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Reciprocity and Plurality

1. Introduction

In investigating the properties of noun phrases, it has proven useful to employ anaphora as a probe to revealing their subtleties. This is especially the case with singular noun phrases, in that aspects of their interpretation have been teased apart by being able to distinguish, for instance, between bound variable and coreference anaphora. In this article we will extend this strategy to explore the syntax and semantics of *plural* noun phrases. Plural noun phrases provide a particularly rich territory for such exploration because they have an anaphoric element all to themselves, which they do not share with singulars. We refer here to *reciprocal pronouns,* which are found in sentences like (1):

(I)   The spies suspected each other.

It is well known that expressions like *each other* and *one another* can cooccur only with plural antecedents; replacing the subject of (1) with the singular *the spy* leads directly to ungrammaticality. Because of this restriction—which we will attempt to explain as we proceed—a detailed investigation of reciprocals reveals, we believe, certain fundamental ways in which the interpretation of plurals differs from the interpretation of singulars. These differences flow, in our opinion, from certain differences in how the semantic structure of plurals is represented in their logical form, especially as this concerns aspects of argument structure and binding. In focusing on these central issues in the semantics of plurals and reciprocals, we will perhaps ignore many aspects of their

behavior that are of inherent interest. Many of these, however, appear to us to allow only types of solutions that fall outside the purview of our theory, with its emphasis on the logical form of reciprocal sentences.

Many of the issues that interest us can be **illustrated** by focusing on two puzzles that loom in the interaction of plural and reciprocal expressions. The first puzzle, whose significance was brought to light by Higginbotham (1985) (citing unpublished work of Dan Finer), is a puzzle of grain. It arises in the context of the analysis of the following sentence:

(2)   John and Mary told each other that they should leave.

What is important about this sentence is that it displays a certain complex of **construals,** being ambiguous at **least** among the following paraphrases:

John told Mary that *he* should leave & Mary told John that *she* should leave.
John told Mary that *she* should **leave** & Mary told John that *he* should leave.
John told Mary, and Mary told John, **"We** should leave."

For ease of exposition we will refer to these three readings as the **"1" reading** (Each told the other, **"I** should leave"), the **"you" reading** (Each told the other, **"You** should leave"), and the **"we" reading** (Each told the other, **"We** should leave"). What ties all these interpretations together is that under each of them the embedded pronoun is understood as anaphorically connected to the subject phrase **John and** Mury. When we consider the representation of this sentence indicating this connection, however, we find, reasoning from the binding theory (Chomsky (1981; 1982; 1986)),that the only indexing possible is the one shown in (3):

(3)   John and Mary, told each other, that they, should leave.

This is because for the pronoun to be construed as anaphoric, it must be coindexed with its antecedent; but in virtue of Principle A—requiring reciprocals to be bound in their governing categories—the reciprocal must also be coindexed with this very same phrase. But if (3) is all we have, Higginbotham reasons, this would be unsatisfactory as a logical form of (2). since this sentence is not univocal, so that (3) would have to do triple duty for the "I," "you," and "we" readings. The problem, then, is that the theory of Logical Form, as it stands, is not sufficiently fine-grained to properly represent the anaphoric possibilities of plural expressions.

There are two possible ways of making the theory more fine-grained. One can opt either for a more fine-grained notation for anaphoric connections, keeping the syntactic structure assigned constant, or for a more fine-grained structural representation, keeping the indexing notation constant. We will argue (in distinction to.Higginbotham) for the latter alternative. As we will show, this analysis allows us not only to characterizeexactly the range of anaphoric possibilities manifest in (3) but also to distinguish the *types* of anaphora found among its ambiguities, some of which are instances of bound variable anaphora, others of coreference anaphora. We will thus discriminate between two syn-

tactically and semantically distinct **"antecedence"** relations that a reciprocal enters into, arising from its dual nature as a kind of anaphor and as a kind of quantifier, restrictions on which must be jointly satisfied at LF. This in turn will reflect on the semantically janus nature of plurals, split between quantificational and referential personae.

The second puzzle that intrigues us, also initially brought to light by Higginbotham, is a puzzle of scope. It pertains to a certain ambiguity of (4):

(4)   John and Mary think they like each other.

We can describe the ambiguities paraphrastically as follows:

John and Mary think they (that is, John and Mary) like each other.
John thinks that he likes Mary and Mary thinks that she likes John.

According to a number of commentators (Higginbotham (1980). Lebeaux (1983). Chomsky (1986)),this ambiguity resolves itself as a matter of scope of the reciprocal, wherein the former construal corresponds to the **narrow** reading of the reciprocal, the latter to the **broad** reading. We believe that this observation is fundamentally correct (although it has been doubted, for instance by Williams (1986)). Part of what raises our curiosity about sentence (4) is found with its broad reading, under which the reciprocal is presumably associated with the matrix phrase **John and Mury** as its antecedent. On this reading (4) is understood essentially as in (5):

(5)   Each of John and Mary thinks that slhe likes the other.

But given this observation about antecedenthood, the following quandary arises: if the matrix subject is an available antecedent forthe reciprocal embedded in the lower clause in (4), then why isn't this an option available for **(6)?**

(6) *John and Mary think that I like each other. **(=** Each of John and Mary thinks that I like the other.)

(6) is a classic instance of a Specified Subject Condition violation—to wit, a violation of Principle A of the binding theory. It exhibits the standard circumstance of a reciprocal failing to find its antecedent within its local syntactic domain. What **we** will conjecture, however, is that such a violation is evaded precisely because of certain peculiar properties of plural anaphora—we note (following Lebeaux (1983)) that (4) is acceptable **only** *if the* pronoun is understood anaphorically. Moreover, our analysis **will** show that this pronoun is understood anaphorically *in different ways* depending upon whether the reciprocal is understood with broad or narrow scope. Like the grain puzzle, then, the scope puzzle will make clear the dual nature of plural and reciprocal expressions, and show how this can be properly represented in the syntax and semantics of LF.

Before turning to these cases, however, we need to make explicit what we understand the syntactic representation of reciprocal sentences to be, and how we understand the **interpretations** of such representations to be obtained.

2. Interpreting Reciprocal Sentences: The Theory

2.1. Logical Form

The basic assumption that will underlie our investigations into the properties of reciprocal sentences is that part of the reciprocal pronoun undergoes movement in mapping onto its LF representation. Though we share this assumption with a number of previous authors (Lebeaux (1983), Belletti (1982), Chomsky (1986)), the specifics of this operation, and our view of its semantic consequences, will differ substantially. Specifically, we will assume that a marker of distribution, the element each in the case under consideration, is removed from its surface position and adjoined at LF to its "antecedent" phrase. Thus, we have the mapping indicated in (7):

(7) The men saw each other $\Rightarrow$ [s[NP[NP the men]₁ each₂] [VP saw [NP e_2 other]₃]]

As we will show, the treatment of the derived subject phrase in (7) is in many respects parallel to that of the surface string the men each. For this type of structure there will be further applications of Quantifier Raising (QR) to the subject and object NPs, yielding the following representation at LF:

(8) [s[NP[NP the men₁] each₂] [s e_2 [VP[NP e_2 other]₃ [VP saw e_3]]]]

In the main, however, we will abstract away from these addiiional LF movements, mentioning them only where relevant, in order to focus on what will be the key aspect of the syntax of reciprocals: the movement of each,

The semantic insight behind our approach is that logical forms like (7)/(8) represent a breakdown of reciprocal sentences into four parts:

group-denoting antecedent – distributor – reciprocator – predicate

In the representations above, the first three parts correspond to the subject NP, each, and e other, respectively. The syntax of these representations is intended to directly mirror the proper semantic composition of the constituents, which we can roughly represent as follows:

(9) each(NP) (e other(VP))

This expresses that (in the type of construction under consideration) both each and its residue after movement (namely, e other) are operators—the former on the subject NP, the latter on the predicate VP—that form complex expressions. In turn, the former derived expression takes the latter as its argument. To put this in the terminology we will employ below, we build up, through the operation of each, a distributed NP, and, through the operation of other, a reciprocated predicate, which in turn stands as the argument of the distributed expression. This is what the logical form (7)/(8) represents, as we will now show by making explicit the semantics of reciprocal sentences.

2.2. Semantics

The distinction we have just introduced between the distributor and reciprocator parts of reciprocal expressions can be traced back to an observation of Bennett (1974) that reciprocal phrases play, semantically, two quite distinct roles. One is that they introduce a universal quantification, whose values are restricted to individuals falling under the collective denotation of the antecedent—this is the distribution; the other is that they require that only assignments of distinct individuals be considered as satisfying the relation to which the reciprocal applies—the reciprocation. That the interpretation of reciprocals bifurcates in this fashion intuitively corresponds to their superficial morpho-syntactic bifurcation, between each and other, each of which can occur independently in nonreciprocal constructions with essentially the meanings just described. This suggests that, in effect, reciprocal expressions have no semantic properties peculiarly their own and that their meaning instead arises from the compositional interactions of the meanings that their constituent parts have in isolation. The hypothesis we will explore, then, is essentially the null hypothesis, that reciprocal pronouns inherit their semantics from the nonreciprocal usages of each and other.

To aid in the exposition of this hypothesis, we will translate the language of logical forms into an interpreting language that will allow us to display clearly the semantic rôles and functions the parts of reciprocal constructions play while still preserving the compositional structure represented at LF. We will assume that by this indirect method LF is interpreted with respect to a model $M = (D, A, \Pi, [\![\ ]\!])$, D is a domain of individuals, A is a subset of D, and Π is a relation on $D \times D$. $[\![\ ]\!]$ is a Function that assigns to each expression a of the language an interpretation $[\![\alpha]\!]$ of the appropriate type. We assume D to have a mereological structure, so that it contains, in addition to atomic individuals of the usual sort, individual sums, understood as collections of atomic individuals. A is the subset of D that contains just the atomic individuals.' Thus, [John] and [Mary] are elements of A, whereas [John and Mary] is an element of D – A composed of just those two individuals. In general, we will assume that objects of this latter sort are the denotations of plural noun phrases. The bound variables of the language will be allowed to range freely over elements of D, regardless of the syntactic number feature of the NPs they correspond to; thus, they may be instantiated, in principle, by either atomic or sum individuals. Π is intuitively the proper-part-of relation; so, for example, [John] Π [John and Mary]. We also define a subrelation of Π, $\cdot\Pi$, the proper-atomic-part-of relation. This is Π restricted to A $\times$ D. Since [John] $\in$ A, [John] $\cdot\Pi$ [John and Mary]. In other words, the domain of this latter relation must be composed of atomic individuals, whereas its counterdomain must be sum individuals; otherwise, the relation is undefined. We use Π and $\cdot\Pi$ equivocally for these relations themselves and as symbols denoting them in the interpretation language.

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[1] Mereological structures have their roots in nominalist assumptions dating back to Liesnewski. Their usefulness to the study of plurality in natural language has been popularized by Link (1983; 1987), among others.

Bennett, in framing his discussion of the semantics of reciprocals, assumed that such expressions are operators on VP, creating other VPs in which they bind two distinct variables. The translation rule corresponding to this syntactic operation, which quantifies each $other_{i,j}$ into a VP, is as follows, where ζ stands for a VP, and ζ' for its translation:

(10)   each $other_{ij}$ $\zeta \Rightarrow \lambda x \forall x_i(x_i \cdot \Pi x) \, \forall x_j(x_j \cdot \Pi x \wedge x_i \neq x_j) \, \zeta'(x_i)$

This reciprocal operator does several things at once: it introduces a universal quantification over the variable x_i, introduces a universal quantification over the variable x,, specifies that each of these is restricted to atomic parts of the value of x, and requires that only assignments that give distinct values for x_i and x_j are considered. Applying (10) to a sentence such as (I I),

(1I)   John and Mary introduced themselves to each other.

we derive (12) as an LF representation corresponding to Bennett's assumptions,

(12)   [$_S$ John and Mary$_1$ [$_{VP}$ each other$_{2,3}$ [$_{vP}$ introduced themselves$_z$ to e_3]]]

which translates as (13):

(13) $\forall x_2(x_2 \cdot \Pi$ John and Mary') $\forall x_3(x_3 \cdot \Pi$ John and Mary' A $x_2 \neq x_3)$ introduce'$(x_2, x_2, x_3))$

This says that any two distinct atomic parts of the pair John and Mary are such that the first introduces him/herself to the second; in effect, that John introduces himself to Mary and Mary introduces herself to John.

    Bennett's analysis has some desirable features that we will seek to preserve in our own, most notably that it introduces three distinct variables corresponding to three distinct indices in the LF representation. We will diverge from Bennett's analysis, however, for a number of technical and empirical reasons, most radically in holding that reciprocals, rather than being simplex expressions, as Bennett would have it, are both syntactically and semantically complex. Thus, we break up each other into the distributor each and the reciprocator e other, each of which occupies its own place in LF structure and makes its own semantic contribution. By doing this, we can make clear what is otherwise occluded under Bennett's treatment, namely, that the distinct morphosyntactic parts of the reciprocal are responsible for different aspects of this complex semantic operation—each contributing the universal quantification and other the distinctness requirement $x_i \neq x_j$. Our thesis about how these distinct semantic roles are compositionally linked stems from an analysis of the *anaphoricity* of reciprocal elements, which we believe has its roots in the role of other, itself an anaphorically complex expression. At the heart of our semantic treatment of reciprocals is seeing precisely the ways in which these various anaphoric roles can come to be satisfied, in the context of the syntactic LF structure of reciprocal constructions.

    Other has two uses as an independent morpheme: "adjectival" (with a head noun) as in (14) and "pronominal" (without overt N) as in (15):

(14)   John came out, and no other doctor went in.
(15)   1 don't like this picture, show me another.

In both adjectival and pronominal uses there is an NP that is semantically incomplete: other N means "N not identical with x." where we assign a value to x. This value can be supplied by the utterance context or by a linguistic antecedent; the latter case is illustrated by the salient reading of (14), as "no doctor other than John." The pronominal use, moreover, is doubly incomplete. because it also leaves open the valuation of N, in the same way that the pro-N *one(s)* requires an anaphoric completion. Accordingly, we must fill in a property, or perhaps a group, from the preceding text and interpret other as "(part of) y not identical with x." For example, other in (15) means "(one of the) picture(s) other than this picture." Let us refer to x and y—the two implicit arguments of other—as its contrast argument (*x*) and its range argument (*y*), where, as noted, the former argument standardly will be an (atomic) individual, the latter a property (= the meaning of a common noun) or group.[2]

    To summarize, other is semantically a 3-place relation: z is a part of y distinct from *x*. We capture this in the following translation:

(16)   other $\Rightarrow \lambda x \lambda y \lambda z (z \cdot \Pi y \wedge z \neq x)$

Other together with its two internal arguments makes a I-place predicate, and as such it can combine with a determiner to form an NP. In (14) and (15) the determiners are no and an, respectively, thus yielding different quantificational forces for the NP as a whole.

    Turning now to reciprocals, the other found in each other and one another has the properties of pronominal other. Its internal range and contrast arguments are always supplied anaphorically; specifically, the range argument will always be coreferential with the group denoting "antecedent" of the reciprocal, whereas the contrast argument will always be a variable bound by *each*, itself a quantifier whose range is the parts of that group. On our analysis, this means that both arguments will be dependent on the same NP, although they will depend on different parts of this phrase and hence receive their valuations in different ways.' Just why these are the only options is explained by the

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[2] For many examples, thinking of the range argument as a group will prove sufficient. For instance. consider the case where it is supplied anaphorically from an antecedent that is a partitive, as in One *of them was* grooming *another*. Here *other* means "atomic part of the referent of *them* not identical with x'' (where *x* is the variable bound by the indefinite subject NP). We will restrict our attention to this kind of case below, so we can think of both implicit arguments of *other* as individuals.

[3] The requirement that the range argument be furnished by the NP that is sister to the moved *each*, and none other, appears to be particular to the reciprocal. It is not a property of anaphoric *other* in general. as pointed out to us by Mats Rooth, who draws attention to minimal pairs like the following:

(i) a.   The youngest three of the women each gave a lecture to the others.
     b.   The youngest three of the women gave lectures to each other.

In (ia) *the others* can mean "the others among the women" or "the others among the three youngest women." indicating that the range argument of *other* can here be anaphoric either to the embedded NP the *women* or to the bigger NP the youngest *three of the women*. But (ib) is unambiguous and permits only the latter construal. We see no allernative to stipulating this as a special property of (he unit *each other*. I n *the* text we will henceforth concentrate on the principles that determine the contrast and external indices. Once the contrast index is determined, the choice of the range index is fixed as well: it i s always the index of the sister of the contrast argument's Ā-binder.

syntactic part of our analysis, below. Given (16), and supposing that x_i and x_k stand for the contrast and range arguments, respectively, the 1-place predicate other in the reciprocator translates as follows:

(17) $[e_i \text{ other}]_i \Rightarrow \lambda z(z \cdot \Pi x_k \wedge x_i \neq z)$

The reciprocator as a whole is an NP in which this predicate restricts an implicit quantifier. We presume this to be a universal quantifier, although the issues underlying this choice are complex, and there is limited indication that this is in general proper. Thus, for instance, in one another there is superficially an indefinite article, whereas in each other there is nothing, assuming that each is not the determiner to other, but rather the first half of the reciprocal, analogous to one in one another. In contrast, in Italian *l'uno . . . l'altro* there is a definite article. Since no semantic contrasts correspond to these contrasts in surface appearance, we must assume that the superficially appearing article (if any) is purely idiomatic. Direct inspection of semantic intuitions also does not resolve the issue. Both Bennett (1974) and Higginbotham (1980) posit a universal quantifier: They like each other means that every one of them likes every other one. But as Fiengo and Lasnik (1973) and Langendoen (1978) note, this is too strong for certain examples: They looked at each other does not require that everyone saw everyone else for truth to obtain, indicating that something weaker than universal force is appropriate for this case. But rather than pursue this matter (on which at this juncture we have little to add to the cited references), we will finesse it, by considering just groups of two, where universal or existential force would yield indistinguishable truth conditions, and follow the usual convention of endowing the NP headed by other with universal force. This NP is thus translated according to (18):

(18) $[e_i \text{ other}]_i \zeta \Rightarrow \lambda y \forall x_j (x_j \cdot \Pi x_k \wedge x_i \neq x_j) \zeta'(y)$

This translation presumes that the other-phrase is adjoined by QR to VP, as in (8).

Reciprocal other, then, is an instance of pronominal other with its range and contrast arguments supplied anaphorically by the complex LF-derived phrase $[NP_k \; each_i]$ as antecedent. The element each, in its uses independent of reciprocals, occurs either as a universal determiner or as a floated universal quantifier. The occurrence that interests us is found in the men each, where each functions semantically as a universal quantifier over the atomic parts of the referent of the phrase from which it is floated—that is. as a distribution operator. By extension, it seems natural to identify each (and one) of reciprocals with this distribution operator, taking it as well as a universal quantificational operator whose range is the atomic parts of the referent of the NP to which it applies— namely, the NP to which it is attached at LF. Each thus translates as follows:

(19) $[a \; each_i]\varphi \Rightarrow \forall x_i(x_i \cdot \Pi \alpha')\varphi'$

It should be borne in mind that, as with our treatment of other, our treatment of each represents something of a convenient simplification. For instance, it does not readily generalize to examples where the NP to which each attaches contains a determiner other

than the definite article, or where it cooccurs with a quantificational adverb. Also, the each in each other differs from floated each in that it may quantify over nonatomic parts, as in one reading of My grandparents *dislike* each other. (See Higginbotham (1980) and Roberts (1987), among others, for discussion of the issues involved here.) However, since we will be able to illustrate our main theses regarding the logical form of reciprocal sentences exclusively in the context of definites denoting pairs, we will persist in speaking of each as a universal distributor, with the presumption that our results will stand up upon substitution of a more sophisticated analysis.

We are now at the point at which we can sew the pieces of reciprocal expressions together. Following our initial discussion of the logical form of reciprocals, we consider prototypically the analysis of The men saw each other with the LF representation in (8):

(8) $[_S[_{NP}[_{NP} \text{ the men}_1] \text{ each}_2] [_S e_2 [_{VP}[_{NP} e_2 \text{ other}]_3 [_{VP} \text{ saw } e_3]]]]$

Relative to this structure, we can determine the application of each to the NP *the* men, to which it is attached. Each, together with this argument, combines with a sentence, so that the conditions set by (19) are met. In turn, the parts of this derived NP determine the contrast and range arguments of other. The former argument, recall, is determined via bound variable anaphora, and this is already explicitly represented in (8) by the trace e_2. To represent the range argument, which is determined under coreference, we add another index to other, so that fleshed out we have the fully semantically determined LF representation in (20):

(20) $[_S[_{NP}[_{NP} \text{ the men}_1] \text{ each}_2] [_S e_2 [_{VP}[_{NP} e_2 \text{ other}(1)]_3 [_{VP} \text{ saw } e_3]]]]$

In this structure other (pace the discussion above) heads an NP containing an implicit universal determiner.[4]

(20) is now appropriately structured for translation into our interpretation language. Using (18) and (19), we arrive at (21), identifying the value of x_k with that of a = the *men*:

(21) $\forall x_2(x_2 \cdot \Pi \text{ the men'}) \forall x_3(x_2 \cdot \Pi \text{ the men'} \wedge x_2 \neq x_3) \text{ saw}(x_2, x_3)$

The predicted truth conditions coincide with those of the standard semantic analyses. such that truth obtains if and only if every man saw every other man different from himself.

Our way of displaying the interpretation of reciprocal sentences as shown by (21) makes apparent three fundamental aspects of their semantic structure. First, it properly expresses their logical argument structure, as represented at LF. Second, it captures the logical role of each and other (or, for that matter, of one and another) in the interpretation of reciprocals, and the contributions each of them makes to its composition; to wit, e other is a reciprocator, introducing a distinctness condition, whereas each is

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[4] Although the index of the range argument is necessary at LF in order to represent all of the semantic structure of reciprocals, we will generally suppress it in what follows.

a **distributor,** compositionally introducing a universal quantification effecting a distribution over the atoms in a proper atomic partitioning of an individual sum. Taking **each** to play this semantic role allows us to immediately derive a fundamental result about reciprocal sentences: Since the predicate ·Π is defined only for counterdomains of individual sums, distributors can apply only to plural NPs, which denote such sums. Consequently, phrases denoting atomic individuals, such as singular noun phrases, can never stand as the antecedents of reciprocal pronouns; just as we cannot say **Mary each saw John,* so we cannot say **Mary saw euch other.*

The third essential aspect of the semantics of reciprocals is that it establishes, corresponding to the indices of the antecedent NP **(each** and e **other,** respectively), three distinct loci of anaphoric binding represented at LF, which in turn correspond to distinct anaphoric relations. On the one hand, there can be **bound variable anaphora**, which will be found if a pronoun is bound either by the quantifier introduced by **euch** or by the quantifier introduced by **other.** On the other hand, there can be **coreference anaphora,** arising when the pronoun picks up as its reference the individual sum denoted by the reciprocal's antecedent (by **the men** in the case at hand). This is an important part of our analysis, because it allows us to distinguish anaphoric relations in reciprocal sentences not only with respect to what expression serves as the antecedent of an anaphoric relation but also with respect to the **type** of anaphora involved—whether it is bound variable or coreference anaphora. As we will show, the distinction in the valuation of the implicit arguments of the reciprocator that we observed in the anaphoric microstructure of reciprocals is recapitulated in their anaphoric macrostructure—that is, with respect to anaphoric connections to the various parts of the reciprocal. To fully characlerize this, however, we need to be more explicit about the conditions that govern the well-formedness of the logical forms of reciprocal sentences, since these conditions determine to a large extent the distribution of these various types of construals.[5]

2.3. Syntax

It is common lore deeply embedded in generative grammar that reciprocal pronouns are to be classified as **unaphors,** alongside reflexive pronouns. Much of their syntactic distribution can be deduced on the basis of this assumption, when it is taken in the context of a theory of anaphoric binding. Although we believe that what the extensive research based on this assumption tells us is largely correct, we do not think it is entirely correct. Rather, we believe (commensurate with our assumptions about the structure of reciprocals) that they are complex, not simplex, elements, and that their categorization reflects this complexity. In particular, we maintain that reciprocals contain both an anaphoric and a nonanaphoric part, and that (for good reasons) previous research has focused on the former. Our assumption about reciprocal expressions can be stated simply as follows:

[5] We leave aside here a number of potentially fascinating issues that arise in the semantics and logical form of reciprocals, among them the effects of symmetrical predicates and plural conjoined antecedents.

(22)   **Syntactic Assumption**
   e of **each** is an anaphor; [**e other]** is an R-expression.

In the context of the binding theory this means that the trace arising from the movement of **each** must be bound in its governing category, whereas the residue phrase of that movement must be free in all categories.[6] From this it follows that just the indexing exemplified by (23) is well-formed:

(23)   [$_{NP}$[$_{NP}$ the men]$_1$ each$_2$] [$_{VP}$ saw [$_{NP}$ e_2 other]$_3$]

In this structure the trace is A-bound by the subject NP, whereas the phrase containing it is free, since it and the subject are contraindexed. Notice that (22) presupposes applicability of the binding theory at post-S-Structure stages of the derivation. The trace of **each** does not exist before LF movement, so if the binding theory were relevant only at S-Structure, (22) would be vacuous.

We now consider the ramifications of this analysis in greater detail. It is a novelty of our approach to treat reciprocal pronouns as having an R-expression "part." That this should be so is not as odd as it perhaps sounds, since examination of the interpretation of reciprocal sentences reveals that they introduce a disjointness condition into the semantic composition; from the binding theory, it follows that they are also syntactically disjoint. On this analysis, reciprocal expressions should be permitted in "disjoint reference" environments, in which, it turns out, they are. Farmer (1987) points out that reciprocals can occur in idioms that standardly require disjointness, commenting on the difficulties this raises for the anaphoricity of reciprocals:

(24)   They cramped each other's style.

If, however, **e other,** the phrase that would occur at LF, is an R-expression, it comes as no surprise that reciprocals are permitted in such environments. Notice, however, that even in such environments, the reciprocal still retains an anaphoric sense: **they** in (24) is no less an "antecedent" than it is in **They saw each other.** Again this is no surprise, since the reciprocal also contains, at LF, the trace of the movement of **each,** which, by hypothesis, is an anaphor, and as this category is merely a subconstituent of the reciprocal NP, it is not subject to the disjointness restriction operant in (24).[7]

Although it is quite apparent how Principle C of the binding theory would be satisfied, it is perhaps less apparent how reciprocals are to satisfy Principle A. Since the trace of **each** is an anaphor, it must be bound in its governing category. We reason as

[6] For our purposes, these basic statements of the conditions of the binding theory will suffice, since our results will remain constant under all embellishments of the binding theory of which we are aware: see Chomsky (1981; 1986) and Aoun (1985), among other references.

[7] Alternatively, one might hold that the *other-phrase* is subject to Principk B of the binding theory—that is, as pronominal. This would imply that such phrases must be distinctly indexed only from other phrases in their local syntactic environment. but not from those in their nonlocal environments. But this would allow for coindexing in sentences such as *The* men *demanded that* euch *other be arrested,* which, although marginal. clearly does *nut* mean that every non-self-identical man demanded that he be arrested, the construal that ought to be possible under the coindexed interpretation.

follows. Consider (23), the simplest sort of case, repeated here:

(23) $[_{NP}[_{NP}$ the men11 each$_2]$ $[_{VP}$ saw $[_{NP}$ e_2 other$]_3]$

The governing category of the anaphor must be identified with that of its containing NP. This will follow if e_2 is the specifier of the entire NP (or alternatively if e_2 is in an adjoined position). The only possibility for A-binding in this domain, as required by Principle A, is by the subject NP. This phrase, however, is complex, having arisen from the adjunction of each$_2$ to the men$_1$, and we have not made explicit so far which index is inherited by the phrase as a whole. Semantic considerations suggest that it is the index 2. This is particularly clear from examination of the semantics assigned to (23), as shown in (19), where we have the (open) sentence x_2 saw x_3 in which the initial argument bears the index of each. Hence, it is the noun phrase *under a distribution* that serves as the actual *argument* of the predicate, whereas the surface subject is, at LF, just *purt* of this argument. Consequently, the index of the distributor can A-bind categories it c-commands, thus satisfying Principle A in (23).

Our decision to let [[*the men] each*] inherit the index of each has a further welcome implication: it predicts that (25) admits only a distributive construal, on the indicated indexing:

(25)   [the men$_1$ each$_2$] saw themselves$_Z$

For it to have the collective reading, the reflexive would have to be bound by the index of the men; but this would not constitute an instance of A-binding, since this phrase is not an argument. Moreover, it might not even be the case that this internal NP c-commands the reflexive. For instance, this would be so if the distributor were the head of a DP that takes the NP as complement, along lines suggested by Abney (1987). If we generalized this to reciprocals, by assuming that LF movement of each is to this position in DP, it would follow that the men in (23) also does not c-command the reciprocal anaphor and consequently cannot be an A-binder. Thus, syntactic and semantic considerations coalesce to show that it is in virtue of the index contributed by each that the reciprocal finds its A-binder. By this line of reasoning we bring reciprocal constructions fully within the strictures of the binding theory?

Implicit in the above deliberations is the motivation for our decision to adjoin each

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[8] It is worth pointing out that our treatment of *e other* as an R-expression with an anaphor inside it might generalize beyond the treatment of reciprocals. It seems to us that the "disjoint anaphor" in Dogrib first discussed by Saxon (1984) could be viewed in the same way. Though apparently not complex morphologically, this item could perhaps be given an LF representation that involves two indices: a referential index that is subject to Principle C and thereby required to be distinct from the index of the antecedent, and an "internal" index that is subject to Principle A. Semantically, the referential index would correspond to the actual referent of the NP and the internal index to an implicit argument construed as having a value identical with the element ta which it is bound. Thus, the inherent semantic content of the item itself would be like that of the English morpheme *other*. This strikes us as a fairly natural way ' ' escape the apparent dilemma that disjoint anaphors create for a theorist striving to integrate syntactic bin   principles with a precise semantic interpretation of indices. The dilemma vanishes with the introduction of a second index, thus removing any tension between a standard version of the binding theory and a straightforward identification of syntactic indices with variables or reference markers in the regular semantic sense.

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to the antecedent NP rather than to the predicate VP, as assumed for instance by Bennett (1974). Since we are treating the trace of each as an anaphor, we must coindex it with an A-position. But if we had adjoined each to the predicate, it would occur in an Ā-position and hence would not qualify as an A-binder. The antecedent NP would be in an A-position, but it would bear the wrong index (namely, the index that refers to the group instead of the one that ranges over its atomic parts), and a violation of Principle A would ensue.[9]

2.4. The Syntax and Semantics of Distributors

The treatment just sketched of the indexing of the antecedent of the reciprocal at LF is just a reflection, on our view, of more general properties of the indexing of plural phrases. We propose that plural NPs can bear two indices, which we will call their *range* and *distribution* indices. In reciprocal constructions this distinction is overtly specified, the distribution index being that contributed by each:

(26) $[NP_i$ each$_j]$

The obligatory distribution induced by the explicit occurrence of each in reciprocals is comparable to the obligatory distributional understanding of (27), where the distributor is equally overt:''

(27)   The men each left.

The distributor, however, may be covert rather than overt, with the result that a plural noun phrase will be ambiguous between "referential" and "quantificational" construals. We will indicate the covert occurrence of a distributor by the symbol D, whose syntax when applied to an NP mirrors, we presume, that of its overt counterpart. Thus, in addition to plural NPs that just bear simple range indices, we also have plural NPs under a distribution. In the general case such phrases will be interpreted as given schematically in (28), by which the distributor introduces a universal quantification over the individuals sewing as the (plural) denotation of the NP (= (19)):

(28) $[NP_i D_j]\phi \Rightarrow \forall x_j(x_j \cdot \Pi NP_i)\phi'$

Notice, importantly for the discussion to follow, that distributors can never apply coherently to singular NPs. Since they inherently denote atomic individuals and therefore do not denote entities that are distributable, there is no semantics defined for them under a distribution. Moreover, since distributors can never apply to NPs that range over

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[9] Although this conclusion could perhaps be obviated if one adopted, which we do not, Williams's (1980) version of the binding theory, which permits an external argument index on the VP to serve as A-binder.

[10] The each that occurs here as a distributor is the floated quantifier, and not the each that occurs as the determiner of a partitive, for instance. It will retain this construal regardless of whether it occurs contiguous to the NP determining its range, as in (27), or not, a result that follows directly on the theory of Sportiche (1988). On this approach. subjects are base-generated as specifiers of VP, and then raised. Quantifier floating is just the effect of raising the inner NP while stranding the quantifier. deriving a constituent containing floated euch and the trace of the raised NP.

individuals, they also cannot apply to **NPs** that are already distributed. Intuitively, this means that they cannot iterate on plural **NPs** that are already under the scope of another distributor, because such phrases are already broken down into their atoms.

The observation that plural **NPs** can be understood either to denote a collection of individuals or to quantify over the members of that collection is, of course, not new. What is new to our analysis is that this distinction is indexically represented at LF, and as such these indices **interact** with the binding theory and with the determination of anaphoric binding generally. In **particular,** this way of elaborating the indexing of **plural** (as opposed to singular) **NPs** predicts that plurals should enter into a greater range of anaphoric relations. In fact, it predicts that there are, in principle, five different ways a pronoun may be anaphorically related to a plural antecedent:

(29)   Antecedent   Anaphoric pronoun
   a. NP_i - NP_i
   b. NP_i - NP_iD_j
   c. NP_iD_j - NP_i
   d. NP_iD_j - NP_j (singular bound variable)
   e. NP_iD_j - NP_iD_k

All of these possibilities are found in the **various** ways of understanding sentence **(30)**, as indicated by the indexings in (31):

(30)   John and Mary argue that they will win $100.
(31) a.   [John and **Mary**]₁ argue that **they**₁ will win $100
   b.   [John and **Mary**]₁ argue that [they₁ D_2] will win $100
   c.   [[John and **Mary**]₁D_2] argue that they, will win $100
   d.   [[John and **Mary**]₁D_2] argue that **they**₂ will win $100
   e.   [[John and **Mary**]₁D_2] argue that [they₁D_3] will win $100

To paraphrase the readings of these structures, **(31a)** means that John and Mary together argued that together they would win $100; **(31b)** that together they argued that each of them would win $100 (for a total of $200); **(31c)** that they each argued that together they would win $100; **(31d)** that John argued that John would win $100 and Mary argued that **Mary·would** win $100; and **(31e)** that John argued that John would win $100 and Mary would win $100. and Mary argued the same thing. It seems to us that (30) can be understood, relative to its anaphoric possibilities, in just these ways and in no others.

The construals of (30) represented in (31) are of two types. In **(31a), (31b), (31c),** and **(31e)** anaphora results from the pronoun being coindexed strictly with the *range* index of the antecedent plural NP. These construals vary in whether a distribution is effected on the antecedent relative to this index **((31c), (31e)),** relative to the pronoun **((31b), (31e)),** or relative to neither **((31a)).** Thus, although the pronoun or the antecedent may ultimately be interpreted quantificationally, the anaphora relation is one of *co-reference.* This contrasts with **(31d),** where the pronoun bears the distribution index of the antecedent phrase—this is the case of *bound variable anapharu.* In this case the

plural pronoun is a ***singular bound variable,*** as shown in its interpretation:

(32) $\forall x (x \cdot \Pi$ John and Mary) x argue that x will win $100

That is, in this case the **plural** pronoun is interpreted as a variable ranging over atomic individuals. Now if the pronoun is a variable, then we would expect it to be subject to whatever constraints hold of bound variable anaphora. For instance, if the antecedent of the pronoun occurs in a scope island, the bound variable **interpretation** ought to be precluded in favor of the varieties of coreference readings. Hajime Hoji (personal communication) points out that this is just what we find in sentences like (33):

(33)   The student that John and Mary taught argued that they would win $100.

This sentence is just four-ways ambiguous, corresponding to (31a–c) and (31e)—that is, to the coreferential construals.

The effects of the covert distribution can be observed as well in the interpretation of reflexive pronouns. Example (34) is ambiguous in just the way we might expect between collective and distributive interpretations:

(34)   Mary **and** Sally introduced themselves to Max.

This difference just turns on whether the subject NP is under the scope of a distributor: thus, **(35a)** represents the collective construal, **(35b)** the distributive:

(35) a.   Mary and **Sally**₁ introduced themselves₁ to Max
   b.   [Mary and Sally, D_2] introduced themselves₂ to Max

Notice that in **(35b)** the reflexive pronoun could not bear the index of ***Mary and Sally,*** since in this structure this phrase is only a constituent of an argument, not an argument, and hence cannot A-bind the anaphor, pursuant to the binding theory.

Our judgments regarding example **(34)** contrast sharply with our judgment regarding **(36),** which differs just in containing a reciprocal expression. It allows only a distributive construal:

(36)   Mary and Sally introduced themselves'to each other.

The reason for the narrower range of construal for this example clearly turns on the presence of the distributor introduced by the reciprocal. However, given the surface position of the reciprocal, it is not apparent how it could be understood to **antecede** the reflexive pronoun, since it does not c-command this latter phrase. At LF, on the other hand, the distributor element ***each,*** attached to the subject NP, does c-command the reflexive; thus, the only well-formed structure is the one shown in **(37),** which represents just the distributed reading:

(37)   [Mary and Sally, **each₂**] introduced themselves₂ to [e₂ other]₃

In this regard the logical form of (36) will represent just what is shown more explicitly in (38):

(38)   Mary and Sally each introduced themselves to the other.

Examples like **(36)**, it should be noted, argue at least prima facie for an actual movement of *each;* we return to this issue in more detail below.

     Relative to these considerations, bear in mind that syntactic and semantic number are frequently at odds in anaphora with plural antecedents. (31d), (35b), and (37) are cases in point. **They** or **themselves** here are singular variables whose values are (atomic) individuals; nevertheless, they are morphologically plural, even obligatorily so. Above and beyond everything else that constrains coreference and bound variable anaphora, there is a requirement that coindexed **NPs** agree in syntactic number. We assume that the complex **NPs** created by LF movement of *each* or by inserting the abstract distributor D bear the feature plural, so that any pronouns or traces they bind likewise must be plural. In all these instances, syntactic plurality masks semantic singularity. In this respect, reciprocal *each* is more like floated *each* than the determiner *each.* which controls the occurrence of singular anaphoric pronouns. So, by way of contrast, the occurrences of *each* considered thus far differ from their near-paraphrases with *each* of partitives; thus, consider (36) and (38) in relation to **(39),** as well as the comparison in (40):

(39) a.   Each of the women introduced herself to the other.
      b.   *Each of the women introduced themselves to the other.
(40) a.   The women convinced each other that *she/they should leave.
      b.   Each of the women convinced the other that she/*they should leave.

Plural agreement is also occasioned by the **postmovement** residue of the reciprocal, the phrase *e other.* Thus, it can license dependent plurals, as Edwin Williams has observed:

(41)   The doctors gave each other new noses.

This contrasts with the base phrase *the other,* so to get a reading comparable to that in **(41),** we must substitute a singular NP:

(42) a.   The doctors each gave the other a new nose.
      b.   Each of the doctors gave the other a new nose.

These examples show that this is so regardless of whether we are in the presence of a floated *each* or of a determiner *each.* Notice finally that these observations indicate a basic difference between *each other* and *each . . . the other* reciprocals. Whereas at LF the former is the pairing of a plural NP with a plural reciprocator, the latter is a pairing with a singular reciprocator. From this difference stem many of the subtle differences between these variant constructions.

     To summarize: We analyze the status of reciprocal constructions **vis-à-vis** the binding theory against the more general background of a theory of indexing of plural expressions. This theory apparently extends the standard notions of indexing in just the right ways to give empirically warranted results for anaphora in plurals, without any special extensions or stipulations in the binding theory. A key feature of our system of indexing

is that it is finely enough structured to represent not only the range of anaphoric possibilities but also the different **types** of anaphora manifest among these possibilities, distinguishing between instances of bound variable and coreference **anaphora.**

3. The Grain **Problem**

Recall the range of ambiguities found with the following sentence:

(43)   John and Mary told each other that they should leave.

As discussed above, this sentence is at least three ways ambiguous, between what we termed the **"I," "you,"** and **"we"** readings. We paraphrase them as follows:

John told Mary that **he** should leave & Mary told John that **she** should leave.
John told Mary that **she** should leave & Mary told John that **he** should leave.
John told Mary, and Mary told John, **"We (together/separately)** should leave.''

Note that we further distinguish here between two sorts of "we" readings, differing in whether what John told Mary, and Mary told John, is that they should leave as a couple or as individuals. The problem that arises here is that under standard assumptions regarding indexing in the context of the binding theory there is only one way to index (43). as in (44), where there is coindexing across the board:

(44)   John **and Mary**$_1$ told **other**$_1$ that they, should leave.

But (43) is multiply ambiguous. Higginbotham (1985) also points out that this "grain" problem reasserts itself in an even more pernicious form when simple control constructions, such as those in (45) and **(46),** are brought into the picture:

(45)   John and Mary persuaded each other to leave.
(46)   John and Mary promised each other to leave.

Here, as in **(43), just** one pattern of simple integer indexing is possible—namely, across-the-board coindexing:

(47)   John and **Mary**$_1$ persuaded each other, [**PRO**$_1$ to leavel
(48)   John and **Mary**$_1$ **promised** each **other**$_1$ [**PRO**$_1$ to leavel

The reason for this is that by the binding theory, the reciprocal must be coindexed with the matrix subject; hence, PRO will also have this index, regardless of whether the sentence is a case of subject or object control. But the rub is that (45) and (46) are not ambiguous in the same way as (43). Rather, both are unambiguous, but in different ways: **(45)** has only a "you" reading, (46) only an "I" reading. It would seem then that unless we build the **theory** of control (redundantly) into the semantics of these sentences, we are left without a satisfactory account of their interpretation **vis-à-vis** (43).

     The various ambiguities we have been considering can be directly represented in our system by the following indexings, given in LF representations, after the movement of *each:*

(49) a. [John and Mary₁ each₂] told [e₂ other]₃ that they₂ should leave
     b. [John and Mary₁ each₂] told [e₂ other]₃ that they₃ should leave
     c. [John and Mary₁ each₂] told [e₂ other]₃ that they, should leave
     d. [John and Mary₁ each₂] told [e₂ other], that [they₁ D₄] should leave

As noted above, the basic representation of reciprocal sentences provides three loci of anaphoric binding: relative to the distribution index contributed by each, relative to the index of e other, the reciprocator, and relative to the range index of the antecedent subject NP. Choice of these loci for the index of the embedded pronoun they corresponds directly to the three types of readings of (43). The first, represented by (49a), is the ''I'' reading; the second, represented by (49b), is the ''you'' reading; the third, represented by (49c) and (49d), are the ''we'' readings, the first the ''together'' reading, the latter the ''separately'' reading. No other anaphoric possibilities exist for the embedded pronoun.

Thus, our theory precisely represents at LF the range of anaphoric possibilities and hence is properly grained. Notice, though, that our theory actually does more than just specify what the antecedents for the pronoun can be: it also differentiates the types of anaphoric relations characterized under each indexing. Recall that on the semantics developed for reciprocals, the distributor and the reciprocator correspond to specific quantificational conditions. Thus, when the pronoun is bound by either of these phrases, it is a case of singular bound variable anaphora. On the other hand, under our semantics the NP John and Mary is not quantificational, but rather referential, denoting the individual sum made up of just John and Mary. Hence, when the pronoun is bound by this phrase, it is an instance of coreference anaphora. It therefore follows on our analysis that the ''I'' and ''you'' readings are bound variable anaphora, whereas the ''we'' readings are coreference anaphora. The theory of reciprocals succeeds then along two dimensions: it properly characterizes both the possible anaphoric antecedents for the pronoun and the type of anaphora that binding by each antecedent involves. Our analysis, therefore, attains exactly the correct degree of grain.''

Turning to the control cases, when the role of each as determining a distribution is factored into the account, the status of matters here also changes dramatically for the bettqr. Recall that on our theory, the object NP does not have the same index as the subject. (This is how we account for Higginbotham's insight that the subject and object NPs are independent antecedents in the constructions under consideration.) Thus, (47) and (48) are replaced by (50) and (51):

(50) [John and Mary, each₂] [persuaded [e₂ other]₃ [PRO, to leave]]
(51) [John and Mary₁ each₂] [promised [e₂ other], [PRO₂ to leave]]

[11] Notice that the ''I'' and ''we'' readings can occur independently of reciprocals. the sentence John and Mury told me that they should leave being ambiguous along just this dimension. This is as it should be. since the abstract distributor D can apply to the matrix subject NP, parallel to the oven application of distributor each in reciprocals. And as with the reciprocal sentences in the text. the ''I''/''we'' ambiguity is traced back to which part of a complex plural phrase there is an anaphoric connection to, although of course there will be no ''you'' reading. since it depends on the reciprocator, which is found only in reciprocals.

These representations give precisely the desired interpretations, where the binding theory fixes the indexings between the matrix subject and object NPs, and control theory fixes the index of PRO in terms of the differential indices of these phrases.[12]

3.1. Bound Variable Anaphoru: Indexing versus Linking

Our'treatment of the grain puzzle centers around an articulation of the structure of reciprocal sentences that makes explicit the representation of a distribution element. But there is another approach that attributes insufficient grain not to the mode of representing reciprocal sentences but rather to the mode of notating anaphoric connections. This is the view of Higginbotham (1985). On his view, the apparent possibility of assigning only a single pattern of indexing to John and Mary told each other that they should leave belies a more general failure of integers as an appropriate notational system for anaphora, from both technical and conceptual perspectives. In lieu of integers, Higginbotham proposes a system under which anaphoric dependencies are indicated by links. For the case at hand two patterns of dependencies are possible, under appropriate reformulations of the binding theory relative to links, which are notated as follows:

(52) John and Mary told each other that they should leave.
     a. _____   _____
     b. _____
         _____

(52a) represents the linking of the pronoun to the reciprocal, which in turn is linked to its antecedent, the subject NP; (52b) represents the independent linking of both the pronoun and the reciprocal to this latter phrase. Clearly, then, Higginbotham's linking approach can more finely display the anaphoric dependencies manifest in (52) than can the assignment of integer indices, under standard assumptions.

But is it fine-grained enough? At first glance it would seem not, since we have established that (52) is three-ways (and perhaps even four-ways) ambiguous. Since (52) is assigned only two linking patterns, we would seem asjustified in being skeptical about this approach, on grounds of grain, as in being skeptical of integer indexing. Such an objection, however, would not quite hit the mark. This is because links are intended to represent only anaphoric dependencies; all that is claimed about (52) is that there are two different such patterns. Nothing precludes one or the other of them from being variously realized semantically, relative to the rules that determine the valuations of the various elements. Apparently, this is as Higginbotham understands matters to be, since he intends (52b), intuitively, to express both the ''I'' and ''we'' readings, as opposed to

[12] Some speakers find that (46) may marginally have a ''we''-type reading. This can be accounted for directly by allowing PRO, as a marked option, to take on the range rather than the distribution index of its controller. Also, care must be taken to guard against a spurious ''we''-type interpretation found in object control sentences, as Edit Doron brings to our attention. Thus, John und Mury persuaded each other to visit Jerusalem appears lo allow a construal under which John and Mary (together) visited Jerusalem. But the irrelevance of this construal to our concerns can be seen by noting that it persists in nonreciprocal sentences: John persuaded Mury to meet in Jerusalem also allows this type of reading.

(52a), which univocally expresses the "you" reading. The multivaluation of (52b) purportedly arises from the rule Higginbotham (1985, (78)) gives for construing pronominal links:

(53)   Suppose a pronominal X is linked to Y in an expression E; then:
       Include some values of Y among those of X.

The values of the pronoun they in (52b) can be included within the values of its antecedent John **and** Mary—which is the plurality this phrase denotes—in one of two ways. They may coincide, giving the "we" reading, or they may be properly included, giving the "I" reading. Then the variations in our understanding of (52), under the linking (52b), arise simply from what it means for some collection to be formally included in another. As such, the "I" and "we" understandings of (52) are not separate readings; rather, they are different special cases of one vague reading. Consequently, a distinction between them need not be made representationally, so indeed the perceived lack of grain in Higginbotham's analysis is illusory.

It would seem, then, that at least for the particular case at hand, articulating either the representational system or the notational system can provide an adequate account of matters. However, this belies certain more basic issues that arise in this context. An approach in terms of (53) differs from ours in making a fundamentally different claim about the semantic status of the "I" and "we" construals. For us, this is not a vagueness, but a genuine semantic ambiguity—the former is a case of bound variable anaphora, the latter a case of coreference anaphora—and this difference is structurally encoded (in (49a) and (49c)). For us, the "I" and "we" construals correspond to two distinct anaphoric bindings; for Higginbotham they correspond to just one anaphoric linking. Which is correct? Suppose the "I"/"we" difference is one of vagueness. Consider again (52b). By the pronoun rule, we take the value of the pronoun to be among those of the matrix subject. If we fix it to be **all** the values of this latter phrase, and then apply the rule for interpreting the reciprocal, (52) will be understood as in the following paraphrase:

(54)   John told Mary that John and Mary should leave and **Mary** told John that John and Mary should leave.

This can be recognized as expressing the "we" construal. If, on the other hand, we fix the value of the pronoun to be fewer than all of the values of the matrix subject, then in a similar fashion we obtain ways of understanding (52) that correspond to the following paraphrases:

(55)   John told Mary that John should leave and Mary told John that John should leave.
(56)   John told Mary that Mary should leave and Mary told John that Mary should leave.

Neither (55) nor (56), however, expresses any way of understanding (52), even though they ought to be possible because they are just as much cases of referential inclusion as that paraphrased by (54).[13] In particular, neither (55) nor (56) expresses the "I" construal as (54) does the "we" construal. This is because, as with the "we" reading, the valuation of the pronoun, as understood through these paraphrases, is *constant* relative to its antecedent. However, the "I" reading requires that its values *vary*, as a function of the values assigned its antecedent. But this is just the difference between the pronoun being *coreferential* with its antecedent and being a variable **bound** by it. And this difference is an ambiguity in the interpretation of (52), not simply a vagueness.

If it were a matter of vagueness, rather than ambiguity, then the "I" and "we" construals would be part and parcel of a single interpretation. Consequently, we would expect them to covary in their occurrence, so that one ought not be present without the other. But consider example (57):

(57)   The candidates criticized each other after they had left the room.

This sentence displays just the same basic three-way ambiguity as (43), and it would be analyzed in just the same way. In particular, it has both the "I" and "we" construals, so we can understand it as we do (58) and (59), where Jones and Smith are the candidates:

(58)   Jones criticized Smith after Jones left the room, and Smith criticized Jones after Smith left the room.
(59)   Jones criticized Smith after Jones and Smith left the room, and Smith criticized Jones after Jones and Smith left the room.

In displaying this ambiguity, however, (57) differs from (60):

(60)   After they had left the room, the candidates criticized each other.

This sentence is univocal; it has only the "we" reading and crucially lacks the "I" reading. Hence, one of these construals can occur independently of the other, contrary to what should be the case if these construals correspond to a vagueness of interpretation.

On the present analysis, the reason why the "I" and "we" readings should be dissociated in this way is immediately apparent from the contrast between (61a) and (61b):

(61) a.   They criticized every candidate after he had left the room.
     b.   After he had left the room, they criticized every candidate.

Although bound variable anaphora is possible in (61a), it is precluded in (61b); thus, although a quantifier that binds a variable in object position can bind into a postposed adjunct clause, it cannot bind into a preposed one. Now recall that on the "I" reading the plural pronoun is a bound variable—that is, this is a case of bound variable anaphora.

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[13] One might object that these are not possible because the plural pronoun is taking on a singular value. We could, however, just rephrase the objection relative to a domain with more than two individuals, and let the pronoun take some nonsingleton subgroup as its value. At any rate, if we were to take this objection, it would also rule out obtaining the "I" construal as of a piece with the "we" construal.

And, as we would expect, its distribution precisely falls under the generalization holding of (61), being present in (57) (postposed adjunct) and absent in (60) (preposed adjunct). This is, of course, unsurprising, since the examples in (61) differ from those in (57) and (60) only in the replacement of the reciprocal phrase by a universal one, and are otherwise structurally identical at LF, save for whether it is *every* or *each* that binds a variable in object position. The "we" reading, on the other hand, remains possible for (57) and (60), since it is not an instance of bound variable anaphora, and hence its occurrence is not licensed by the narrower conditions governing bound variable anaphora.

It now amply appears that the correct generalization about the range of construals of the sentences we have been considering lies not in the clustering of the "I" and "we" readings, as one type of anaphoric dependence, as opposed to the "you" reading, but rather in the clustering of the "I" and "you" readings, as instances of bound variable anaphora, as opposed to the "we" reading, which revolves around anaphora via coincidence of reference. This clustering extends beyond the cases we have been considering thus far. For instance, just as bound variable anaphora is possible in (62),

(62) They told every boy's parents that he should take the exam.

it is also to be found in (63),

(63) They told each other's parents that they should take the exam.

which displays the now standard three-way ambiguity, including the "I" and "you" construals, of such reciprocal sentences.

To summarize: It seems to us that any adequate treatment of anaphoric relations found in reciprocal sentences must be able to properly characterize the bound variable1 coreference distinction, as we have in our theory—that is, as a matter of ambiguity in the syntactic and semantic structure of such sentences. A theory that treats it otherwise (as a matter of vagueness) will be improperly grained in its logical representations.

4. The Scope Puzzle

The second puzzle mentioned earlier pertains to a perceived ambiguity in sentences like (64):

(64) John and Mary think that they like each other.

This sentence can be understood as follows:

(65) John and Mary think: John and Mary like each other.
(66) John thinks that he likes Mary and Mary thinks that she likes John.

We will refer to the former reading as the *narrow* reading, and the latter as the *broad* reading. These are meant to be loaded terms, because we believe that this difference resolves itself as a matter of scope—in particular, in the scope of *each,* depending upon whether it is attached to the complement or matrix subject:

(67) a.   [John and Mary, D] think [that [they, each$_2$] like [e_2 other],]
    b.   [John and Mary, each$_2$] think [that they$_2$ like [e_2 other],]

In (67a) the pronoun picks up the reference of the NP *John and Mary*; in turn, this reference comes under the scope of a distributor, namely, that introduced by the extracted *each* attached to the pronoun. That phrase then binds the trace of *each* in accordance with the binding theory, as discusser! above. In (67b) the pronoun is bound by the index of *each,* attached now to the matrix subject, and in turn it binds the trace of *each,* bringing this structure as well into compliance with Principle A. In the former structure, then, *each* has narrow scope, and in the latter structure it has broad scope.[14]

The distinction in scope covaries with a difference in the type of anaphoric relation: the narrow scope reading (67a) exhibits coreference anaphora, whereas the broad scope reading (67b) exhibits bound variable anaphora. Thus, in (67a) the pronoun bears an occurrence of the *range* index of its antecedent, whereas in (67b) it bears its *distribution* index. Things could not have been otherwise. Suppose that in (67a) the pronoun were bound by the distribution index, so that it was a bound variable ranging over atomic individuals. But then it could not serve as the argument of a distributor, as it must, since *each* applies to it. On the other hand, suppose that in (67b) the pronoun bore the range index of its antecedent. Then we would have a violation of the binding theory: since the pronoun no longer bears the index of *each,* it could not bind the trace of this phrase. So just as the ambiguities surrounding the grain puzzle turn in part around the difference between coreference and bound variable anaphora, so do those of the scope puzzle, where broad scope is correlated with bound variable anaphora, and narrow scope with coreference anaphora. This interaction finds a precise characterization in our theory, as based on our understanding of the representation and interpretation of plural expressions.

The plausibility of taking the ambiguity in (64) as a matter of scope is supported by the following observation. Consider sentence (68), which is contradictory:

(68) They are taller than each other.

When we embed (68), however, a surprising thing happens. The resulting sentence takes on a noncontradictory reading:

(69) They think they are taller than each other.

On this reading (69) is understood, as is (70), to ascribe noncontradictory thoughts to the individuals denoted by the pronoun:

(70) Each of them thinks he is taller than the other(s).

This is in addition to the construal of (69) under which it asserts the holding of contra-

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[14] Note that we have assigned the matrix subject in (67a) a distribution operator. This is because subjects of pure attitude verbs are normally understood as distributed, regardless of whether this is overtly marked or not—we can only have our own thoughts, beliefs, and so on. Other embedding verbs do not impose this requirement (for instance, people can say things together), and our points could be made without the encumbrance of a distribution by substituting *say* for *think.*

dictory thoughts. This observation brings to mind Russell's (1905) well-known comments regarding *The* ship *is longer than it* is, which, as with our example, can be consistently embedded under verbs like *think.* And as Russell concluded that this fact is to be explained as a matter of scope, so do we: in our case, if *each* has broad scope, then the "noncontradictory" reading results, whereas if it has narrow scope, the result is the "contradictory" reading. (We suppress the formal details here.)

Given that the scope of *each* covaries with anaphora type, we would expect conditions on *euch* to interact in ways that would limit the possibilities of interpretation. Consider (71), in contrast to (69), in which an explicit distributor is attached to the matrix subject:

(71)   They each think they are taller than each other.

What is interesting about this case is that it does not display the ambiguity of (69), but rather has only the contradictory construal, indicating that only narrow scope is possible for *each.* The reason for this follows directly from the ungrammaticality of (72):

(72) *They each examined each other.

And the reason for this, as noted, is that the application of a distributor to an already distributed noun phrase is semantically undefined. Hence. for (71) only assignment of narrow scope will lead to a well-formed meaning. This sentence in turn contrasts with the ill-formed (73), in which *they each* occurs not as the matrix subject but as the complement subject:

(73) *They think they each are taller than each other.

For the reasons just cited, we know that attachment of the *each* of *each other* to the complement subject cannot lead to a well-formed interpretation. The only alternative is attachment to the matrix subject, in which case the embedded subject must be the antecedent of the reciprocal. This, however, will lead directly to a violation of the binding theory. Since the complex expression they *each* is a quantificational expression (which contains an embedded pronominal part), it, like other quantifiers—or more correctly the variables they bind—must satisfy Principle C. Consequently, the two occurrences of this phrase in LF—one derived, one not—must be contraindexed, so that the embedded occurrence in (74) must have an index distinct from that of the matrix subject, which c-commands it:

(74)   [they, each$_2$] think they each$_3$ are taller than [e_2 other]

But this directly violates Principle A, since the trace of *each* is not locally bound.[15]

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[15] Example (73) is noted by Barss (1986). who also comments on the disambiguation to the broad readin in sentences like *Which picture of euch other do they think they euch like?* Barss's theory of such effect attempts to capture the insight that the contents of the preposed phrase can be interpreted relative to any c the cyclic stops it makes on the way to its surface position. For the reasons just outlined, however, interpretin the reciprocal phrase relative to its underlying position in the embedded clause cannot give rise to any wel formed construal. On the other hand, if it is interpreted relative to the complement Comp position. one wel formed interpretation will be possible—the broad one—since relative to this position the reciprocal will b construed as outside the scope of the complement subject, and hence the interpretation of the former will n depend on that of the latter.

4.1. A Nonscope Analysis

In taking the view that the ambiguity of (64) and its ilk is a matter of scope, we are in the company of a number of others who have examined reciprocal constructions. Not all researchers agree with this view, however. Opposition has been registered, for instance, by Williams (1986) (and also echoed by Haïk (1985)). Williams notes that an ambiguity apparently similar to the one we have observed for (64) is to be found in (75):

(75)   They think they are sick.

For Williams this is an ambiguity between the glosses in (76),

(76) a.   They think they-as-a-group are sick.
     b.   'Each of them thinks that he is sick.

which he underslands to be the difference between coreference—(76a)—and bound variable anaphora—(76b). This, Williams takes it, is just the same difference that distinguishes the construals of (64), and hence whatever accounts for (75) will also account, by extension, for the reciprocal case. This leads Williams to conclude that ". . . the ambiguity . . . is entirely independent of the reciprocal" (p. 281) and that it correspondingly cannot turn on aspects of the *scope* of the reciprocal.

From our point of view, in a reciprocal sentence, anaphora type and scope are tightly interconnected. However, this is not the case from Williams's point of view, according to which the seeming scope effects are epiphenomenal, being in fact just aspects of the more general properties of the anaphoric possibilities of plural pronouns. Though we clearly agree with Williams to some extent—for instance, on the source of the ambiguity of (75)—we believe that the following arguments cast serious doubt on the full generality of his proposal.

(a) Consider sentence (77), in comparison to (75):

(77)   They each think they are sick.

This sentence displays exactly the same range of ambiguity as its counterpart without *each*—*the* presence of *each* serves only to indicate explicitly an aspect of its interpretation that was otherwise implicit. But now reconsider (71), which lacks a broad scope construal, in contrast to (69):

(71)   They each think they are taller than each other.

From Williams's point of view, it is inexplicable that this sentence can only be read as the attribution of contradictory thoughts and that it lacks any noncontradictory understanding. This is because whatever gives the noncontradictory interpretation of (69) must be an effect arising from the properties of anaphora, and, as (77) shows, making the distributor *each* explicit does not normally affect these latter properties. Consequently, we would expect (71) to exhibit the same range of construals that (69) does. But this is contrary to fact. On our analysis, on the other hand, these observations follow directly. As noted, the lack of a broad reading in (71) arises from the conflicting semantic roles

of the two distributors; no such problem arises for (77), however, since there is but a single distributor in this sentence. Note that the treatment we propose here turns on the properties of *each,* and in particular the locus of the distribution it introduces. But it is precisely this factor that Williams seeks to exclude—incorrectly we believe.

(b) The following sentences are truth-conditionally equivalent (or at least close enough to it for our purposes):

(78) a. They look like each other.
      b. They look alike.

Now we embed them:

(79) a. John and Mary think they look like each other.
      b. John and Mary think they look alike.

Although (79a) exhibits the familiar ambiguity found in other examples of its type, (79b) does not. (79a) can mean either that John thinks that he (John) looks like Mary and Mary thinks that she (Mary) looks like John—the broad construal—or that John and Mary both think that they (John and Mary) look like each other—the narrow construal.[16] (79b), on the other hand, is unambiguous, only having a construal comparable to the latter, narrow interpretation. Our analysis suggests a reason for this contrast. Since (79a) contains the element *each,* which can be detached from its phrase, the extra reading can arise as a matter of scope. But (79b), with just an intransitive predicate, contains no element that can be assigned scope, and hence only the "narrow" interpretation is possible. But this difference is clearly not one of anaphora.

(c) In a sense the force of the previous argument arises from the reciprocal meaning in one case being incorporated within a lexical item and hence being undetachable in any syntactic sense. A similar line of argumentation can be presented even more explicitly on the basis of an observation about Italian, brought to our attention by Luigi Rizzi. He points out that Italian has two distinct forms of the reciprocal pronoun, a full form and a clitic form: *l'uno . . . l'altro* and si. *Of* interest here is the contrast between the following minimal pair:

(80) a. I   due pensano [di essersi   battuti]. (contradictory)
         the two thought   be-each *other* beaten
     b. I   due pensano [di avere prevalso *l'uno sull'altro*]. (ambiguous)
         the two thought   have prevailed *the one ovrr the other*
         'Those two thought they had defeated each other.'

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[16] Care must be exercised in precisely formulating this distinction. This is because *look* like is a symmetric relation, so that the proposition that Mary looks like John is equivalent to the proposition that John looks like Mary, and consequently to the proposition that John and Mary look alike. So how could Mary, for instance, believe she looks like John without also believing they look alike? One possibility is that she has a de re belief about a certain look, which happens to be John's, without knowing that John looks that way. Another possibility is as with mathematical ignorance: Mary might be saying to herself "I look like John." yet fail to draw the inference that John looks like her. (Though this perhaps has a certain ring of implausibility, given how obvious it is.) Third. there might be some difference in "perspective" accompanying the two thoughts, but it is unclear just what this consists in. Thus, to be more explicit here, we would have to become deeply involved in the semantics of attitude reports, a task that lies outside the limits of this study.

Taken by themselves, the embedded complements in these sentences are both contradictory, regardless of the use of the full or clitic form. When they are embedded, only the full *l'uno . . . l'altro* form can in addition take on the expected noncontradictory interpretation; the clitic form remains only contradictory. This contrast arises, we presume, because the clitics form morphological units with the predicates to which they are attached, so that they cannot be affected by movement operations. The full form, on the other hand, includes an autonomous distributor (as in English) and is subject to movement; see Belletti (1982). However this syntactic difference is to be precisely worked out, there seems to be no hope of explaining the contrast in (80) under a view that denies a separate representation for the broad scope construal."

To summarize, we conclude that no account can succeed in which the differences in interpretation that we are attributing to scope are attributed solely to the properties of anaphora, as Williams has proposed. Though Williams is surely correct that sentences like *They think* they *are* sick are ambiguous between coreference and bound variable construals—represented on our theory as in (81),

(81) a. [they₁D₂] think they₁ are sick
     b. [they₁D₂] think they₂ are sick

—he is evidently incorrect in holding that this, and no more, is just the ambiguity found with reciprocal sentences. Instead, in that case the possibilities of anaphora covary with scope: narrow scope of the reciprocal correlates with a coreferential construal of the pronoun, wide scope with a bound variable interpretation. What the evidence shows, we believe, is that scope and anaphora in reciprocals are distinct, but interacting, phenomena.

4.2. Long-Distance Reciprocals

From the considerations of the previous sections we conclude that reciprocals do have scope and that this scope can be either narrow or broad. In this section we examine

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[17] French and Spanish speakers have given us roughly similar reactions when presented with translations of (80a,b). (Thanks to Adele Mercier and Ana Santisteban for their judgments.) Thus, they found analogues of the (b) examples ambiguous in the expected way, and spontaneously rejected analogues of the (a) sentences as somehow deviant. Over a wider range of examples, however, our hypothesis that the clitic reciprocal could never take broad scope was not fully confirmed. The following Spanish text is apparently fully natural.

 (i) Juan y Maria me confesaron secretamente que se gustaban. Ambos piensan que no son correspondidos.
      'Juan and Maria confessed to me secretly that they liked each other (clitic). Both think that their feelings (lit.: they) are unrequited.'

The continuation here makes it clear that neither of the two said "We like each other," which is what the previous sentence would imply if *se were* confined to narrow scope. Apparently even the clitic reciprocal can take broad scope under certain conditions that remain to be elucidated, though our evidence indicates that these are not the same conditions under which broad scope is available for their nonclitic counterparts. As long as there are any minimal pairs at all where the range of available interpretations is contingent upon a grammatical alternation, we have reason to assume that we are dealing with genuinely distinct readings rather than just with different ways in which a single vague reading can be true.

some further properties of long-distance reciprocals—that is, those in which *each* takes broad scope.

In representing the variation in the interpretation of reciprocal expressions, we have taken advantage of the devices the grammar makes available for expressing unbounded dependencies. We have expressed this as movement at LF of the element *each*, and although perhaps one could replace this with an extensionally equivalent indexing system, there does seem to be evidence that the movement view is warranted. Thus, one diagnostic for movement is that movement is blocked across "nonbridge" verbs:

(82) *Who did they mutter that they were taller than?

Comparably with reciprocals, a broad scope construal is excluded in this environment:

(83) They muttered that they are taller than each other.

This sentence can only be understood as asserting the utterance of contradictory sentences. The parallelism with (82) indicates that viewing *each* as undergoing movement at LF is not off the mark, a point that is further confirmed by observing that other diagnostics of movement are also satisfied. For instance, it has been known since Huang (1982) that movement of nonarguments is sensitive to whether extraction takes place from an adjunct clause or an argument clause. We have already considered the case of a reciprocal embedded in an argument: to wit, the ambiguity of *They think they are taller than each other.* But compare this with (84), which clearly exhibits only the contradictory, or narrow, reading:

(84) John and Mary criticized Max when they defeated each other.

In contrast, other binding properties that clearly are just instances of coindexing and not movement—for instance, anaphoric binding—are not sensitive to the argument1 adjunct distinction. Thus, recall example (57), in which the pronoun in the adjunct can be coindexed with either the subject or object NP of the matrix clause:

(57) The candidates criticized each other after they had left the room.

Now we know that reciprocals, in virtue of having to satisfy Principle A of the binding theory, must have a "short antecedent" that binds the trace of *euch* and that must be an A-binder. But what of the "long antecedent"? Need it also be an A-binder? Apparently not; an example from Williams (1986) shows otherwise:

(85) Their friends think they like each other.

Here *each* can take *their* as its long antecedent; this is perhaps made even clearer in (86), which allows a noncontradictory reading:

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

In these examples the long antecedent of the reciprocal will not A-bind the anaphoric trace of *each* at any stage of the derivation onto LF. This is simply because the NP to

which *each* attaches—namely, their—will not c-command the trace of *each.* This phrase can, however, be an A-binder of the trace of *each,* since the derived phrase with *each* attached is subject to QR and hence can be extracted to a position in which it c-commands the trace of *euch.* Under assumptions developed in May (1985), for instance, this result would be achieved by adjunction to the containing NP, as shown in (87), the structure at LF of (85):

(87) [NP[NP their₁ each₂] [NP e friends]][think they₂ like [e₂ other]₃]

Neither in this structure, nor in any steps in its derivation, is the trace of *each* A-bound, either by *each* or by the NP to which it is attached—that is, the long antecedent. This phrase is, however, Ā-bound by the long antecedent at LF.[18] We take it that this sort of binding at LF is a requirement—not surprisingly, since the trace is a variable bound by the distribution operator. A-binding by the long antecedent—or more precisely, by its trace after QR at LF—of course is not prohibited if the long antecedent happens to originate in an A-position c-commanding the reciprocal (as it does in "standard" examples like (64)); it is just not required.

Part of the generalization that emerges from our analysis is that an NP can serve as a long-distance antecedent of a reciprocal just in case it occurs in a syntactic position from which it can be extracted at LF to another position from which the *local* antecedent falls within its scope. The existence of some such constraint is not unexpected, since the semantic effect of attaching *each* to an NP is to derive an expression with quantificational force, as our semantics shows. Consequently, islands for scope will also be islands to reciprocal antecedence:

(88) The guy who saw John and Mary thinks they are taller than each other.

This sentence has only the contradictory reading that is the hallmark of *each* having narrow scope; this is so even though *they* is understood to have *John and Mary as* its antecedent. This is as we expect, since relative clauses are standardly scope islands. Hence, there is no way that this latter phrase, with *each* attached, could come to syntactically bind (that is, c-command) the local antecedent *they* at LF.

In sum, there are two separate conditions that jointly delimit the range of well-formed reciprocal sentences and their readings: (a) *e* in *e other* requires an A-binder in its minimal governing category at some point in the derivation; (b) *e* in *e other* must be bound at LF by [NP *each*], the distributed NP hosting *each*. In "ordinary" examples not involving broad scope reciprocals, one single NP, the reciprocal's so-called antecedent, satisfies both requirements: it hosts the moved *each,* forming with it the [NP *each*]that A-binds, and hence binds, e in *e other* at LF, hence satisfying both conditions (a) and (b). In the broad scope examples we have considered here, however, different NPs satisfy the two requirements: the "long antecedent" hosts *each* and thus provides the binder required by (b), and the "short antecedent" is the A-binder required by (a).

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[18] This is because the first maximal projection dominating this phrase is S (= IP), which also dominates the pronoun; see May (1985) for details.

A consequence of our proposal is that (89) is ungrammatical, because the only possible antecedent is at best an A-binder.

(89) *The boys' friend saw each other.

and although (90) is grammatical, it is grammatical only when the entire subject NP (with friends as its head) is construed as the antecedent:

(90) The bays' friends saw each other.

This sentence cannot mean that friends of each of the boys saw the other boy. This effect is not ameliorated even if there is a long antecedent in an A-position, as we can see by the ungrammaticality of (91a) and by the fact that (91b) has only a contradictory construal, with the entire plural complement subject as the antecedent, rather than the pronoun embedded within this phrase:

(91) a. *They think their friend is taller than each other.
    b. They think their friends are taller than each other.

These results are as we would expect.

The theory we are proposing predicts that so long as the binding theory is satisfied locally, the scope of the reciprocal may be unbounded, so that the long antecedent need not be in the next clause up, as in the examples examined thus far. Sentences like the following appear to support this result:

(92) They claimed the coach said they would defeat each other in tomorrow's match.

Broad scope is possible because this sentence apparently has a noncontradictory understanding, possible only if each has broad scope. But this scope must be the matrix clause, because the intermediate clause has a singular subject and hence could not possibly be a long antecedent. Thus, *each* apparently can be launched indefinitely far in search of a long-distance antecedent so long as its trace independently satisfies Principle A.

Our judgments here differ from those in Lebeaux (1983), although it does seem to us that the broad construal is most readily available when the examples involve only verbs of saying rather than attitude verbs. With attitude verbs judgments are less sure. Thus, although it does seem to us that the broad scope reading is possible for an example like They think Mary believes they are *taller* than *each other*, for others this may be less clear. The point, however, is that examples like (92) show that broad scope is possible in principle, although it may be modulated by other factors that we do not fully understand at this time.

Long-distance reciprocals are instructive in yet another respect in lending plausibility to an approach to the treatment of reciprocals with nonsubject antecedents, as in (93):

(93) I questioned them about each other.

Ever since Bennett (1974) it has been recognized that such cases pose difficulties for an analysis in which the reciprocal is an operator on the VP. Our response to this is to let the distribution operator take sentential arguments, as in the following representation, in which 'euch has been attached to them, with the composite phrase then undergoing QR, as above:

(94) [them$_1$ each$_2$] [I questioned e_2 about [e_2 other]]

Here the trace of each is bound by the trace of the moved derived phrase, where this latter phrase in turn is the long antecedent, as it must be, since it occurs in an A-position. This, of course, is the same pattern found with broad scope reciprocals, except that in the case at hand a trace is the local binder, rather than a pronoun. (Notice that it is unclear how we could derive this result if each were attached to VP rather than NP, since then the trace of each would not be locally A-bound.) On this analysis what we have, so to speak, is an LF topicalization structure, comparable to overt S-Structure topicalizations like (95),

(95) Them, I questioned about each other.

rather than to cases like (96),

(96) *As for them, I questioned you about each other.

in which the only possible antecedent for the reciprocal—them as it occurs in the preposed constituent—would have to occur in an A-position at LF if it is to c-command the trace of each at all.[19]

A conceivable alternative to our analysis would be to treat them about each other as a small clause. Then them would be a subject in the strict sense, and nothing special would need to be said, denying, in effect, that there are any real instances of nonsubjects controlling reciprocals. It would mean that the antecedent of the reciprocal, though not literally a sister to a VP, would be a sister to a constituent of the same semantic type, namely, a predicate. Though this would certainly be so for true small clause constructions, and might perhaps be promising for examples like (97),

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[19] Note that if e *other* in (94) undergoes additional LF movement, as we suggested above, then apparently this movement would bleed the binding theory. if it applies solely at LF. This indicates that it is proper to take the binding theory not in this way, but rather as being satisfied so long as there is at least some point in a derivation at which the appropriate clauses are met. Consequently. later steps in the derivation toward LF may destroy the licensing configuration. (This is suggested on independent grounds by Belletti and Rizzi (1988).) We must also make sure that QR in effect never feeds the binding theory. A pertinent example, supplied to us by Mats Rooth, is (i):

(i) *The men want you to help each other.

This would be generated if Principle A could be satisfied after moving e other to the higher VP, a perfectly avaitable scope option for all we know:

(ii) [[the men]$_1$ each$_2$] [e_2 [[e_2 other]$_3$ [want [you, to help e_3]]]]

But if we suppose that only A-positions are visible to the binding theory (Chomsky (1986)), the moved phrase [e_2 other] in (ii) is invisible and hence (ii) does not serve to license the derivation it is part of. More precisely. then, we assume that for each element subject to the binding theory, there has to be some point in the derivation where it is visible and meets the appropriate condition.

(97)   1 put them next to each other.

in which *them* is in effect the subject of next *to each other,* it is considerably less plausible, from the semantic point of view, for (93). This is because, although They *are next to each other* can stand independently as a coherent predication, *They *are about each other* cannot. It thus remains unclear, at least from the semantic side, how a small clause analysis could be worked out for the general case.

The alternative we employed, invoking QR, does not raise semantic problems of this sort. In invoking QR, however, we must make certain that a moved derived instance of [NP *each*] cannot come to serve illegitimately as a reciprocal's antecedent in the sense of the binding theory. For instance, we would not want to derive a well-formed LF representation for (98) as in (99):

(98)   *Each other saw them.

(99)   [them₁ each₂] [e₂ other] saw e₂

This dilemma is only apparent, of course, since we have been careful to discriminate between two senses of "antecedent of a reciprocal": the phrase that A-binds it at LF, and the A-binder needed to satisfy the binding theory. (94) and (99) are alike with respect to the first, but differ with respect to the second, with the latter structure lacking any A-binder. Thus, the distinction between the A- and A-binders of a reciprocal plays a role not only in accounting for properties of long-distance reciprocals but also in accounting for legitimate and illegitimate instances of nonsubjects serving as antecedents of such expressions.

The last topic we would like to address in connection with long-distance antecedents is that of multiple reciprocals sharing the same antecedent. The phenomenon occurs independently of broad scope construals but interacts with them in a complex and interesting manner. Our discussion is once again indebted heavily to observations by Higginbotham (1980; 1985).

A simple example of two reciprocals apparently sharing an antecedent is (100), whose meaning suggests an LF representation along the lines of (101):

(100)   John and Mary read each other's books in each other's languages.

(101)   [John and Mary₁ each₂] read [e₂ other]₃'s books in [e₂ other]₃'s languages

To achieve such representations, we must allow coindexed occurrences of reciprocal distributors attached to a single plural NP to absorb into a single distributor, in effect allowing movement of *each* to apply across the board.[20] We assume that this operation is possible just in case both occurrences of *euch* bear the same index and are of the same semantic type—note that this will be possible in (101). What (101) represents, therefore, is a single distribution of the NP *John and* Mary that binds multiple variable positions—namely, all those occupied by the superficial occurrences of *euch.*

[20] Note that it does not matter whether the distributor is *each* or *onr,* since *John und Mary read euch other's books in one another's languages* has exactly the same status as (100).

We do not intend this absorption mechanism to affect the explanation for the ungrammaticality of (72) as described above:

(72)   *They each examined each other,

We take it that (72) differs from (101) in a relevant semantic respect. Although we have been glossing over the differences for the purposes of this study, we note in passing that floated *each* and the distributor in reciprocal sentences do not really have fully identical interpretations. Floated *each* is a genuine universal quantifier, whereas the *euch* of *ruch other* might be more accurately described as signaling the presence of a quantifier, whose force it however determines only vaguely or in composition with a cooccurring quantifier. This implies that floated *euch* will not tolerate competition from quantificational determiners or adverbs quantifying the same NP, whereas *ruch other* is compatible with them:

(102) a.   *Most students here each own a car.
      b.   Most students here know each other.
(103) a.   *The musicians mostly each bought Max a copy of *The Shape* of *Juzz to Come.*
      b.   The musicians mostly bought each other copies of *The Shape* of *Jazz to Come.*

Given this difference, it is not surprising that a floated *euch* should be unable to absorb with the distributor component of a reciprocal, as in (72). Presumably absorption affects only instances of the same lexical item, and (72) contains merely homophones.

Returning to long-distance antecedents, it turns out that they can also be shared among a number of different reciprocal expressions. An example from Higginbotham (1985) shows this to be so:

(104)   John and Mary told each other that they love each other.

This sentence is two-ways ambiguous. On the one hand, John and Mary told one another the same things—that John loves Mary and Mary loves John; on the other, they told one another different things—John told Mary that he loves her, and Mary told John that she loves him. But this is just the difference in meaning occasioned by narrow versus broad scope of *each.* So, on the one hand, the embedded *each* can attach to the embedded subject while the matrix *euch* attaches to the matrix subject, providing a derivation of the following structure, representing the narrow reading:

(105)   [John and Mary₁ each₂] told [e₂ other]₃ that [they, each₄] love [e₄ other]₅

On the other hand, the embedded *each* can be attached to the matrix subject, deriving our representation of the broad scope construal:

(106)   [John and Mary₁ each₂] told [e₂ other]₃ that they, love [e₂ other]₄

These are the only derivations leading to well-formed interpretations. All other cases would lead either to semantic indefinability or to violations of the binding theory, along

lines discussed above. The representation we have given in (106) exploits the same absorption option that we appealed to in our treatment of (100). Here it is an *each* from the matrix clause and one from the complement clause that end up adjoined to the same matrix NP, and since they bear the same index and are semantically identical, we are warranted in treating them as a single operator.

Examples like (104) resemble other interesting examples noted by Higginbotham (1980). The resemblance resides in the fact that there are multiple reciprocal expressions all vying for a single antecedent. However, in these cases the resulting sentences are curiously anomalous:

(107) *They saw each other hitting each other.

Higginbotham describes the problem here as one of "antecedent clash." He labels as the "proximate antecedent" of an NP that phrase which most immediately c-commands it, whereas the "evaluative antecedent" is the antecedent from which interpretation derives. Examples like (107) are problematic because the proximate and evaluative antecedents are instantiated to different variables.[21] (107) is represented as in (108), where we have absorbed the two occurrences of each:

(108)   [they$_1$ each$_2$] saw [[e_2 other], hitting [e_2 other]$_4$]

But this structure is a straightforward violation of the binding theory, since the most deeply embedded trace of each is not locally bound. Thus, the crucial difference between examples like (104) and (107) is that the former has an intermediate phrase that can serve as the A-binder of the anaphoric part of the embedded reciprocal, and the latter does not.

4.3. Specified *Subject* Condition *Effects*

At LF, then, it is apparent that sentences of the type we have been considering are to be regarded as being represented by structures distinct in the scope relations they encode. To say that each can have broad scope is, on our view, tantamount to claiming that reciprocal expressions can have "long-distance" antecedents. But, as is well known and

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as we have maintained, reciprocals are subject to Principle A of the binding theory, which requires that they have local antecedents. This is the puzzle of scope. We have already seen part of the solution, as presented in the discussion surrounding (67b); recall that there the binding theory was satisfied because the embedded pronoun, a bound variable, can serve as the local binder of the anaphoric part of the reciprocal—the trace of *each*. Thus, the Specified Subject Condition effect is ameliorated because the specified subject itself serves as the antecedent. It cannot do so in all cases:

(109) a. *They think that John and Mary like each other.
     b. *They think that John likes each other.
     c. *They think that he likes each other.

None of these sentences allow a broad scope reading (nor, in the case of (109b) and (109c), do they allow narrow scope either).[22] For these sentences broad movement of *each* is consistent with the following two classes of variation of indexical patterns at LF:

(110) a. *[they$_1$ each$_2$] [think that John and Mary$_4$ like [e_2 other]$_3$]
     b. *[they$_1$ each$_2$] [think that John$_4$ like [e_2 other]$_3$]
     c. *[they$_1$ each$_2$] [think that he, like [e_2 other]$_3$]
(111) a. *[they$_1$ each$_2$] [think that John and Mary$_2$ like [e_2 other],]
     b. *[they$_1$ each$_2$] [think that John$_2$ like [e_2 other],]
     c. *[they, each$_2$] [think that he$_2$ like [e_2 other]$_3$]

All of the cases in (110) are systematically excluded as violations of Principle A—since the embedded subject is contraindexed from the matrix subject, there is no local binder for the trace of each. Hence, we turn our attention to the structures in (111), all of which satisfy Principle A, since the traces are bound by their respective complement subjects. Now for this to be so, these latter phrases must each bear what we have called the distribution index of the matrix subject. But then (111a) and (111b) violate another clause of the binding theory, Principle C, which requires that the complement subjects, being R-expressions, be free, which patently they are not. (111c), on the other hand, is consistent with the binding theory, since the pronoun need only be free in its governing category, which indeed it is. Moreover, it is also presumably semantically coherent, because singular pronouns can certainly serve as bound variables, which, as we have seen, is the semantic function of a plural pronoun occurring in this position; see (67b). But in fact this structure is ruled out independently. Even though both singular and plural pronouns can be interpreted as singular bound variables, to do so they still must *syntactically agree* with their antecedents. Thus, (111c) is ill-formed for just the same reason as (112), even though it possesses a perfectly well-formed interpretation:

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[21] In discussing these cases, Higginbotham refers to antecedent clash as giving rise to what he calls a "flickering ambiguity." Higginbotham draws an analogy to anomalous figures discussed in the literature on visual perception. which are claimed to be anomalous precisely because the viewer is unable to decide between two conflicting interpretations. We find this analogy somewhat tenuous, since in the anomalous figures, neither interpretation of the figure is itself well-formed. But in the present case, according to Higginbotham's analysis, both interpretations are well-formed, yet antecedent clash gives rise to anomaly, rather than ambiguity, as Higginbotham himself points out. Moreover, why should it be that other cases of antecedent clash give rise to perfectly sensible results? Thus, for the sentence *John and Mary told each other that they should leave*, on the "you" reading the proximate antecedent of *they* is the reciprocal, and the evaluative antecedent is the matrix subject. yet this is a perfectly well-formed interpretation. It should be noted that Higginbotham argues that antecedent clash extends to reflexives. This is not expected under our analysis. However, to the extent that this effect exists, it is much less clear than in the case of reciprocals. Thus, *They saw each other hitting themselves* seems much better than (104), and, as well, gives a sharp contrast between reciprocal and reflexive: *They heard each other talking to *each other/themselves*. We tentatively conclude that such effects as exist with reflexives are to be handled by some other mechanism.

[22] (109a) is grammatical on an irrelevant "shon antecedent" interpretation, under which the embedded subject is the antecedent of the reciprocal and referentially disjoint from the matrix subject.

(112) ***They** each saw his mother.

The Specified Subject Condition effects thus follow in full.

To summarize, there is a wide range of evidence to support the view that reciprocals are assigned scope. Our view most closely follows that of Lebeaux (1983) in assuming the movement of just part of the reciprocal expression, although the proper analysis of narrow versus broad scope reciprocals is predicated upon the articulation of its interaction with types of anaphora. In particular, we have shown that this distinction correlates with coreference versus bound variable anaphora, and that it is properties of the latter that allow the broad scope of the reciprocal to be consistent with the binding theory.

5. Reciprocals and Control

Higginbotham (1980) provides yet another provocative observation regarding reciprocal constructions, this one pertaining to their interaction with control properties. He notes that (113) is unambiguous, in **contrast** to sentences like *They think they like each other:*

(113) They wanted to visit each other.

Higginbotham's claim is that control constructions are, in general, unambiguous, allowing only for a broad scope interpretation. That this is indeed the case for (113) is confirmed by the ungrammaticality of (114), which contains an additional distributor:

(114) *They each wanted to visit each other.

Higginbotham suggests that PRO simply cannot **be** an antecedent for a reciprocal; hence, there can never be any narrow readings in control constructions.

Here we would like to offer an account for Higginbotham's observation to the extent that it is correct. Note first that the observed effect is not entirely general. The examples in (115) are ambiguous between broad and narrow scope, and the examples in (116) have only a narrow interpretation—witness the deviance of the plausible paraphrase of (116a) on the broad reading as in (117):

(115) a.   They decided to keep each other's comments confidential.
      b.   They contracted to grant each other parking privileges.
(116) a.   They gathered to fight each other.
      b.   They met to talk to each other.
(117) *They each gathered to fight the other.

On our view the reason for this range of observations with control constructions turns on subtle interactions between inherent semantic properties of the controlling verb and properties of control PRO. The correct generalization, we believe, is the following: Narrow scope is excluded when the controlling NP must be under the scope of a distributor, as a function of the lexical meaning of the predicate of which it is an argument. When this predicate may (or must) be collective, then a narrow interpretation is possible (or necessary). PRO, when obligatorily controlled, strictly "inherits" the distributive1

collective property of its controller. To see this, consider first the analysis of **Higgin**botham's example (113), to which we can assign the following representations:

(118) a.   [they₁ **each₂**] wanted [PRO₂ to visit [*e*₂ other]₃]
      b.   *[they₁ *D*₂] wanted [[PRO₂ each,] to visit [*e*₃ other]₄]
      c.   *[they₁ *D*₂] wanted [[PRO₁ **each₃**] to visit [*e*₃ other]₄]

For reasons that should now be transparent, (118a) is perfectly well-formed and expresses the appropriate interpretation. But what of (118b)? Since *want* is intentional, it is, on its standard understanding, inherently distributing relative to its subject, which is consequently assigned a distribution index. Since this is an obligatory control structure, this index is assigned to PRO, which consequently is a bound variable ranging over atomic individuals. (118b) is therefore ruled out because a further distributor cannot apply to a PRO that already ranges over atomic individuals. (118c) is excluded because PRO has been coindexed with the group-denoting argument of D, instead of the whole [NP *D*], in violation of the obligatory control requirement.

Now what of where narrow scope *is* possible? By way of example, consider the narrow interpretation of (115b), *They contracted to grant each other parking privileges. Contract* is a predicate that allows either distributed or collective subjects; as we have seen, if it selects the former, then only broad scope of an embedded reciprocal is possible. On the other hand, if it selects a collective subject, narrow scope is possible; the account follows directly, given the representation in (119):

(119)   they, contracted [[PRO₁ **each₂**] to grant [*e*₂ other], parking privileges]

Since the matrix subject is collective, it bears only a range index. This is passed to PRO under obligatory control. *Each* then operates on PRO, with the derived complex phrase standing as the local binder of the trace of *each.* Thus, this structure is well-formed. Moreover, the analysis extends directly to the account of the examples in (116), which allow only narrow scope because they allow only collective subjects. It also accounts directly for the rather attenuated understanding of *They wanted to visit each other,* under which *they* denotes a group having a collective want, fit to a scenario in which John and Mary have somehow worked out a consensus between them in private and are now as a couple presenting their agreed-upon plans to an external addressee. To the extent to which this is a plausible construal, *want* takes a collective subject, and the reciprocal in turn can be understood to have narrow scope.

Plurality, reciprocity, and control therefore appear to interact in precisely the ways our theory predicts. The possibility of broad or narrow scope is a function of the semantic status of the controller of PRO. PRO itself behaves just as the pronominal does in the cases of scope discussed immediately above—thus, (119), in our terminology, is an instance of coreference anaphora, whereas (118a) is a case of bound variable anaphora. Therefore, PRO is subject to distribution depending on whether it is coindexed with a group-denoting NP itself or with a distributor on such an NP, where the occurrence of

the distribution is in turn determined by various aspects of the lexical semantics of the control verb.

6. Concluding Comment

Our goal in these investigations has been to employ reciprocal constructions as a probe to the syntactic and semantic fundamentals of plural nominal expressions. The property of nominals that we have taken as most fundamental is that they are *ambiguous* between distributive and collective construals and are not merely vague between these understandings. This basic semantic property of plurals corresponds, we have argued, to a syntactic ambiguity at Logical Form. Relative to this ambiguity we have called into question the assumption standard in most studies of plural anaphora that their binding properties can be identified with those of singular anaphors (and pronouns). Rather, we have shown that plural expressions are quite distinct in this regard, in ways that can be traced back to the structural properties that distinguish the representations of the distributive and collective construals. Our strategy throughout has been to explore in detail a theory of reciprocals that embodies these syntactic and semantic fundamentals of plurals, and to the extent that our theory achieves a depth of empirical explanation we will take them as justified.

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