation where four out of the group [[them]] know the fifth member of that group, a semanticist famous from TV, but that person doesn't know the other four and those four are complete strangers to each other). This is a weaker reading. It seems too weak in that people's intuition appears to be that the sentence would not be true in a situation where someone is known to other group members. Unless there is a different explanation of the surprisingly strong interpretation that (220) receives, the example seems to indicate that IAO is not, in fact, limited the way I claimed above.

What could be an alternative explanation for the strong interpretation of (220)?[16] Irene Heim and Roger Schwarzschild (p.c.) suggest that the effect

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[16] Here is an observation that indicates that the story we told about (220) is not all there is to say about it, quite independently of my personal struggles: none of the data in (i)–(iii) are acceptable.

(i) (Let's make a bunch of teams such that)
none of them outnumber each other.

might be due to a homogeneity presupposition that plural predication is subject to, which affects interaction with negation. Consider (223):

(223) a. The children are asleep.
b. The children are not asleep.
c. A: Are the children asleep?
B: No (it is not the case that the children are asleep).

(224) a. The women know the men.
b. The women don't know the men.
c. A: Do the women know the men?
B: No (it is not the case that the women know the men).

Example (223b) and even (223c), where relative scope is unambiguously negation over distribution, are understood as claiming that the children are awake. This is unexpected, given what we have said so far: they should merely mean that not all children are asleep (an observation made for example in Loebner (1987, 1995, 2000) and Schwarzschild (1994)). Similarly for (224b, c), which are taken to mean that no woman knows any man – rather than: not every woman knows all the men, or: not every woman knows and is known by a man. It seems that we get some kind of 'all or nothing' effect for the groups involved in a plural predication. One way to capture the behavior of (223) is as a presupposition of homogeneity in the definition of distribution. A full-fledged theory of this can be found in Schwarzschild (1994); I will limit myself to describing the result of such a theory in (225), following essentially Loebner (1995) ((225) is simplified to distribution to individuals):

(225) $*P(A) = 1$ iff $\forall x[x \in A \rightarrow P(x)]$
$0$ iff $\forall x[x \in A \rightarrow \sim P(x)]$
undefined otherwise

This way, (226a) will be true iff (226b) is true, and similarly for (227):

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(ii) None of them procreated each other.

(iii) (Line up these glasses on the shelf in such a way that)
none of them are behind each other.

On an IAO interpretation, (i) should mean that the teams have equal number of players, (ii) should mean that nobody is anyone else's parent, and (iii) should mean that no glass is behind another glass. Two factors should conspire to make an IAO interpretation available: the choice of an asymmetric predicate, and the negative antecedent which makes this the strongest possible interpretation. Yet they are all impossible.

(226) a. $\sim\forall x[x \in C \rightarrow asleep(x)]$
b. $\forall x[x \in C \rightarrow \sim asleep(x)]$

(227) a. $\sim\forall x[x \in W \rightarrow \forall y[y \in M \rightarrow know(x,y)]]$
b. $\forall x[x \in W \rightarrow \sim\forall y[y \in M \rightarrow know(x,y)]]$
c. $\forall x[x \in W \rightarrow \forall y[y \in M \rightarrow \sim know(x,y)]]$

To ensure that (224b) obligatorily receives such a strong interpretation, we need a presuppositional semantics of cumulation as well as distribution. A first try is (228):

(228) $**R(B)(A) = 1$ iff $\forall x[x \in A \rightarrow \exists y[y \in B \,\&\, R(y)(x)] \,\&$
$\forall y[y \in B \rightarrow \exists x[x \in A \,\&\, R(y)(x)]$
0 iff $\neg\exists x[x \in A \,\&\, \exists y[y \in B \,\&\, R(y)(x)]]$
undefined otherwise

With this in mind, let's reconsider (220), repeated as (229) under an SR interpretation (230a):

(229) None of them know each other.

(230) a. $\sim\exists X[X \leq them \,\&\, \forall x[x \in X \rightarrow \forall y[y \in X \,\&\, x \neq y \rightarrow know(x, y)]]$
b. $\forall X[X \leq them \rightarrow \sim\forall x[x \in X \rightarrow \forall y[y \in X \,\&\, x \neq y \rightarrow know(x, y)]]$
c. $\forall X[X \leq them \rightarrow \forall x[x \in X \rightarrow \forall y[y \in X \,\&\, x \neq y \rightarrow \sim know(x, y)]]$

Expression (230a) is equivalent to (230b) and by virtue of the presuppositional analysis of distribution in (225), (230b) is true iff (230c) is true. (230c) expresses the requirement that nobody knows anybody else. A WR analysis will lead to the same result. Thus, if we can assume a presuppositional semantics for plural operators, we understand the behavior of (229) – we get a much stronger interpretation than the wide scope of negation would seem to indicate, due to homogeneity.

Clearly, assuming a presuppositional definition of the plural operators is a non-trivial step. I leave further investigation for another occasion. My plot has to be, in any case, that the interpretation of (229) is not an IAO interpretation, and the homogeneity presupposition is a promising approach.

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[17] In fact, Winter (1996) does apply the SMH to relational plurals. His assumptions about plural predication are somewhat different from the ones made in this paper, however, and he explicitly excludes from consideration cases in which pluralization mechanisms have applied (cf. section 6 of his paper).

An anonymous reviewer suggests that my theory predicts that SMH effects be found in relational plurals as well as reciprocals. I believe that this is true in the general sense that we do not expect a principle like the SMH to have reciprocal sentences as its only application; nor is that Dalrymple et al.'s intention (cf. section 6.4 of their paper). One might hypothesize that SMH effects show up whenever there is a well-defined set of alternative interpretations for an expression which are ordered by entailment. This would indeed plausibly be the case for relational plurals.[17] The relevant candidate meanings for an elementary relational plural sentence would be (231) (parallel to (219)):

(231) Doubly distributive → Situation-based Cumulative → Cumulative

Now consider (232):

(232) a. The two women know the two men.
b. The two women married the two men.

While we are inclined to judge (232a) false if one of the women doesn't know one of the men, the analogous situation is no problem for (232b), presumably because of our assumptions about marriage. Indeed, cumulative interpretations are often not easy to get, and seem most natural when a doubly distributive interpretation is for some reason implausible. While exploring SMH effects in relational plurals is beyond the scope of this paper, I am inclined to be cautiously optimistic that we can find such effects and that they will make sense in relation to the SMH effects with reciprocals. In that case, we should find a formulation of the SMH that does not make reference to reciprocity – something like (233) (once more being as faithful as possible to Dalrymple et al.'s original proposal):

(233) *Strongest Meaning Hypothesis (SMH):*
Let $S_a$ be the set of theoretically possible alternative interpretations for a sentence S. Then, S can be uttered felicitously in a context c, which supplies non-linguistic information I relevant to S's interpretation, provided that the set $S_c$ has a member that entails every other one.

$S_c = \{p: p \text{ is consistent with I and } p \in S_a\}$

In that case, the use of S in c expresses the logically strongest proposition in $S_c$.

Future research would have to be devoted to the question of how to identify sets of alternative interpretations $S_a$ that would trigger application of the SMH, and how to distinguish those cases from cases in which genuine ambiguity is preserved.

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