

**Distributivity & Reciprocal Distributivity**  
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**1. Introduction and preliminary assumptions**

In this paper, I will sketch a theory of distributivity and of its role in the interpretation of reciprocal NPs in English.<sup>1</sup> Thus, we will consider examples like the following, involving overt or covert simple distributivity, (1), and reciprocals, (2):

- (1) Joan and Mary (each) ate a bagel.
- (2) Joan and Mary like each other.

The central idea is that distributivity arises due to a distributive mode of predication. That is, there are two kinds of predication, the first realized by simple function argument application, as in PTQ (Montague 1973), and the second, distributive predication. The account owes its general features both to my earlier work on this subject (Roberts 1987) and to a recent article by Heim, Lasnik & May (1991, hereinafter HLM). In the remainder of this section, I will sketch very briefly the type of theory I will assume for the semantics of plurals and the relationship between syntactic and semantic plurality. In §2, I will lay out the main features of HLM and point out some problems with that account. And in §3, I will present my own proposal and show how it overcomes these problems.

I assume that the domain of individuals in a model has a lattice-theoretic structure of the general type proposed in Link (1983); the count domain is a free, complete, atomic join semi-lattice (see also Landman (1989a)). I adopt Link's terminology regarding the lattice; in particular, I use *i-sum* to refer to a non-atomic element of the lattice, and I will call the elements which join to form an *i-sum* the *i-parts* of the sum in question (the *i-part* relation is reflexive). I

will write  $a \oplus b$  for the join of the individuals  $a$  and  $b$ , and use  $\Pi$  for the part relation (so:  $(a \oplus b) \Pi (a \oplus b \oplus c)$ ) and  $\text{part}$  for the atomic-part relation (if  $a$  is atomic,  $a \text{part} (a \oplus b \oplus c)$ , but not  $(a \oplus b) \text{part} (a \oplus b \oplus c)$ ).

As for the relationship between syntactic and semantic number, following Roberts (1987), a singular CN denotes a set of atomic individuals in the model, whereas a plural CN denotes the complete atomic join semi-lattice generated by the denotation of its singular counterpart. That is:<sup>2</sup>

$[[CN]] \subseteq A$  (the set of atomic elements in the lattice)  
 $[[CN_{+pl}]] (= *CN)$  is the set of elements in the complete, join semi-lattice generated by  $[[CN]]$ , i.e.  $[[CN]] \subseteq [[CN_{+pl}]]$

Hence, the denotation of a singular CN is a subset of the denotation of its plural counterpart. From this and the fact that Craige has a nose, it follows that (3) is true:

(3) Craige has noses.

Of course, in any ordinary context where we can imagine uttering (3), it would not be taken as true. But it can be argued that its anomaly follows straightforwardly from a Gricean quantity implicature which would arise almost unavoidably in such a context. Since the singular would be more informative than the plural (because the singular denotation is a subset of the plural), use of the plural implicates that for all the speaker knows, Craige has more than one nose. But given that it is well-known that Craige is a human and that humans can have no more than one nose, no competent speaker would reasonably believe this implicature or give rise to it by using the plural.

I also assume that distributivity involves quantifying over all the i-parts of the range, rather than just over the atomic i-parts. This leads to the interpretation of (1) in (1'), rather than the interpretation suggested by Link, shown in (1''):

(1')  $\forall x [x \Pi j \oplus m \rightarrow \text{ate-a-bagel}'(x)]$

(1'')  $\forall x[x' \Pi j \oplus m \rightarrow \text{ate-a-bagel}'(x)]$

Most of the time in distributivity, domain restriction operates to restrict the domain of quantification to the atomic i-parts of the range, giving the same effect as we find in (1''). But this is not always the case, as illustrated by the phenomenon of plural quantification (Link 1987). Consider (4) and (5):

- (4) a) No competing candidates like each other.  
 b) \*No competing candidate likes one another.  
 (5) a) All identical twins look alike.  
 b) \*Every identical twin looks alike.

On the most accessible readings of (4a) and (5a), quantification ranges not over atomic companies or individual people who twins, but over i-sums (intuitively, "sets") of candidates which compete with each other, and over i-sums (or "pairs") of individuals who were born as a set of identical twins. We would not be inclined to give (5) a reading where we look at all the i-sums in the join semi-lattice generated by the atomic set of twins, but I will assume that, again, domain restriction applies to restrict our attention to just those i-sums in that lattice whose i-parts were born together. Not only does the assumption that distributivity ranges over all i-parts of the range permit us to explain plural quantification, but in conjunction with the hypothesis about the relationship between the denotations of singular and plurals CNs shown above, this permits us to explain the anomaly of (4b) and (5b), i.e. to account for the fact that plural quantification is only possible when the head CN is plural. Of course, even if the head CN is plural, we can pragmatically restrict the range of quantification to only atomic individuals, as in (6):

(6) Most/all female cardinals have a red beak.

I will assume that number agreement is obligatory between antecedent and pronoun or anaphor, reflected in a feature matching requirement.

And finally, I assume that there are two types of anaphora (Partee (1972), Roberts (1984,1987), HLM): bound variable anaphora and discourse, or coreference anaphora. The former is constrained by restrictions on the scope of the antecedent, usually captured in a formal theory via the requirement that the pronoun be c-commanded or f-commanded by its antecedent at some level of representation or interpretation of a sentence. Hence, bound variable anaphora is strictly intra-sentential. I also assume that it involves syntactic coindexation. Discourse, or coreference, anaphora may, though it need not, be intersentential; I will assume that it doesn't require coindexation. The only restriction is that any operators which have scope over the antecedent have scope over the pronoun as well, a restriction expressed in terms of discourse markers in dynamic theories of interpretation (Kamp (1981), Heim (1982), Groenendijk & Stokhof (1990)).

## 2. The account in Heim, Lasnik & May (1991)

HLM propose a theory of reciprocals and of distributivity more generally which takes as its point of departure the English expression *each other*. They argue that the syntax and semantics of this expression are a function of its morphological complexity. Rather than treating it as a simple anaphor, as in previous work in GB, on their analysis it is an R-expression which contains an anaphor at LF. Their LF for (2) is given in (7), and the semantic interpretation of the various parts of that expression are given in (8):

(7) [[ Joan and Mary]<sub>1</sub> each ]<sub>2</sub> [s e<sub>2</sub> [vp [ e<sub>2</sub> other (1)]<sub>3</sub> [vp like e<sub>3</sub> ]]]

- (8) a) other' :  $\lambda x \lambda y \lambda z (z \circ \Pi y \ \& \ z \neq x)$   
 b) [ e<sub>1</sub> other (k) ]<sub>h</sub>' :  $\lambda z (z \circ \Pi x_k \ \& \ z \neq x_i)$   
 c) [ e<sub>1</sub> other (k) ]<sub>h</sub> ζ' :  $\lambda y \forall x_h (x_h \circ \Pi x_k \ \& \ x_i \neq x_h \rightarrow \zeta'(y))$   
 d) [α each<sub>i</sub> ] φ' :  $\forall x_i (x_i \circ \Pi \alpha' \rightarrow \phi')$   
 e) (7d)' :  $\forall x_2 (x_2 \circ \Pi j \oplus m \rightarrow \forall x_3 (x_3 \circ \Pi j \oplus m \ \& \ x_2 \neq x_3 \rightarrow \text{like}'(x_2, x_3))$

In (7), *each* has been adjoined to the reciprocal antecedent,<sup>3</sup> the subject NP, giving its index to the result. Then the remainder of the reciprocal is adjoined to VP and the derived subject is adjoined to S (= IP). Crucially, HLM stipulate that the trace of *each* in the reciprocal at LF is an anaphor. In (7) it is bound by the trace of the subject, satisfying Principle A of the binding theory, and the entire reciprocal, an R-expression, is free, satisfying Principle C. In (8a), *other*' is a three-place relation: '*z* is a part of the range *y* which is other than the contrast *x*'. The contrast and the range arguments are supplied anaphorically; the contrast will be bound by the raised *each*, as we see in the translation of the reciprocal's LF in (8b), while the range will be coreferential with (though not bound by) the original plural subject--in (7), *Joan and Mary*. In (8c), we see the interpretation which results when (8b) is adjoined to the VP,  $\zeta$ ; this introduces universal quantification over atomic i-parts of the range. The derived subject also introduces universal quantification over the range, as we see in (8d), and the resulting interpretation for (7) is given in (8e). The interpretation is basically that all disjoint pairs of members of the group *Joan-join-Mary* like each other, which gives the right truth conditions for this example.

Distributivity more generally is treated with an implicit operator with the same effect as the raised *each* in the reciprocal examples. Consider the LF of (1) in (9), and its interpretation in (10):

(9) [[Joan and Mary]<sub>1</sub> D ]<sub>2</sub> [<sub>s</sub> e<sub>2</sub> ate a bagel ]

(10) a) [NP<sub>i</sub> D ]<sub>h</sub>  $\varphi'$  :  $\forall x_h (x_h \text{ } \Pi \text{ NP}_i' \rightarrow \varphi')$   
 b) (9)' :  $\forall x_2 (x_2 \text{ } \Pi (j \oplus m) \rightarrow \text{ate}'(x_2, a \text{ bagel}))$

The implicit operator *D* adjoins to the surface subject, giving the result a new index, and introduces into the interpretation universal quantification over atomic i-parts of the group *Joan-join-Mary*. The meaning of (10b) is that each such i-part ate a bagel.

HLM assume that floated quantifiers start out in DS adjoined to an NP subject, which is itself generated in the Specifier of VP. At SS, the NP moves to the Specifier of IP, leaving the floated quantifier behind.



(15) - (17) illustrate HLM's treatment of the Scope Problem:

(15) Joan and Mary think that they like each other.

- i) narrow scope: Joan thinks Joan likes Mary and Mary likes Joan;  
Mary thinks Mary likes Joan and Joan likes Mary
- ii) wide scope: Joan thinks Joan likes Mary, and Mary thinks Mary likes Joan

(16)i) [[Joan and Mary]<sub>1</sub> D]<sub>4</sub> think that [they<sub>1</sub> each]<sub>2</sub> like [e<sub>2</sub> other (1)]<sub>3</sub>

ii) [[Joan and Mary]<sub>1</sub> each]<sub>2</sub> think that they<sub>2</sub> like [e<sub>2</sub> other (1)]<sub>3</sub>

(17)i)  $\forall x_4[x_4 \text{ } \Pi_j \text{ } \Theta_m \rightarrow \text{think}'(x_4, [\forall x_2(x_2 \text{ } \Pi_j \text{ } \Theta_m \rightarrow \forall x_3(x_3 \text{ } \Pi_j \text{ } \Theta_m \ \& \ x_3 \neq x_2 \rightarrow \text{like}'(x_2, x_3))])])]$   
 ii)  $\forall x_2(x_2 \text{ } \Pi_j \text{ } \Theta_m \rightarrow \text{think}'(x_2, [\forall x_3(x_3 \text{ } \Pi_j \text{ } \Theta_m \ \& \ x_3 \neq x_2 \rightarrow \text{like}'(x_2, x_3))])])]$

There are two readings of (15), the "narrow scope" and "wide scope" shown in (i) and (ii). In the LF for the narrow scope reading, shown in (16i), the surface subjects of the matrix and subordinate clauses are coindexed, and *each*<sub>2</sub> from the reciprocal is adjoined to the subordinate subject. There is another, implicit distributivity over the matrix subject, but this is independent of the reciprocal. For the wide scope reading, the LF in (16ii) has the reciprocal *each*<sub>2</sub> adjoined to the matrix subject; the subordinate subject is coindexed not with the surface subject of the matrix, but with the derived LF subject. But the anaphor trace of *each*<sub>2</sub> is still bound within its Minimal Governing Category, by the subordinate subject, *they*<sub>2</sub>. In such cases, the movement of *each*<sub>2</sub> itself is not restricted by Binding Condition A. Again, the range argument of the reciprocal, the (1) after *other* in (16), is not bound by its antecedent, *Joan and Mary*, but only coreferential with it. The possibility that the distributive operator *each*<sub>2</sub> may take scope outside the Minimal Governing Category of the reciprocal NP also provides an account of how we can derive non-contradictory readings of examples like (18):

(18) Joan and Mary think they will defeat each other.

As in (15), if *each* takes wide scope, Joan thinks she will defeat Mary and Mary thinks she will defeat Joan, without either thinking contradictory thoughts.

HLM can also account for examples with non-subject reciprocal antecedents, examples that prove difficult for accounts such as Bennett's (1974), which treat reciprocals as operators on VP:

- (19) a) I questioned them about each other.  
 b) [them<sub>1</sub> each]<sub>2</sub> [I questioned e<sub>2</sub> about [e<sub>2</sub> other (1)]<sub>3</sub>  
 c)  $\forall x_2(x \cdot \Pi x_1 \rightarrow \forall x_3[x_3 \cdot \Pi x_1 \ \& \ x_3 \neq x_2 \rightarrow \text{question}'(1, x_2, x_3)])$

They also make correct predictions for examples involving control and multiple reciprocals, which I'll skip over here for lack of space.

This account represents a real advance in our understanding of reciprocals, and of their relationship to distributivity more generally. However, there are some problems with the account which will motivate the alternative I propose. Before discussing these, let me point out a crucial criterion of adequacy for such an account, the ability to handle examples with conjoined VPs where one VP is given a collective interpretation, the other distributive. Examples are given in (20) and (21):

- (20) The men each agreed to help build the raft, and gathered on Thursday to get started.  
 (21) Mary and Bill won the lottery together and bought each other presents.

*Gather* and *win the lottery together* are predicates which have no atomic elements in their extensions, as we see by the infelicity of (20')/(21'):

- (20') \*The men each gathered on Thursday to get started.  
 (21') \*Mary and Bill each won the lottery together.

This was one of the arguments that Roberts (1987) offered against theories which locate distributivity in the subject of a predication, since in such accounts either one would generally expect either a collective or a distributive interpretation of conjoined VPs, but not mixed readings.<sup>4</sup> HLM's account in effect locates distributivity in the

subject, and so we might suspect that it would have problems with these mixed VP examples. But recall their assumption that subjects are base-generated in the Specifier of VP position. In such an account, sentences with conjoined VPs should have a trace of subject in each VP (I'm not sure how across-the-board movement from DS would merge the DS subjects into one). Hence, if they assume that VP conjunction is interpreted with something like the Derived VP rule of Partee (1973), examples like (20) and (21) may be no problem. However, without DS generation of subject in the Specifier of VP, the conjoined VP examples would pose a significant problem for HLM.

Mats Rooth (p.c. to HLM) points out what I take to be an important problem for the HLM approach. This arises in the distinction between examples like (22) and (23):

- (22) The youngest three of the women each gave a lecture to the others.  
 (23) The youngest three of the women gave lectures to each other.

In (22), each of the youngest three women may have given a lecture either to the other two youngest women or to all the other women, young and old; i.e., the range argument of *other* is relatively free. But in (23) there is only one reading, where each of the youngest three women gave a lecture to the other two youngest women; that is, the range argument is not free, but must be the c-commanding NP *the youngest three of the women*. In HLM, the requirement that the reciprocal antecedent be the coreference anaphora antecedent of the range must be stipulated (p.69). But since coreference anaphora is not taken to be syntactically constrained, this appears ad hoc-- there is no principled reason why the range couldn't be coreferential with some other accessible element in discourse. It seems desirable that this property follow from the anaphoric aspect of the reciprocal.

There are three problems which pertain to predictions about the scope of the quantificational element *each*. First, as we see in (24a), the "antecedent" of a reciprocal may be itself quantificational:

(24) a) No kids spoke to each other.

b)  $\sim \exists x_1[*\text{kid}'(x_1) \ \& \ \forall x_2(x_2 \Pi x_1 \rightarrow \forall x_3[x_3 \Pi x_1 \ \& \ x_3 \neq x_2 \rightarrow \text{speak}'(x_2, x_3)])]$

HLM note that antecedents may be quantificational, but seem to assume that such examples may all be treated using absorption; this procedure, requiring (so far as I know) that the two operators involved have the same quantificational force, would not be suitable for (24). More importantly, the only reading for such examples is the type illustrated in (24b), where the subject quantifier has wider scope than the universal quantification introduced by *each*. We never get *each* wider than the subject. But HLM seem to predict otherwise: if *each* is adjoined to *no kids*, one would expect that at least the wide-scope universal reading should be available, if not both scopes.<sup>5</sup>

Another problem with scope was noted by Williams (1991), in his comments on HLM. He notes that floated *each* behaves differently from the surface quantifier *each*. The latter tends to take widest scope in cases like (25), but *[[the men] each]* in HLM's LF for (26) cannot:

(25) Someone or other has said that each of the men likes the other.

(26) Someone or other has said that the men like each other.

In response, HLM modify their theory so that "NPs of the form [NP *each* ] are not eligible for QR but are obligatorily interpreted *in situ*." However, they point out (p.174,fn.3) a problem for this stipulation in examples like the following:

(27) Their coaches think they will defeat each other.

(27) has a non-contradictory reading. In order to obtain it, HLM must raise *each* to adjoin to the possessive pronoun *their* within the subject, and the latter must then c-command *they* at LF. But *their* would have to undergo QR in order to c-command *they*, which it cannot under the *in situ* modification.

The third scope problem involves the observation by Dowty & Brody (1984) that the surface position of overt floated *each* may fix its scope relative to other INFL elements, such as negation or modals. Examples include:

- (28) The students all didn't leave.
- (29) The students didn't all leave.
- (30) Joan and Mary could each have eaten pizza.
- (31) Joan and Mary each could have eaten pizza.

The only reading of (28) is one where the universal has wide scope over the negation, so that no students left; but (29) permits the wide-scope negation reading. The modal in (30) may have either an epistemic or root interpretation; some speakers report that the modal in (31) has only the root interpretation. If, as sometimes assumed, epistemic modals are taken to be S modifiers and root modals to be VP modifiers, this would suggest a correlation between surface position of the floated quantifier and its potential scope. But I do not see how HLM could accommodate such observations in an account in which all floated quantifiers are basically NP-modifiers, generated within the NP in the Specifier of VP.

Finally, J.J. Nakayama (p.c.) points out that there are some ad hoc features of HLM's account which are problematic from the point of view of GB theory. For example, if the trace of reciprocal *each* is to be an anaphor, then *each* itself must be an NP, under the usual assumptions of the binding theory. But the NP which results when *each* is adjoined to the reciprocal antecedent is then quite odd, out of line with both X' theory and the theory of movement and adjunction. What kind of movement is this and what would motivate it within GB theory?

### 3. A theory of distributivity as a mode of predication

In the theory I will present here, distributivity generally, and reciprocals in particular, involve a special mode of predication, **distributive predication**, in which the logical subject is an I-sum, each of whose I-parts are said to have the property denoted by the

predicate. The logical subject is not necessarily a syntactic subject and the predicate may be derived by abstraction, rather than a syntactic VP. The domain of the universal quantification involved in distributivity, the  $i$ -parts of the relevant  $i$ -sum, is usually pragmatically restricted, as discussed above. To implement this idea, we introduce a set of indexed features  $\{D_i : i \in N\}$ , members of which are freely assigned to nodes in a syntactic tree. A given feature  $D_i$  identifies subcategories of S, VP, and CN (and has no effect on other categories). This feature makes no difference to the interpretation of the constituents it dominates. However, the resulting subcategories,  $S:D_i$ ,  $VP:D_i$ , and  $CN:D_i$ , may be input to semantic rules of distributive predication (though non-distributive predication may apply to them, as well). Hence, addition of one of these features makes the category in question a potentially distributive predicate. The feature index  $i$  plays an important role in constraining distributive predication where reciprocals are involved, as we will see.

Below are the rule schemas for distributive predication. Since I don't think that the theory of distributivity tells us nothing about which framework for semantic analysis one should use, I have implemented it in a fairly classical version of Montague Grammar, co-numbering the rules with the corresponding non-distributive rules in Montague's PTQ (1973). Similarly, I have chosen to represent the syntax of examples using GB LF's similar to those of HLM for convenience of comparison, though it could be implemented in other theories as well.

#### Rule Schemas for Distributive Predication

T4 $D_i$  Subject-Verb Predication:

If  $\alpha_i \in P_T$ ,  $\delta \in P_{V:D_i}$ , then  $F_4(\alpha, \delta)$  translates into  
 $\alpha'(\lambda x_r [\forall x_i (x_i \Pi x_r \rightarrow \delta'(x_i))])$ .

T14 $D_i$  Quantifying Into S [QI-S]:

If  $\alpha_i \in P_T$ ,  $\phi \in P_{t:D_i}$ , then  $F_{10,i}(\alpha, \phi)$  translates into  
 $\alpha'(\lambda x_r [\forall x_i (x_i \Pi x_r \rightarrow \phi')])$ .

T15D<sub>1</sub> Quantifying Into CN [QI-CN]:

If  $\alpha_i \in P_T$ ,  $\delta \in PCN:D_{-i}$ , then  $F_{10,i}(\alpha,\delta)$  translates as

$$\lambda y.\alpha'(\lambda x_r[\forall x_i(x_i \Pi x_r \rightarrow \delta'(y))]).$$

T16D<sub>1</sub> Quantifying Into VP [QI-VP]:

If  $\alpha_i \in P_T$ ,  $\delta \in PVP:D_{-i}$ , then  $F_{10,i}(\alpha,\delta)$  translates as

$$\lambda y.\alpha'(\lambda x_r[\forall x_i(x_i \Pi x_r \rightarrow \delta'(y))]).$$

The variable  $x_r$  in these rules is a distinguished variable; it will play an important role in the account of reciprocals.

As an example of how the rules work, let us consider a case of simple distributivity, example (1) above, whose LF and translation in the present theory are shown in (32):

(32) [= (1)] LF: Joan and Mary<sub>1</sub> [<sub>VP:D<sub>-1</sub></sub> ate a bagel]  
 trans:  $\forall x_i(x_i \Pi j \oplus m \rightarrow \exists y(\text{bagel}'(y) \wedge \text{ate}'(x,y)))$

The truth conditions for the translation require that each of the i-parts of Joan-join-Mary ate a bagel. Normally, this would be understood to apply only to the atomic i-parts of the i-sum in question.

Floated quantifiers will be generated *in situ* and translated as functions from predicates to distributive predicates:

(33) each<sub>r</sub>' (floated):  $\lambda P \lambda x[\forall y(y \Pi x \rightarrow P(y))]$

Hence, floated quantifiers are, in effect, lexicalized distributive predication. Since they are generated *in situ* as adverbials, and since adverbials are known to appear in various locations in INFL and VP, we can imagine an approach to Dowty & Brodie's observations about the fixed scope of floated quantifiers and other auxiliary elements which correlates surface order with scope in LF, though I won't attempt such an account here. Also, this approach permits a lexical meaning account of the differences in interpretive possibilities that

we find with different floated quantifiers (e.g. *all* vs. *both* vs. *each*; see Dowty (1986)).

With respect to reciprocals, I retain HLM's interpretation of the lexical item *other*, taking three arguments as in (8a) above: 'z is a part of the range distinct from the contrast'. English reciprocals will have the LF and translation in (34):

$$(34) \text{ [each other } (x_1)(x_r)]_k: \lambda P[\forall x_k(x_k \Pi x_r \wedge x_k \neq x_1 \rightarrow P(x_k))]$$

The LF involves the three arguments of *other*, the contrast  $x_k$ , the range  $x_r$ , and  $x_1$ . Like HLM, the entire reciprocal is an R-expression. But it differs from HLM's (8e) in several respects: though both the range and contrast are free variables in this translation, as in HLM, in this theory the contrast,  $x_k$ , is the anaphor which will be bound by the reciprocal antecedent, rather than the range as in their account. The range,  $x_r$ , is the same distinguished variable we saw in the rules for distributive predication; given the way those rules work, the range will get semantically bound by the reciprocal antecedent in the course of interpreting the associated distributivity via one of the distributive predication rules. We see this in the treatment of (2) in (35):

$$\begin{aligned} (35)[=(2)] \text{ LF: } & \text{Joan and Mary}_1 \text{ [vp:} D_{-1} \text{ [each other } (x_1)(x_r)]_3 \text{ [vp like } e_3 \text{ ]]} \\ & \text{VP:} D_1': \lambda y[\forall x_3(x_3 \Pi x_r \wedge x_3 \neq x_1 \rightarrow \text{like}'(y, x_3))] = \delta' \\ (35): & \lambda P[(j \oplus m)](\lambda x_r[\forall x_1(x_1 \Pi x_r \rightarrow \delta'(x_1))]) \\ & = \forall x_1(x_1 \Pi j \oplus m \rightarrow \forall x_3(x_3 \Pi j \oplus m \wedge x_3 \neq x_1 \rightarrow \text{like}'(x_1, x_3))) \end{aligned}$$

The translation of the VP,  $VP:D_1'$ , is the result of non-distributively quantifying *each other* into the VP. We then apply distributive predication, T4D, to the result and the translation of *Joan and Mary* to get (35). Coindexation of *Joan and Mary* with the anaphoric contrast argument of *other*,  $x_1$ , satisfies Principle A and causes the latter to be bound by the universal quantification introduced in the course of distributive predication. The same rule abstracts on the range,  $x_r$ , with the result given as argument to the translation of *Joan and Mary*. Hence, Joan and Mary obligatorily provide both the range

and the set of contrasts, as desired. This obligatory relationship of the reciprocal antecedent to both the contrast and the range predicts the unambiguous status of examples like (23), overcoming Rooth's problem for HLM.

The use of  $x_r$  is a technical way of implementing the central idea about reciprocals--that they presuppose occurrence in a distributively applied predicate. Since  $x_r$  is only introduced in conjunction with such a presupposition, if the predicate in question is not distributively applied to its subject, then  $x_r$  will remain free, leading to failure of its familiarity presupposition and hence to infelicity in the technical sense of Heim (1982). This general approach is significantly different from that of HLM, since the latter make the associated distributivity an entailment, both syntactically and truth conditionally, of the reciprocal. I will argue that the present account is empirically superior in several respects.

The account handles the Grain Problem and Scope Problem straightforwardly, as illustrated in (36) and (37), respectively:

- (36) [= (12)] SS: Joan and Mary<sub>1</sub> told [each other]<sub>3</sub> they<sub>k</sub> should leave.  
 pre-LF: Joan and Mary<sub>1</sub> [<sub>VP</sub>D<sub>-1</sub> told [each other (x<sub>1</sub>)(x<sub>r</sub>)]<sub>3</sub> they<sub>k</sub> should leave]  
 transl'n:  $\forall x_1(x_1 \Pi j \oplus m \rightarrow \forall x_3(x_3 \Pi j \oplus m \wedge x_3 \neq x_1 \rightarrow \text{told}'(x_1, x_3, \square \text{leave}'(x_k))))$   
 $k = 1$ : 'I' reading  
 $k = 3$ : 'you' reading  
 $k = r$ : 'we' reading

- (37) [= (15)] Joan and Mary<sub>1</sub> think they<sub>1</sub> like [each other (x<sub>1</sub>)(x<sub>r</sub>)]<sub>3</sub>  
 at LF: a) narrow scope reading:  $D_I$  adjoins to embedded VP  
 b) wide scope reading:  $D_I$  adjoins to matrix VP only  
 a): think'( $j \oplus m_1, (\lambda P.P(x_1)(\lambda x_r[\forall x_1(x_1 \Pi x_r \rightarrow \forall x_3(x_3 \Pi x_r \wedge x_3 \neq x_1 \rightarrow \text{like}'(x_1, x_3))))))$ )  
 = [via alphabetic variance on  $\forall x_1$ ]  
 think'( $j \oplus m_1, \forall x_{10}(x_{10} \Pi x_1 \rightarrow \forall x_3(x_3 \Pi x_1 \wedge x_3 \neq x_{10} \rightarrow \text{like}'(x_{10}, x_3))))$ )

$$\begin{aligned}
 \text{b)'}: & \lambda P.P(j\oplus m) (\lambda x_r [\forall x_1 (x_1 \Pi x_r \rightarrow \text{think}'(x_1, \forall x_3 (x_3 \Pi x_r \wedge x_3 \neq x_1 \\
 & \qquad \qquad \qquad \qquad \qquad \qquad \qquad \qquad \qquad \rightarrow \text{like}'(x_1, x_3)))))) \\
 = & \forall x_1 (x_1 \Pi j\oplus m \rightarrow \text{think}'(x_1, \forall x_3 (x_3 \Pi j\oplus m \wedge x_3 \neq x_1 \rightarrow \text{like}'(x_1, x_3))))
 \end{aligned}$$

As in HLM, the narrow scope reading (37a) involves an extra free  $D_1$  on the matrix VP, unrelated to the reciprocal. In the final line of the translation of (a), note the coindexation of  $j\oplus m$  with the two range arguments  $x_1$ . Given this (non-accidental) coindexation, *Joan and Mary* will discourse bind these arguments, under the assumption that co-indexation, though not necessary to discourse binding, will automatically lead to it when none of the elements coindexed is bound by an operator (see Roberts 1987, where this assumption holds).

(38) illustrates how the correct results are obtained for the non-subject antecedent example (cf. (19) above):

$$\begin{aligned}
 (38) \text{ A1 and Steve introduced Joan and Mary}_1 \text{ to each other}_3. \\
 \text{LF: A\&S}_4 [\text{vpJ\&M}_1 [\text{vp:D}_1 [\text{each other } (x_1)(x_r)]_3 [\text{vp intro } x_1 \text{ to } x_3]]] \\
 \text{VP:D}_1' \text{ (via quantifying } \textit{each other} \text{ into the most embedded VP):} \\
 \lambda y [\forall x_3 (x_3 \Pi x_r \wedge x_3 \neq x_1 \rightarrow \text{intro}'(y, x_1, x_3))] & = \delta \\
 \text{Quantifying } \textit{Joan and Mary} \text{ into } \delta \text{ via T16D:} \\
 \lambda y [\lambda P.P(j\oplus m) (\lambda x_r [\forall x_1 (x_1 \Pi x_r \rightarrow \delta(y))])] & = \\
 \lambda y [\forall x_1 (x_1 \Pi j\oplus m \rightarrow \forall x_3 (x_3 \Pi j\oplus m \wedge x_3 \neq x_1 \rightarrow \text{intro}'(y, x_1, x_3))] \\
 (38)': \forall x_1 (x_1 \Pi j\oplus m \rightarrow \forall x_3 (x_3 \Pi j\oplus m \wedge x_3 \neq x_1 \rightarrow \text{intro}'(a, x_1, x_3))
 \end{aligned}$$

Recall that the distributive predication rules require that the index on the subject match the subcategorization marker. Further, in order to satisfy the familiarity presupposition of the range argument of a reciprocal, the index on the distributive subcategorization must be the same as that of the contrast argument, and hence of the reciprocal antecedent. This mechanism insures that in examples like (38) the reciprocal antecedent must play both roles--binder of the contrast and subject of the distributive predication.<sup>6</sup>

(39) shows the treatment of (39), where the reciprocal antecedent, *no kids*, is quantificational. It falls out of the account that the reciprocal antecedent takes wider scope than both the universal

introduced by *each other* and the universal introduced in the course of distributive predication:

$$\begin{aligned}
 (39) & [= (24)] \text{ No kids}_1 [\text{vp:D}_1 \text{ spoke to } [\text{each other } (x_1)(x_r)]_3 ] \\
 & \text{VP:D}_1' \text{ (via quantifying } \textit{each other} \text{ into the most embedded VP):} \\
 & \lambda y [\forall x_3 (x_3 \Pi x_r \wedge x_3 \neq x_1 \rightarrow \text{spoke-to}'(y, x_3))] = \delta \\
 (39)': & \text{ (applying distributive predication, T4D}_1\text{)} \\
 & \lambda P [\sim \exists x (*\textit{kid}'(x) \wedge P(x))] (\lambda x_r [\forall x_1 (x_1 \Pi x_r \rightarrow \\
 & \quad \forall x_3 (x_3 \Pi x_r \wedge x_3 \neq x_1 \rightarrow \text{spoke-to}'(x_1, x_3))])]) \\
 & = \sim \exists x (*\textit{kid}'(x) \wedge \forall x_1 (x_1 \Pi x \rightarrow \forall x_3 (x_3 \Pi x \wedge x_3 \neq x_1 \rightarrow \\
 & \quad \text{spoke-to}'(x_1, x_3)))
 \end{aligned}$$

For reasons of space, I cannot discuss several types of examples which the theory handles adequately. These include the control examples, those involving multiple reciprocals, and examples motivating T15D, distributively quantifying into CN. The theory also predicts readings where a non-subject reciprocal antecedent has wider scope than the subject.

With respect to Williams' observation about the difference between reciprocal *each* and the determiner, illustrated by (26), in the present theory the reciprocal antecedent/embedded subject in such an example is never itself quantificational. Hence, we would expect that the lack of the wide-scope *each* reading of (25) for (26) is the same type of phenomenon as we observe in (40), where there is no reading where the property of being such that someone has said you are happy is distributively predicated of the group of men. I'm not sure why this reading doesn't arise, but at least the theory seems to pick out the correct parallel examples:

(40) Someone or other has said that the men are happy.

Finally, one might claim that there is another important difference between the two accounts. HLM claim that theirs is a compositional account of the contribution of *each'* and *other'* to *each other'*; on the assumption that *each* is the same post-nominal operator we find in *The boys earned a dollar each*. But other assumptions are possible: if

we assume that *other*' is (8b) (with  $\Pi$  substituted for  $\Pi'$ ), and *each*' is (41), the same determiner we find in *Each boy earned a dollar*, then by function-argument application, we obtain (42):

- (41) *each*':  $\lambda Q \lambda P [\forall x (Q(x) \rightarrow P(x))]$   
 (42)  $\lambda Q \lambda P [\forall x (Q(x) \rightarrow P(x))] (\lambda z (z \Pi x_k \ \& \ z \neq x_i))$   
 =  $\lambda P [\forall x (x \Pi x_k \ \& \ x \neq x_i \rightarrow P(x))]$

(42) is very close to the translation of *each other* in (34); the only difference is that this compositional derivation does not introduce the distinguished variable  $x_i$ . That is, *other* in general does not presuppose distributivity, nor does *each*, but *each other* does. I would argue that (34) captures what is compositional about *each other* as well as HLM's (8e), while claiming that the distributivity presupposition of the NP is an idiomatic accretion. There are clearly idiomatic aspects to the interpretation of *each other*--as HLM acknowledge, its quantificational force often seems to be weaker than the universal operator in (41) (see Langendoen (1978), Roberts (1987, §3.1.3.2)). Also, HLM have to posit an invisible determiner in the reciprocal (see (8c)), so that *each other* in effect contributes two universal operators; while I don't object in principle to invisible operators, the use of one in this case makes the result seem less compositional in the sense claimed. And with respect to the possibility of a universal theory of reciprocals, I think the present theory appears to be as promising as HLM's. For example, there is no superficial evidence from reciprocal constructions in languages like Italian (*l'uno...l'altro*) that they involve (synchronously or diachronically) the type of adnominal operator which HLM claim *each* to be in *each other*. The Italian construction also seems to have a slightly idiomatic flavor, and any distributivity involved might be claimed to arise from an idiomatic presupposition.

In closing, I want to touch all too briefly on a point of considerable interest. This is the question of groups, especially as developed in Landman (1989a, 1989b). And it bears on another concern which might be raised in connection with the present theory: If we admit a second series of predication rules, as I propose, why not expect a third or a

fourth? That is, why are there just two ways of predicating something of a logical subject? Landman points out that there are two ways we can think of a sum--as a whole or in terms of its i-parts, and he builds into his models two distinct sets of individuals corresponding to these two ways of thinking about sums. The resulting theory is quite elegant and interesting, particularly the resulting relationship between distributivity and cumulative reference. But note that in view of the kind of data considered here, which he does not consider, Landman would have to constrain predicates with floated quantifiers or reciprocals to apply only to non-atomic i-sums, not to atomic groups. With floating quantifiers, he might claim that the lexically-introduced i-part relationship, *I*, presupposes that the range argument is non-atomic (HLM make a similar claim for *I'*), an assumption that would filter out group subjects for such predicates. But how would the distributivity associated with reciprocals be introduced? In any case, his theory doesn't provide a ready answer to the issues raised here. This, in conjunction with the problems he encounters with conjoined group and collective VPs, has led me to consider the present alternative. I agree with him that there are two ways of thinking of a sum, but here I have realized this intuition differently, in terms of two different ways of predicating properties of sums. I hope to take this question up in more depth in future work.

#### Notes:

<sup>1</sup>This is a report on research in progress. I'd like to thank Tony Blum, Bob Kasper, Hee-Rahk Chae, Andreas Kathol, Manfred Krifka, Fred Landman, Carl Pollard, and JJ Nakayama for discussions which were important in forming the views expressed here, and Irene Helm and Robert May for very helpful comments following my presentation at SALT.

<sup>2</sup>There are well-known lexical exceptions to this rule. E.g. *scissors* is semantically singular.

<sup>3</sup>Though the reciprocal is an R-expression in HLM, as in the account in S3 below, I will use the term *reciprocal antecedent* to refer to the NP which licenses the reciprocal, giving value to its contrast and range arguments.

<sup>4</sup>Roberts (1987), motivated by conjoined collective and distributive VPs and by non-subject distributive antecedents, claims to be using *D* as an adverbial operator on predicates, sometimes corresponding to VP constituents, but sometimes only derived by abstraction. However, as this is implemented in Chapter 4, the *D* operator in fact operates like an NP quantifier, giving the same effect as HLM's adjunction of *each* to the

antecedent. Hence, it actually encounters problems with conjoined VPs. Though I cannot go into details here, a theory which attempts to use  $\mathcal{D}$  along with quantifying in, e.g. with non-subject reciprocal antecedents, runs into non-trivial problems with accidental variable binding in the course of lambda conversation, leaving the range free.

<sup>5</sup>To derive the interpretation in (24b) we must also allow quantification to range over non-atomic elements of the lattice *\*kid*, but HLM could change their account to permit this very easily.

<sup>6</sup>Indexing the subcategorization feature is a change from the theory presented at SALT. Irene Heim (p.c.) pointed out to me that if the distributivity is free to apply to any predicate which contains the reciprocal, this predicts wrong truth conditions for examples like (38), since *Joan and Mary* might bind the contrast while the distributive predication took *Al and Steve* as subject.

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