Reconciling Dependent Plurals with *Each Other*

Alexis Dimitriadis
University of Pennsylvania

In this paper I discuss the interpretation of dependent plural pronouns (pronouns bound by a distributing definite antecedent), and argue that they should be treated as "donkey" pronouns involving restricted functions. Such pronouns have been central to the study of reciprocals, and I follow in the tradition of studying the interaction of the two.

Most analyses of the reciprocal allow it the option of finding its "range" argument through movement or binding to a non-local antecedent. I argue that such "long distance" reciprocals are insufficiently motivated, and cannot handle the full range of constructions involving dependent pronouns. I show that the proposed functional analysis of dependent pronouns makes it possible to account for "long distance" reciprocals without resorting to wide scope, by referring directly to the functional translation of their antecedent.

1. Introduction: The Scopal Analysis of the Reciprocal

I use the term *dependent plural pronoun* for pronouns that are interpreted as having a different value for each part of some non-quantificational, distributively interpreted antecedent. Sentence (1) has a reading, given in (1a), under which the content of John's belief is different from that of Mary's: the embedded subject can be understood as referring to the individual members of the matrix subject.

(1) John and Mary think *they* are sick.
   a. John thinks John is sick, and
      Mary thinks Mary is sick.
   b. John and Mary think that [John and Mary are sick].

The dependent reading of (1) can be expressed by treating the pronoun as a variable bound by a universal quantifier that ranges over the members of the set {John, Mary}. However, I argue that this is not the correct treatment; hence the descriptive label "dependent pronouns", which does not commit us to any particular analysis.

The interaction of dependent plural pronouns with reciprocals has been an important test of adequacy for treatments of either phenomenon. Sentence (2) has a reading (which I will, non-standardly, call the *dependent* reading) under which John thinks "I like Mary", and Mary thinks "I like John". This reading poses the following problem: the dependent pronoun *they* is most naturally represented as a bound variable, and is therefore semantically singular. But this pronoun is also the antecedent of the reciprocal *each other,* and it is well-known that reciprocals require a plural antecedent; thus the reciprocal is left in need of a plural antecedent.

Tanya Matthews and Devon Strolovitch (eds), *SALT IX*, 52-69, Ithaca, NY: Cornell University.

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

The standard solution is to have the reciprocal look for its antecedent (or at least for part of it) outside the embedded clause. This is the analysis adopted by Heim, Lasnik, and May (1991a,b), who claim that the reciprocal in (2) can be bound (non-locally) by a distributor adjoined to the matrix subject, *John and Mary.* (They call these *long distance* or *wide scope* reciprocals). The version of the analysis proposed in their (1991a) paper gives the following analysis to the dependent reading of (2):

(3) [John and Mary_1 each_2] think [that they_2 like [e_2 other]$_3$]
= John thinks "I like Mary", and Mary thinks "I like John".

In this representation, the *each* part of the reciprocal has raised to adjoin to the matrix subject; it is translated as universal quantification over the atomic parts of the plural individual *John and Mary,* and binds the pronoun $\textit{they}_2$ and the argument e_2 of the lower part of the reciprocal.[1]

In response to criticisms by Williams (1991), Heim et al. (1991b) propose a revised analysis in which the reciprocal, rather than raising, is bound in situ by an independently inserted covert distributor. (Even in the version of Heim et al. 1991a, distributors can be freely inserted as necessary). Although it is not clear that they actually embrace the revised proposal, and subsequent work is generally based on the original analysis, the revised proposal is easier to defend than the stronger original analysis and is also better suited to discussion of the issues addressed here; accordingly, I will base my discussion on the revised analysis. As Heim et al. point out, it shares the essential features of the original, movement analysis—including the claim that "long-distance" reciprocals involve binding of the reciprocal by a non-local antecedent. Under this proposal, representation (3) is replaced with (4).

(4) [[John and Mary]$_1$ D_2]$_2$ think that [they_2 like [each_2 other]$_3$]
= John thinks "we like each other", and Mary thinks the same.

The alternative reading of (2), which I will refer to as the *fixed* reading, says that John and Mary hold the same belief: "We like each other". In the analysis of Heim et al. (1991b), the two readings are differentiated depending on the location of the binder of *each.* The fixed reading is given the analysis in (5), and hence is often referred to as the "narrow scope" reading. (The higher distributor D expresses the fact that John and Mary each think their own thoughts).

(5) [[John and Mary]$_1$ D] think that [[they_1 D_2]$_2$ like [each_2 other]$_3$]

Covert distributors are freely inserted at LF as necessary. The distributor (and raised *each,* in the original analysis) introduces universal quantification over the members of the set it adjoins to. In the following, φ is a proposition containing the movement trace t_j (left after quantifier-raising the matrix subject [NP_i D_j]$_j$), which is interpreted as the variable x_j:

(6) [NP_i D_j] φ: $\forall x_j(x_j \cdot\Pi \mathrm{NP}_i)\ \varphi$

The symbol $\cdot\Pi$ denotes the *proper-atomic-part-of* relation; its definition guarantees that the distributor cannot be applied to a singular NP. The *each* part of the reciprocal is bound by the distributor, and interpreted as the variable x_j. The reciprocal itself is an operator that raises to adjoin to VP; it introduces a second universal quantifier, which binds a variable in ζ (the movement trace t_k of the reciprocal).

(7) [each_j other]$_k$ ζ: $\lambda y.\forall x_k(x_k \cdot\Pi x_i \,\&\, x_k \neq x_j)\zeta'(y)$

The variable x_i (which is not bound, but is coindexed with the syntactic antecedent of the reciprocal) is the *range argument* of the reciprocal; it provides the set of entities that the reciprocal ranges over. Formula (7) quantifies over those atomic parts of x_i that are distinct from x_j; the latter is bound by the distributive quantifier D_j (and coincides with y when the reciprocal's antecedent is the subject). The variable x_j is called the *contrast argument* of the reciprocal.

The range argument is represented as a free variable, but there is no arbitrariness to its value: It must represent the set over which the contrast argument ranges. Accordingly, Heim et al. (1991a:fn. 3) stipulate that "once the contrast index is determined, the choice of the range index is fixed as well: it is always the index of the sister of the contrast set." This system translates sentence (8a) as in (b).

(8) a. The children like each other.
b. $\forall x_j(x_j \cdot\Pi \mathrm{children}')\forall x_k(x_k \cdot\Pi \mathrm{children}' \,\&\, x_k \neq x_j)\ \mathrm{like}(x_j, x_k)$

Both versions of the Heim et al. analysis assign to reciprocals the semantics of *strong reciprocity* (every element must be related to every other element), which they admit is an oversimplification. (In the two-person examples they consider, strong and weak reciprocity give the same truth conditions). Since their analysis has been the point of departure for so many other treatments, I use it as the basis for my discussion and ignore issues of distributivity type (but see section 7).

1.1. *The Scope of the Wide Scope Analysis*

The indisputable benefit of the scopal analysis of reciprocals, as already noted, is that it provides the required plural antecedent for the reciprocal. Most subsequent treatments, whether they treat distributivity as a property of NPs or (like Sternefeld 1998) as a property of VPs, rely on a similar scope asymmetry in order to provide the reciprocal with a plural contrast argument under the dependent reading.

But such wide scope, if it exists, is not as productive as one might hope: the reciprocal cannot be bound by just any quantifier, or even by all distributors. If, for example, the reciprocal in (9) could take wide scope, that sentence would have the reading shown in (10). But this reading is not possible; it would say that John thinks the boys like Mary, and Mary thinks the boys like John.

(9) John and Mary think that the boys like each other.

(10) a. *[[John and Mary]$_1$ D_2] think that [[the boys]$_3$ D_4] like each$_2$ other.
b. $\forall x_2(x_2 \cdot \Pi \text{ john} \oplus \text{mary}')$ think$(x_2, \hat{}[\forall x_4(x_4 \cdot \Pi \text{ boys}')\forall x_k(x_k \cdot \Pi \text{ john} \oplus \text{mary}' \,\&\, x_k \neq x_2)$ like$(x_4, x_k)])$

Heim et al. rule out such constructions by requiring the *each* part of the reciprocal to be A-bound in its minimal governing category; since the only available A-binder, *the boys,* is not coindexed with D_2, the wide scope configuration is ruled out. While not a problem for their theory, the non-existence of such readings means that the wide scope of reciprocals is only utilized when the remote distributor ranges over the same values as the local antecedent; and this makes the reality of long distance reciprocals hard to verify unequivocally.

The original analysis of Heim et al. claimed that the *each* part of the reciprocal underwent covert movement, and therefore led to testable predictions in the case of long distance reciprocals. But since the revised theory does not involve movement of *each* out of the clause, it can only be supported by interpretive evidence. (Williams (1991) gives evidence against a movement analysis for *each*).

In addition to being underutilized, so to speak, long-distance reciprocal binding is also too limited to account for the full range of constructions involving reciprocals. In section 3, I discuss dependent reciprocal constructions in which a suitable antecedent for the reciprocal is unavailable at any distance; I will propose a way to derive the reciprocal's interpretation directly from the local antecedent.

The wide scope analysis of reciprocals was motivated by the existence of constructions where the antecedent of a reciprocal was a dependent pronoun; if we treat the pronoun as a bound variable, it is inevitable that the reciprocal must look further for its range argument. Before we go on to examine the problems that the wide scope analysis runs into, it is worth checking whether it is really necessary. The following section considers, and discards, the alternative of treating dependent pronouns as plural, cumulatively-interpreted referential expressions.

2. Are Dependent Pronouns Real?

We accept sentence (11a) as having a sense in which it is true in a situation where each man kissed only one baby, his own. One way to derive this reading is to give it a *cumulative* interpretation (cf. Scha 1984), which requires that every man kissed at least one baby and that every baby was kissed by at least one man, but nothing more; clearly these conditions are satisfied if every man kissed his own baby (or babies). Why not, then, apply the same analysis to sentence (11b), and even (c)?

(11) a. The men kissed the babies.
b. The men kissed their babies.
c. The men urged their babies to play with each other.

Although the cumulative analysis is appropriate for some constructions, it is generally acknowledged that others, particularly those involving pronouns, involve

a pairing of the members of one NP with those of another that is more structured than the cumulative analysis can account for; this must be considered a distinct reading. (See Heim et al. (1991a) and Schwarzschild (1996) for some discussion).

We begin by considering the readings of sentence (1), repeated here as (12).

(12) John and Mary think they are sick.

As Heim et al. (1991a) show, the cumulative analysis is too permissive. It would allow (12) to describe any one of the following states of affairs:

(13) a. John thinks John and Mary are sick, and Mary thinks the same.
b. John thinks John is sick, and Mary thinks Mary is sick.
c. *John thinks Mary is sick, and Mary thinks John is sick.
d. *John thinks John is sick, and Mary thinks John and Mary are sick.
e. *John thinks Mary is sick, and Mary thinks John and Mary are sick.
f. *John thinks Mary is sick, and Mary thinks Mary is sick.

Heim et al. (1991a) note that only the first two of these readings are possible: The "fixed" reading (a), and the bound-like "dependent" reading (b). The "crossed" reading (c) is impossible, as are the mixed readings (d) and (e). Reading (f) is ruled out by any analysis that explicitly appeals to cumulativity: the sum of all referents for the interpretation of *they* in (f) is just *Mary,* which is not equal to the entire presumed antecedent, *John and Mary.* But the unavailability of readings (c)–(e) is not predicted by the cumulative analysis.

It must be acknowledged at this point that it is not completely impossible to accept (12) as a description of one of the states of affairs (c) through (e), given some goodwill and some practice with such examples: After all, they all fall under the cumulative reading of (12), which says that John and Mary, between them, hold beliefs about the group of people consisting of John and Mary. However, it should be plain that the status of these readings is very different from the status of (a) and (b). At any rate the difference in acceptability between the dependent reading (b) and the crossed reading (c) cannot be predicted by any true cumulative analysis.

2.1. *The Fixed Reading*

So far we have considered only interpretations of (12) in which the pronoun refers to one or more of John and Mary. In addition to the readings given in (13), let us now consider the following possibilities:

(12) John and Mary think they are sick.
(14) a. John and Mary think that [the Spice Girls are sick].
b. John and Mary think that [Mary and Margaret are sick].
c. *John thinks Bill is sick, and Mary thinks Margaret is sick.
d. *John thinks John is sick, and Mary thinks the Spice Girls are sick.

Interpretations (a) and (b) are easily available, provided only that the prior context has established the desired referent for *they* as a possible pronominal antecedent. For example, the following context firmly establishes interpretation (a):

(15) The Spice Girls haven't toured recently.
John and Mary think *they* are sick.

The well-formed interpretations have in common the property that John and Mary believe the same proposition. Interpretations (c) and (d), on the other hand, require John and Mary to believe different propositions, and are impossible or at least much harder to get: The only well-formed reading in which John and Mary believe different propositions is the dependent reading (13b). Note that this effect is independent of whether John, Mary or both are properly included in the antecedent of *they;* hence I will refer to any reading where all elements of the subject believe the same proposition as a *fixed* reading, regardless of whether or not the subject of the embedded clause matches the subject of the matrix clause.

2.2. *The Importance of Being a Pronoun*

Consider also the following sentences, given the background that Street and Weinberg ran against each other in an election that can only have one winner.[2] (We switch to these examples because the sentence *John and Mary think that John and Mary are sick* incurs a Principle C violation).

(16) a. The people who voted for Street and Weinberg thought that they would win the election.
b. The people who voted for Street and Weinberg thought that Street and Weinberg would win the election.

Sentence (16a) is ambiguous: It allows the (unrealistic) fixed reading, in which each voter expected *both* candidates to win; and it allows the plausible, dependent reading under which every voter expected the candidate they voted for to win the election. But sentence (16b) only allows the fixed reading, contrary to what a cumulative analysis would predict: Since the pronoun is assumed to take *Street and Weinberg* as its antecedent, the two sentences should have identical readings.

Sentence (16a) is of particular interest because the dependent pronoun is not c-commanded by its antecedent (which is trapped in a relative clause, a scope island). Since this pronoun cannot be straightforwardly interpreted as a bound variable, a cumulative analysis would be particularly welcome—had it been supported by the data.

Consider also what a true cumulative reading would mean in this case: It would merely say that each of Street and Weinberg's supporters expected one of the two of them to win the election, but nothing more specific; there might be some optimistic and some pessimistic supporters in both camps, as long as *someone* expected each one of them to win. Supposing that Street and Weinberg had been the only candidates in that election, (16a) should be paraphrasable as

(17) The people who voted for Street and Weinberg thought that someone would win the election.

It should be clear that sentence (16a) says a lot more than that. The dependent reading of such sentences depends on interpreting the embedded pronoun as if it is a variable bound by a higher quantifier ranging over the members of its antecedent NP; and this mechanism is specific to pronouns, since a full NP in place of the pronoun (as in example (16b)) cannot receive the same interpretation.

I used the hedge "as if it is" in the previous paragraph because the structural configuration of (16a) prohibits binding of the pronoun by its intended antecedent. The next section shows that such constructions can also have dependent reciprocal readings, posing a serious challenge to the scopal analysis of reciprocals as well as to a straightforward binding analysis of dependent pronouns. In section 4, I propose treating dependent pronouns as "donkey pronouns" containing a function-denoting variable, in the style of Engdahl's (1986) adaptation of Cooper (1979).

3. Distributing Without C-Command

My claim that sentences like (16a) can have a dependent reading is at odds with the findings of earlier studies, including Heim et al. (1991a,b) and Williams (1986, 1991), who conclude that dependent pronouns cannot find their antecedent inside a relative clause. Such conclusions appear to have been based on incomplete evidence, as we will see by reconsidering some of their examples.

Sentence (18a) has several readings (Heim et al. (1991a) count five), including the dependent reading, which says that John thinks he will win $100 and Mary thinks *she* will win $100. Sentence (b) lacks the dependent reading, suggesting that it requires c-command between the pronoun and its antecedent. These findings carry over to reciprocal sentences, which impose the same conditions on the dependent "long distance reciprocal" (i.e., dependent) reading. Thus example (19a) allows the dependent reading, and (19a) forbids it.

(18) a. John and Mary think they will win $100.
b. The student John and Mary taught argued that they will win $100.

(19) a. John and Mary think they are taller than each other.
b. The guy who saw John and Mary thinks they are taller than each other.

On the other hand, sentence (20a) is known to license the dependent reading. Heim et al. (1991a:90) conclude that the possessive pronoun, along with an adjoined distributor, undergoes QR to adjoin to the containing NP, from where the possessive-distributor complex c-commands the reciprocal, giving the structure in (b).[3]

(20) a. Their coaches think they are faster than each other.
b. [$_{NP}$[their$_1$ D$_2$] [*e* coaches]] [think they$_2$ are-faster-than [each$_2$ other]]

The contrast between (19b), which does not allow the dependent reading, and (20a), which does, is thus attributed to whether or not the intended antecedent of the dependent pronoun appears inside a scope island. However, this conclusion appears to be an artifact of the examples studied. The problem with (19b), it turns out, is simply that there is a single guy, who necessarily argued a single, irrational thing: that John and Mary are taller than each other. In other words the matrix predicate has a singular subject, and so its complement can only be asserted once. The missing reading of (18b) is immediately recovered if we substitute a plural number of students as in (21a); similarly (if with some more difficulty), as we go from (19b) to (21b). Conversely, sentence (20a) loses the dependent reading if we substitute a singular subject, as in (21c).

(21) a. The students John and Mary taught think they will win $100.
b. The guys who saw John and Mary think they are taller than each other.
c. Their coach thinks they are faster than each other.

Let us look more closely at the conditions that determine the acceptability of the dependent reading. The dependent reading of sentence (21b) requires that John and Mary were each seen by a different guy (or guys), and that the guy who saw each one thinks that he or she is the taller of the two. The reading depends on our grasp of the one to one match between the guys and John and Mary, and consequently it is much easier to "get" such constructions when a natural one-to-one relationship between definite sets is involved. For example, the dependent reading of (22a) is just as easy to get as that of (20a). Sentence (22b), another example from Williams (1986:281), lacks the dependent reading because its subject is indefinite, and thus cannot set up a definite mapping between the referent of *them* and a unique set of people who know them. (In other words, it does not have a unique *witness set*).

(22) a. The coaches that trained them think they are faster than each other.
b. People that know them say they like each other.

The dependent readings of such sentences cannot be expressed under the scopal analysis of reciprocals. Heim et al. predict that the dependent reading of (22a) is impossible, since the local antecedent of the reciprocal is not coindexed with its remote binder; even if this condition could be suitably relaxed (to remove it entirely would drastically overgenerate), binding of the reciprocal by the matrix distributor in (22a) would give reciprocation over coaches, not over trainees. The problem is that the range argument of the reciprocal should always match the possible values of its *local* antecedent, but the scopal account uses the range of the remote antecedent instead.

4. Toward an Analysis of Dependent Pronouns

In sentence (23) there is no antecedent that could bind the pronoun *them* as a bound variable; the intended antecedent is buried in the relative clause. Since the depen-

dent reading is nevertheless available and we have ruled out the cumulative option, our conclusion must be that either the intended antecedent of the reciprocal is somehow able to bind outside the relative clause, or the pronoun is not directly bound by the NP *Street and Weinberg,* but by something else.

(23) The voters who support Street and Weinberg hope they will win.

The first alternative brings to mind Sharvit's (to appear) analysis of "functional relative clauses," which contain a quantifier that appears to bind a pronoun outside the relative clause. In Sharvit's analysis of such sentences, the referential index of a quantificational NP can in effect escape the relative clause through absorption into the relative clause operator. But the functional relative clauses she discusses have grammaticality conditions very different from those of the dependent constructions with relative clauses: English does not easily allow functional relative clauses in non-identity sentences; functional relative clauses may have singular heads, while as we saw in section 3, the dependent reading requires relative clauses with plural head nouns; finally, the functional reading of quantificational relative clauses is sensitive to the syntactic position of the quantifier, while dependent pronouns can take their antecedent from any position inside a relative clause (cf. example (23)).

These differences mean that we cannot extend Sharvit's analysis to relative clauses with definite embedded NPs; the resulting theory would not be able to predict the distributional differences between the readings involving functional relative clauses with embedded quantifiers and those with embedded definites.

4.1. *Dependent Pronouns as Donkey Pronouns*

Engdahl (1986) adapted Cooper's (1979) treatment of donkey pronouns into a functional form, and eliminated the Russellian assertion of uniqueness that was part of Cooper's representation. Her translation is as follows:

(24) $\lambda P.P(\Phi)$,
where Φ is a variable ranging over function expressions; e.g., Φ might be $W(u)$, the function giving u's donkey.

The function in Φ may be of any arity, including zero (in which case it just denotes an individual). To handle the pronoun *it* in (25), we can let $\Phi = W(u)$, where W is a free variable of type <e, e> and u is a free variable over individuals (destined to be bound by the universal quantifier ranging over *every man who owns a donkey).* The context may then supply a value for W such that $W(x)$ is x's donkey.

(25) Every man who owns a donkey beats *it.*

We can adopt the same analysis for dependent pronouns: In a sentence like (21a), repeated below as (26), the pronoun *they* is not bound by *John and Mary* but

denotes the expression $\lambda P.P(S(u))$, where S is a function that maps every student taught by John or Mary to the person in the set {John, Mary} who taught him or her. (Note that the dependent reading of (26) presupposes that John and Mary taught distinct sets of students; if there is overlap, our intuitions about the meaning of (26) get confused). Sentence (26) then translates as (27), which says roughly that each of the students taught by John and Mary thinks that the person that taught them will win $100.

(26) The students John and Mary taught think they will win $100.
(27) $\forall x \cdot \Pi \{y : y \text{ a student that John or Mary taught}\}$ think$(x, \hat{}[\text{win-\$100}(S(x))])$

Simple cases of dependent pronouns can be translated as the identity function, or simply as bound variables.

5. Split Dependent Plurals

The analysis of dependent pronouns in terms of functions is further supported by the fact that dependent pronouns can have split antecedents, so that (28) has reading (28a).

(28) John and Mary told Harry that *they* are rich.
  a. John told Harry that John and Harry are rich, *and* ...
     Mary told Harry that Mary and Harry are rich.
  b. John told Harry that John is rich, *and* ...
     Mary told Harry that Mary is rich.

Actually sentence (28) allows two different dependent readings, the *split dependent* reading (28a) and the *singular dependent* reading (28b). And once again, there is also a multitude of fixed readings, which I group together: Perhaps John and Mary told Harry that *John and Mary* are rich, or that the Rockefellers are rich, etc. Whether they involve third parties or just the participants of this sentence, all these other readings have the property that John and Mary said the same thing.

Interpretations (28a,b) are the only possible dependent readings of sentence (28); there is no "crossed" reading where John told Harry that Mary is rich, and Mary told Harry that *John* is rich (as in (29a)). There are also no readings mixed between split and singular dependence, as in (29b), or between "fixed" and dependent readings, as in (29c). In other words, the interpretation of *they* is determined only once per construal, proving that we are dealing with genuine ambiguity, not vagueness.

(29) a. *John told Harry that Mary is rich, *and* ...
     Mary told Harry that John is rich.
  b. *John told Harry that John and Harry are rich, *and* ... (split + singular)
     Mary told Harry that Mary is rich.

c. * John told Harry that John is rich, *and* ... (dependent +
Mary told Harry that the Rockefellers are rich. "fixed")

We now have the following classification of licit readings: "fixed" readings that could refer to anything, as long as all speakers state the same proposition; a "singular dependent" reading, in which the dependent pronoun is identified with each speaker separately; and a "split dependent" reading, in which the dependent pronoun refers to one speaker plus some other, fixed argument of the sentence.

Since ordinary split anaphora has been described in terms of assigning multiple indices to the pronoun (see Higginbotham 1981), we might consider treating split dependent pronouns in the same way, assigning them one referential and one bound index. However, it appears that the fixed readings enjoy much greater freedom for antecedent selection than does the fixed part of the split dependent reading. As we have seen, a fixed-reading pronoun can easily be understood as referring to individuals mentioned earlier. But for some reason, the fixed part of split dependent pronouns appears to be restricted to individuals in the current sentence, as in example (28). Even in the presence of suitable prior context, it seems difficult, if not impossible, to include a discourse-supplied entity:

(30) Jane is hard to get along with. John and Mary said that they disagreed over trivial things. =
?? John said that he and Jane disagreed, *and* ...
Mary said that she and Jane disagreed.

In any case it seems safe to say that such readings, if possible, are not nearly as easy to obtain as non-dependent reference to a third party.

We can then represent a split dependent pronoun as a function that takes any individual x to the complex individual consisting of x plus some other, fixed individual. While singular dependent pronouns can receive functional translations (including the identity function) in the style of Engdahl (1986), the fixed readings should be represented (or at least representable) as referential expressions, *not* as the constant function; otherwise they would be expected to obey the same restrictions that the fixed part of dependent pronouns obeys.

Finally, note that there is at least one way that a split dependent pronoun can pick out an individual from outside the sentence. In the following example (called to my attention by an anonymous reviewer), there is a split dependent mapping from women to women plus their husbands.

(31) a. Q: What did the women tell you about themselves and their husbands?
A: They told me that they are rich.
$f(x) = \lambda x\ x \oplus$ husband-of-(x)

Here the non-identity part of the function is not referential, but another function; hence our generalization about the fixed part of split dependent pronouns is not violated. We do need to add this type to our inventory of dependent pronoun functions, which we can now summarize as follows:

(32) 1. Fixed:
they = <any *fixed* group>

2. Dependent:

(a) Singular (identity map): they = $x \rightarrow x$

(b) Split-antecedent: they = $x \rightarrow (x \oplus \text{Harry})$

(c) Split-antecedent (functional): they = $x \rightarrow (x \oplus f(x))$

5.1. *Interaction with Reciprocals*

Since split dependent pronouns pick out a series of plural individuals, there are two ways that they could function as antecedents of reciprocals. Sentence (33a) has a reading given in (b), in which each man urges mutual support between himself and Mary. (The pronoun represents the function $\lambda x.\, x \oplus \text{Mary}$). Although this should be classified as a dependent reading, its analysis under the system of Heim et al. need not involve a wide scope reciprocal, but would be as given in (c). Here we have two distributors, one within the scope of the other. The embedded distributor D_j ranges over whatever each value of *they* refers to; the reciprocal must be bound by the embedded distributor, mapping, for example, Tom to Mary and Mary to Tom when *they* refers to Tom and Mary.

(33) a. Tom, Dick and Harry told Mary that *they* should support each other.

b. Tom told Mary that $\text{they}_{t,m}$ should support $\text{each other}_{m,t}$.
Dick told Mary that $\text{they}_{d,m}$ should support $\text{each other}_{m,d}$.
Harry told Mary that $\text{they}_{h,m}$ should support $\text{each other}_{m,h}$.

c. [(T,D&H) D_i] told Mary that [they_i D_j] should support [each_j other]

Sentence (33a) can also have the singular (non-split) dependent reading, in which *they* refers in turn to Tom, Dick and Harry alone, and reciprocation is among them only; and of course any number of "fixed" readings, under which Tom, Dick and Harry have stated the same proposition about mutual support by some group of people (for example, that the Rockefellers should support each other). But reading (33b) is the *only* way the reciprocal can be interpreted when the pronoun has the split-dependent reading. If the reciprocal could take wide scope here, it would be bound by the matrix distributor, giving the following structure:

(34) a. [(T,D&H) D_i] told Mary that they_i should support [each_i other].

b. $\forall x_i \in \{T, D, H\}\ \forall x_j (x_j \in \{T, D, H\}\ \&\ x_j \neq x_i)$ [x_i told Mary that $x_i \oplus$ Mary should support x_j]

This structure does not correspond to an actual reading: it says, among other things, that Tom told Mary that Tom and Mary should support Dick.

Since the pronoun does not denote the identity function, the theory of Heim et al. predicts that the missing reading should be impossible. But given that we have seen dependent readings with other dependent pronouns that were translated via

non-identity functions like $\lambda x.$*teacher-of*(x), we might expect a dependent reading under which the reciprocal matches each pair of the form $x \oplus$ Mary to some other pair or pairs of the same form:

(35) Tom told Mary that Tom and Mary should support Dick and Mary (also, Harry and Mary), etc.

Why is this reading not possible, then? One possibility is that the reciprocal must be construed with the closest available distributor, which in this case is the embedded distributor. Alternately, the reason may be that the sets over which *they* ranges are not disjoint, but have *Mary* in common: Tom⊕Mary, Dick⊕Mary, Harry⊕Mary. If the reciprocal operator is in fact required to match individuals that have no part in common, reading (35) would be ruled out, since no licit reciprocation is possible.

Although the legitimate readings of example (36) are far from clear, it is predicted by this analysis to have a "wide scope" dependent reading, where each woman said that she and her husband are richer than the other couple in question. To the extent that this reading exists (and several of my consultants accepted it), it seems to treat being rich as a collective property of the husband and wife teams; thus there is only one distributor, and both of the conditions hypothesized about are satisfied: there is no overlap between the values of *they,* and there is only one distributor, the matrix one.

(36) Q: What did the women tell you about themselves and their husbands?
A: They told me that *they* are richer than each other.
$f(x) = \lambda x.\, x \oplus$ husband-of-(x)

6. Toward a Scopeless Analysis of Reciprocals

As it stands, the scopal approach to reciprocals cannot account for dependent readings in which the dependent pronoun corresponds to a function other than the identity: it predicts, wrongly, that the range and contrast arguments would match the long-distance binder, not the dependent pronoun. Having adopted a functional analysis for the dependent expressions, we could address the issue of reciprocals by internally applying the pronoun's reference function to the (non-local) range and contrast arguments of the reciprocal, and keeping the long-distance binding relationships as they are. This move would add another unbound variable to the translation of the reciprocal (recall that the range argument is a free variable), this one based on the local binder. But once we have given ourselves access to the pronoun's reference function, a simpler alternative is possible: we can drop all reference to the long-distance binder, and let the range argument of the reciprocal be the range of the reference function. For concreteness, I base the discussion in this section on the analysis of Heim et al. (1991b); similar adjustments can be made to more recent scopal treatments.

6.1. *Dependent Pronouns as Restricted Anaphoric Functions*

This discussion assumes the plural semantics of Link (1983). (See also note 1). I use a number of definitions from the same work: The relation $x \Pi y$ stands for "x is part of y", $*P$ is the closure of P under the sum operation, and σ is a maximality operator:

(37) $\sigma x P x = \iota x(*P x \,\&\, \forall y(*P y \rightarrow y \,\Pi\, x))$

Reciprocal interpretation requires access to the range of the dependent pronoun function; I make the dependence explicit by amending the functional representation of pronouns to use *restricted* anaphoric functions:

(38) $r = \lambda x.\iota z(x \,\Pi\, \text{ANT} \,\&\, z = W(x))$

Here ANT (for *antecedent*) is an open variable, the plural individual that constitutes the domain of r. The function $W(x)$ is some (unrestricted) reference function of the type considered until now (that is, the version used by Engdahl 1986). For example, the split dependent pronoun in (39a) would correspond to the function given in (b):

(39) a. John and Mary told Harry that *they* are neighbors.
b. $\lambda x.\iota z(x \,\Pi\, \text{John} \oplus \text{Mary} \,\&\, z = x \oplus \text{Harry})$

The domain and range of a restricted function r can then be retrieved by application of the maximality operator:

(40) a. $\sigma y(\exists z\, r(y) = z)$ = The maximal y in the domain of r
b. $\sigma y(\exists z\, r(z) = y)$ = The maximal y in the range of r

Expression (40a) simply recovers the domain restrictor ANT. It denotes a (possibly) plural individual d with the property that any individual in the domain of r is a part of d; this is not, strictly speaking, the domain of the function r (which is a *set* of possibly overlapping individuals), but is sufficient for our purposes. I will refer to formula (40a) as the *domain sum* of r, and abbreviate it DS(r).

When ANT is non-atomic, these expressions only make sense if the function term $W(x)$ is defined in terms of predicates that are closed for sums—in particular, of plural predicates.[4] For example, $\lambda x.\iota y$*mother-of$(x)(y)$ (the functional translation of *their mothers)* has a maximum argument, the sum of all individuals in its domain, but $\lambda x.\iota y$ mother-of$(x)(y)$ does not. It follows that while dependent pronouns can appear in singular NPs such as *their mother,* we cannot compute their domain or range.

This suggests an explanation for the requirement that reciprocal antecedents must be headed by plural nouns, as shown by the contrast between (41a/b), although this is not a requirement of dependent readings in general (as shown by the grammaticality of (c)).

(41) a. John and Bill want their clients to sue each other.
b. *John and Bill want their client to sue each other.
c. John and Bill want their wife to be proud of them.

To make the restricted function available to the reciprocal, we need to modify the representation of the pronoun in LF. In Engdahl's (1986) formulation, the pronoun is a free variable that may have a functional translation such as $S(u)$, where u is a variable bound by a higher quantifier. We replace this with the bipartite structure [R u], where R is a free variable interpreted as a restricted reference function. After functional application, the value of the pair is $R(u)$. (Which, I assume, can freely type-raise to $\lambda P.P(R(u))$).

We can take pronouns to carry an inner (referential) and an outer (binding) index, as suggested by Heim (1993), and identify the inner index with the reference function and the outer index with the variable u.

I assume that we can always derive a restricted reference function from a referential NP by restricting the identity function to the subparts of that NP. Of course if it denotes an atomic individual, the range of the function will have only one element and no reciprocation will be possible.

6.2. *A Revised Semantics for Reciprocals*

We can now define a reciprocal operator that takes as its range argument the reference function corresponding to its antecedent; we let the contrast argument be the dependent antecedent itself. Heim et al. treat the reciprocal as a VP operator that adds a universal quantifier with scope over the VP; its translation was given earlier as (7), and repeated here. (Recall that x_k occurs in ζ as the translation of the movement trace of the reciprocal). Given our definition of dependent pronouns, we can rewrite (7) as (42), eliminating non-local binding of the reciprocal without loss of coverage.

(7) [each$_j$ other]$_k$ ζ: $\lambda y.\forall x_k(x_k \cdot\Pi\, x_i \,\&\, x_k \neq x_j)\zeta'(y)$
(42) [each$_j$ other]$_k$ ζ: $\lambda y.\forall x_k(\exists w \cdot\Pi\, \mathrm{DS}(r) \,\&\, x_k = r(w) \,\&\, x_k \wedge x_j = 0))\zeta'(y)$

"$\wedge$" is the meet operation on the semilattice of individuals (i.e., z, x must have no part in common). The revised distinctness condition is necessary since we wish to allow evaluation over non-atomic individuals. (Heim et al. only consider distribution over atomic individuals, two of which are non-overlapping if and only if they are distinct).

Where does r come from? It is a free variable that is constrained to match the antecedent's restricted reference function. In the system of Heim et al., the contrast argument of the reciprocal is provided through binding by a distributor, and the range is a free variable that must be coindexed with the sister of the contrast argument's binder (Heim et al. 1991a:fn. 3). In the proposed bipartite representation, $\lambda x.r(x)$ appears in the right place—the same position that the domain of a distributor appears under the independent reading. Compare the constituent structure of the independent reading in (a) with that of the dependent reading in (b):

(43) a. [[John and Mary]$_1$ D_4]$_4$ think [they$_1$ D_2]$_2$ like [each$_2$ other]$_3$
= John and Mary think that [John and Mary like each other].
b. [[John and Mary]$_1$ D_2]$_2$ think [$\lambda x r(x)_1$ u_2]$_2$ like [each$_2$ other]$_3$
= John thinks John likes Mary, Mary thinks Mary likes John.

After the reciprocal is quantifier-raised, (43b) translates as in (44), where *they*$_2$ is [$\lambda x.r(x)$ x_2], i.e., translates as $r(x_2)$ after functional application. Here r is the restricted identity function, so that DS(r) is j⊕m and $r(x_2)$ is just x_2.

(44) $\forall x_2(x_2 \cdot \Pi\, j \oplus m)$ think(x_2,
$\hat{}[\forall x_3(\exists w \cdot \Pi\, DS(r)\ \&\ x_3 = r(w)\ \&\ x_3 \wedge r(x_2) = 0)$ like($r(x_2), x_3$)]

In the dependent reading of example (45), r maps lawyers to their clients; $r(x_2)$ is x_2's client, and the reciprocal matches each client to all clients disjoint from him or her, as it should.

(45) The lawyers that represent John and Mary advised them to sue each other.

Since the function r that the reciprocal uses is not passed as an argument, one could imagine passing to the reciprocal a function that has a larger domain than its antecedent. In essence, this is a weakness that this account shares with that of Heim et al., who need to stipulate that the range argument of the reciprocal is coindexed with the sister of the reciprocal's binder (the NP to which the binder-distributor adjoined). Correspondingly, I assume that requiring r to be the *antecedent's* reference function ensures the proper choice of reference function. One can imagine a rule that coindexes the free variable representing the reference function in the reciprocal and in its antecedent, forcing variable interpretation to assign them the same value.

7. Conclusions

The approach to reciprocals presented in the last section is little more than an outline. For concreteness, I have based my discussion on the analysis of Heim et al. (1991b), and have not attempted to address any shortcomings of their account that are orthogonal to the issue of reciprocal scope. In particular, the resulting semantics for reciprocals follow Heim et al. in improperly requiring strong distributivity. More recent treatments, such as those of Sternefeld (1998) and Schwarzschild (1996), do better at capturing the nature of reciprocation; but while their treatments of dependent reciprocals differ, they share the shortcoming of the Heim et al. analysis: The range of the reciprocal is incorrectly predicted to match the long-distance binder, not the local antecedent. Mutatis mutandis, the analysis presented here can be straightforwardly combined with the more sophisticated scopal accounts.

We now come to the limitations of my own part of the proposal. The mechanism described here expresses, in a limited way, the dual function of dependent

reciprocal antecedents as singular bound variables and as the set-denoting range argument of the reciprocal. The proposed analysis relies on contextually determined free variables, which are harder to constrain that the strict Principle A behavior of reciprocals would have us wish for. A more direct approach is possible in a framework like Jacobson's (1999) *variable-free semantics,* in which all pronouns are represented as functions that combine with predicates through Function Composition. In such a system it is straightforward for the reciprocal to directly access the restricted function represented by the dependent pronoun, eliminating the need for an unbound variable. Because of the extensive differences between Jacobson's system (which assumes Categorial Grammar) and the present framework, I must defer discussion of this approach to future work.

Endnotes

* I wish to thank Anthony Kroch and Maribel Romero for extensive discussions that have been absolutely essential to the research presented here. I am also grateful to Robin Clark, Yael Sharvit, Amanda Seidl, and an anonymous SALT-9 reviewer for important contributions to the form and content of this paper; and to more people than I could name here, for their assistance with grammaticality judgments.

1. I follow Heim et al. in assuming the plural semantics of Link (1983): Plural "individuals" are lattice sums corresponding to sets of individuals, with no internal structure. What Schwarzschild (1992) calls the "union semantics of plurals", in which plural individuals are sets of atomic individuals (again with no "group" structure), is a set-theoretic adaptation of Link's model. I follow the informal practice of treating the two representations as notational variants; John⊕Mary is the same as the set, or plural individual, {John, Mary}. (In the set framework, an atomic individual is identified with the singleton set containing just that individual).

2. I am grateful to Anthony Kroch for bringing contrasts like (16a/b) to my attention.

3. In the original Heim et al. (1991a) account, the distributor is the *each* part of the reciprocal; after QR, the complex c-commands the movement trace of *each.* Here and elsewhere, I have incorporated the adjustments proposed in Heim et al. 1991b to the discussion of their analysis.

4. This discussion assumes that ANT is a referential expression of type <e>. To adapt the formulas in (40) to quantificational NPs, we would need (along with the necessary type adjustments) some way of fixing a unique *witness set.* (See Chierchia (1993), Sharvit (to appear) on using unique witness sets as function domains). If quantifiers without a unique minimal witness set are ruled out, we might have an explanation for the absence of the dependent reading in the sentence "People that know them think they like each other" (example (22b) in the text, from Williams 1986:218).

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619 Williams Hall
University of Pennsylvania
Philadelphia, PA 19104–6305
alexis@ling.upenn.edu