Distributivity in reciprocal sentences

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Abstract. In virtually every semantic account of reciprocity it is assumed that reciprocal sentences are distributive. However, it turns out that the distributivity must be of very local nature since it shows no effect on the predicate or other arguments in reciprocal sentences. I present a semantic analysis of reciprocals that treats reciprocal sentences as distributive but captures the local nature of distributivity.

1 Introduction

Two meaning components are present in reciprocals. First, reciprocals express anaphoricity to a plural argument. Second, they specify that the causal relation holds between distinct parts of the plural argument. I call the first meaning component of reciprocals *anaphoric condition*, and the second component *distinctness condition*. In (1) the anaphoric condition ensures that the object has the same reference as the subject. The distinctness condition specifies how the relation of hating is satisfied. More concretely, (1) is only true if Morris hated Philip and Philip hated Morris.

(1) Morris and Philip hated each other.

In order to capture the distinctness condition of reciprocals we have to interpret the relation in reciprocal sentences distributively. That is, the relation *hate* in (1) does not hold of the plurality Morris and Philip itself, rather, it holds of distinct individuals forming this plurality. To account for the distinctness condition we thus need some way of ensuring distributive quantification in reciprocal sentences.

In this paper I am going to argue that the distributive quantification necessary for capturing the distinctness condition of reciprocals must have a very limited scope. In fact, it should scope only over the reciprocal itself, and exclude other arguments, as well as the verb. The observation is not new. It has already been made in Williams' response to Heim et al. (1991a). However, Williams himself notes this as a problem but does not propose a semantic analysis. Subsequent analyses of *each other* either ignored this problem, admitted that their account cannot deal with it or claimed that the problem is not real. I am going to argue against the last solution and propose a semantic analysis of reciprocals with a limited scope of distributivity. The analysis is possible if we combine the theory of reciprocity with Landman's analysis of distributivity limited to thematic roles (Landman, 2000).

The paper is organized as follows. In the next section I list three arguments that point to the very limited nature of distributive quantification in reciprocal sentences. In Section 3 I show that parallel arguments exist in case of cumulative quantification, which led Landman (2000) to postulate a novel type of distributivity. Building on his idea (albeit not his actual implementation) I show how the same approach can account for the behavior of reciprocals. Section 4 is the conclusion.

2 Data

At least three arguments point to the conclusion that distributivity in reciprocal sentences is very limited in its scope.

The first argument comes from reciprocal sentences of type DP-V-each other-(P) DP, that is, where another argument is present. Consider (2a). As noted in Williams (1991), Moltmann (1992), to get the interpretation 'each child giving a different present', the plural DP is preferred over the singular one, cf. the difference between (2a) and (2b) in this interpretation.

(2) a. Two children gave each other a Christmas present.
?? under the reading 'each child giving a different present'

b. Two children gave each other Christmas presents.
OK under the reading 'each child giving a different present'

There are two strategies how one builds distributivity into reciprocal sentences. One option (Dalrymple et al. 1998, Sabato and Winter 2005 among others) is to build distributivity into the meaning of reciprocals. The second option makes use of distributivity postulated independently of reciprocals (Heim et al. 1991b, Beck 2001, among others). I focus here on the first option and come to the second option at the end of this section.

In the first approach one assumes that reciprocals scope over relations and require, in its basic reading, that the extension of relation includes all pairs of non-identical individuals. In example (2a), the relation is '$\lambda x \lambda y.x$ gave y a Christmas present'. Since x and y are distinct individuals (2a) can mean that the first child gave one present to the second child and the second child gave another present to the first child. Thus, we derive as the default reading the reading which is dispreferred in (2a). Obviously, the problem would disappear if we ensured that *a Christmas present* is outside the scope of the reciprocal, hence *each other* would not distribute over it. However, it is unclear why indefinites should by default scope over reciprocals given that normally the inverse scope is a dispreferred option.

This is Williams' and Moltmann's argument why distributivity should be very local or absent in reciprocal sentences. Dalrymple et al. (1998) and Beck (2001) respond to this by claiming that the reading marked as '??' in (2a) is possible so there is nothing bad after all if we derive it. I think that this cannot be the end of story, though. Williams' point was not that the reading (2a) is impossible, only that it is marked, roughly equally as the distributive reading of (3) is marked.

(3) Two children gave Mary a Christmas present.

The distributive reading of (3) improves if we substitute the indefinite subject with a DP whose head is a universal quantifier *both* or *all*, and the same holds for (2a). This intuition has also been confirmed in a questionnaire studies, see Dotlačil (2009). Suppose we derive the marked status of the distributive reading in (3) by assuming that numeral noun phrases do not distribute, unlike quantifiers. This solution would fail to extend to (2a) since here there is an independent source of distributivity, namely, the reciprocal itself, which gives rise to the dispreferred reading by default. Thus, contrary to Dalrymple et al. (1998) and Beck (2001) I believe that even if one accepts (2a) under the relevant reading, one still needs to explain why the reading is somewhat marked, in a parallel fashion to (3), and accounts in which reciprocals freely distributes over *a Christmas present* lack the explanation. Notice that if *each other* distributed only very locally, we might be able to say that the marked status of (2a) has the same reason as the marked status of (3).

The second argument for the very local scope of distributivity comes from a cumulative quantification, studied by Scha (1981) and Krifka (1989), among many others. Its connection to reciprocity has been discussed in Sauerland (1998) and Sternefeld (1998). The problem can be shown on (2b) but since this involves complications due to the presence of bare plurals, I use two different examples. The first one is a variation on (2b), the second one is from the Corpus of Contemporary American English.

(4) a. Two children gave five presents to each other (in total).
    b. Critics and defenders of the Catholic Church have been aligned against each other in two conflicting camps.

A possible reading of (4a) is that two children gave each other some presents, such that in total five presents were given. (4b) can mean that critics have been aligned against defenders in one camp and defenders were aligned against critics in another camp so in total there were two competing camps. Consider (4b) in more detail. If the reciprocal scopes above *two conflicting camps* we get the reading that critics were aligned against defenders in two conflicting camps and defenders were aligned against critics in two (possibly different) camps. If *two conflicting camps* scopes above the reciprocal, we get the reading that there are two conflicting camps and critics were aligned against defenders in these two camps, and so were defenders. Neither of the readings is correct. In a nutshell the problem is as follows. (4a) and (4b) are cases of a cumulative quantification. Normally, we can derive the cumulative reading if we assume that none of the arguments distributes over the others and all arguments are interpreted in their thematic positions (in line of Krifka 1989 and others since). However, this is incompatible with the account of *each other* which requires distributivity. The problem could be avoided if we had a system where *each other* does require distributivity, but distributivity is only very local, not affecting the interpretation of other arguments.

The third argument comes from the fact that reciprocal sentences can combine with collective predicates. This is shown in (5a), from Dimitriadis (2000), and (5b), from the Corpus of Contemporary American English.

(5) a. Bill and Peter, together, carried the piano across each others lawns.

b. Cooper and friends gather at each other's homes to perform tunes and ballads.

The problem is that in Dalrymple et al. (1998) and others, (5a) ends up meaning that Bill together carried the piano and so did Peter, which is nonsense. However, (5a) and (5b) can be interpreted. The problem would again be avoided if we ensured that the distributivity associated with *each other* does not scope over the adverb *together* in (5a) or the collective verb *gather* in (5b).

These are problems for Dalrymple et al. (1998) and Sabato and Winter (2005) but they are similarly problematic for accounts in which reciprocals make use of independently postulated distributivity. Consider (6).

(6) Morris and Philip hated each other.

There is a long tradition of analyzing referring expressions (like coordinations of proper names in (6)) as possibly distributing over the predicate. Various alternative analyses of how to achieve this exist. Regardless of the option we choose we build the distinctness condition of *each other* upon the capability of the subject to distribute over the predicate (Heim et al. 1991b, Beck 2001, among others). In particular, we might interpret *each other* as follows (see Beck 2001):

(7) $[\![\text{each other}]\!]$=the other one(s) among x different from y

Now, we let x to be bound by the plural argument, antecedening the reciprocal, and y to be bound by the distributive quantifier. In (6) we thus derive the reading which could be (somewhat clumsily) paraphrased as 'each of Morris and Philip hated the other one among Morris and Philip different from himself', that is, Morris hated Philip and Philip Morris. Since it is necessary that the antecedent of reciprocals distribute, we run again into the problem why (2a) is degraded under the indicated interpretation. We also cannot explain why (5a) and (5b) are possible. Finally, (4a) and (4b) are problematic. Since the subject has to distribute in these readings, we derive that, for instance, (4b) is interpreted as 'critics were aligned in two competing camps, and so were defenders' which is not the correct interpretation.[1]

To sum up, three arguments point to the conclusion that distributivity, necessary to capture the distinctness condition of reciprocals, applies only very locally. In the next section, I propose an analysis of these data.

[1] The last problem can be avoided but we have to assume an operator that applies to syntactically derived relations and cumulates on their both arguments (see Beck and Sauerland 2000 and literature therein). This analysis has been assumed in Sternefeld (1998) and Sauerland (1998). I am assuming that this operation is not possible. Even if we allow it the analysis still faces the two other problems.

3 Distributivity and reciprocals

3.1 Background assumptions

I assume that the interpretive model includes D_e, the domain of individuals, and D_v, the domain of events. Both D_e and D_v are structures ordered by 'sum', $\oplus$ in such a way that $\langle D_e, \oplus \rangle$ is isomorphic to $\langle \wp(D_e) - \{\emptyset\}, \cup \rangle$, similarly for D_v. For more details, see Landman (1991). I furthermore assume that sentences are interpreted in neo-Davidsonian fashion. Verbs are predicates of events, and arguments are introduced through separate thematic roles. For example, ((8a)) is interpreted as (8b).

(8) a. Burt and Greg kissed Clara and Lisa
b. $(\exists e)(*\text{kiss}(e) \wedge *Ag(\text{Burt} \oplus \text{Greg}, e) \wedge *Th(\text{Clara} \oplus \text{Lisa}, e))$

Notice that, as is standard in event semantics (see Krifka 1989, Landman 2000, Kratzer 2003, among others), predicates and thematic roles are pluralized by $*$. $*$ is defined below. It should be straightforward to see how we could extend $*$ to cumulate on relations of higher arity than 2.

(9) a. $*Px = 1$ iff $Px = 1$ or $x_1 \oplus x_2 = x$ and $*Px_1$ and $*Px_2$
b. $*R(x, y) =$ iff $R(x, y) = 1$ or $x_1 \oplus x_2 = x$ and $y_1 \oplus y_2 = y$ and $*R(x_1, y_1)$ and $*R(x_2, y_2)$

Thus, the event e is possibly a plural event that has subevents in which parts of the plurality Burt $\oplus$ Greg kissed parts of the plurality Clara $\oplus$ Lisa. This would be true, if, for example, e consisted of subevents e_1 and e_2, where Burt kissed Clara in e_1 and Greg kissed Lisa in e_2. This is the so-called cumulative reading.

To arrive at (8b) compositionally, I make the following assumptions. First, thematic roles are introduced separately in the syntax. Since each thematic role is of type $\langle e, \langle v, t \rangle \rangle$ to combine them together we either need to assume some lift operator which lifts one thematic role so it can apply to the other or we can assume a special mode of composition, event identification (Kratzer, 2003). I am going to assume the latter here, for any two arbitrary types that end in $\langle v, t \rangle$:

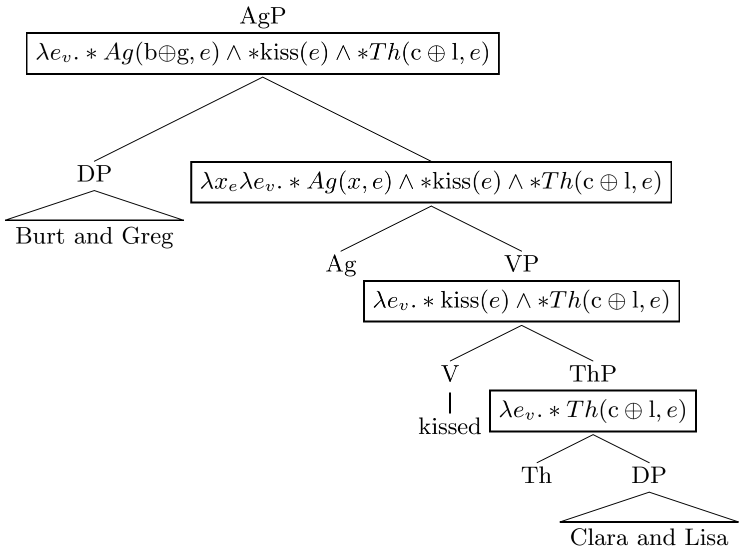
(10) Event Identification (ei):
a. $Y_{\langle v,t \rangle}$ ei $Z_{\langle v,t \rangle} = \lambda e.Y(e) \wedge Z(e)$
b. $Y_{\langle \sigma_1, \sigma_2 \rangle}$ ei $Z_{\langle v,t \rangle} = \lambda P_{\sigma_1}.Y(P)$ ei Z if σ_2 ends in $\langle v, t \rangle$
c. $Y_{\langle \sigma_1, \sigma_2 \rangle}$ ei $Z_{\langle \sigma_3, \sigma_4 \rangle} = \lambda P_{\sigma_1} \lambda Q_{\sigma_3}.Y(P)$ ei $Z(Q)$ if $\sigma_{2,4}$ end in $\langle v, t \rangle$

Finally, we want generalized quantifiers to be interpretable in their thematic positions (see Krifka 1989). For that we assume LIFT:

(11) LIFT: $\lambda R_{\langle e, \langle v,t \rangle \rangle} \lambda Q_{\langle \langle e,t \rangle, t \rangle} \lambda e.Q(\lambda x.R(x, e))$

The syntactic structure (12) shows how we derive (8b) in a stepwise fashion using the assumptions we made so far.

(12)



In the next section, I want to discuss more complicated cases in which cumulative readings intertwine with distributive readings, which will form the key insight for understanding what is going on in reciprocal sentences.

3.2 Distributivity in cumulative readings

Consider the following sentence, from Landman (2000).

(13) Three boys gave six girls two flowers.

Example (13) can be true if there are three boys and six girls and each boy gave flowers to some of the six girls and each girl received flowers from some of the three boys, and each boy gave out two flowers. For instance, one boy gave one flower to girl_1 and one flower to girl_2, the second boy gave one flower to girl_3 and one flower to girl_4 and the third boy gave one flower to girl_5 and girl_6. The problem with this reading is that *three boys* distributes over *two flowers* (so, each boy gives out two flowers in total) but three boys and six girls are interpreted cumulatively, that is, neither of these arguments distributes over the other argument. For more discussion and more examples showing the same point, see Roberts (1990), Schein (1993), Landman (2000) and Kratzer (2003). To account for this reading, we need to allow the subject to distribute only very locally, over the theme argument, and excluding the goal argument. The analysis of this is proposed in Landman (2000). However, I am going to differ from his approach because it is not clear how it could be extended to reciprocals.[2]

[2] Champollion (2010) offers an account that can deal with examples like (13) in an eventless framework. I have to leave it open whether his analysis could be extended to reciprocals.

The basic idea is that we let some thematic roles be related not to the event e but to some subevent e'. Thus, we assume a null operator which optionally applies to a thematic role and requires it to relate to e', a subevent of e:

(14) The operator making a thematic role related to the subevent e'
$\lambda R_{\langle e,\langle v,t\rangle\rangle}\lambda x\lambda e'\lambda e.R(x,e') \wedge e' \leq e$

We can then distribute only over e' and exclude distribution over the whole event e. In (13) we let the agent and theme be related to e', the subevent of e:

(15) $$\lambda x\lambda e'\lambda e.\exists y,z\begin{pmatrix}\text{2 flowers}(y) \wedge \text{6 girls}(z) \wedge *Ag(x,e') \wedge *Th(y,e')\\ \wedge e' \leq e \wedge *\text{give}(e) \wedge *Go(z,e)\end{pmatrix}$$

To let the agent distribute over the theme argument it suffices to allow cumulation of (=the application of $*$ to) the first two arguments of this function. I notate the distributive operator which enables this as $\mathcal{D}$. $\mathcal{D}$ is defined as:

(16) $$\mathcal{D}(Q_{\langle e,\langle v,\langle v,t\rangle\rangle\rangle}) = \lambda x\lambda e. * (\lambda y\lambda e'.Q(y,e',e))(x,e)$$

We cumulate on the first two arguments of Q. Thus, x and e can be split into parts, for instance, x_1, x_2 and e_1, e_2 and x_1, e_1 satisfies $\lambda y\lambda e'.Q(y)(e')(e)$, and the same holds for x_2, e_2. To see what $\mathcal{D}$ is doing consider the example above. $\mathcal{D}$ applies to (15) which derives the following:

(17) $$\lambda x\lambda e. * \begin{pmatrix}\lambda y\lambda e'.\exists z,z'(\text{2 flowers}(z) \wedge \text{6 girls}(z') \wedge *Ag(y,e')\\ \wedge * Th(z,e') \wedge e' \leq e \wedge *\text{give}(e) \wedge *Go(z',e))\end{pmatrix}(x,e)$$

If *three boys* applies to (17) (by LIFT) we derive that *three boys* and e can be split into parts, and we can pair up the parts of the nominal argument with the parts of the event such that each pair satisfies the following function:

(18) $$\lambda y\lambda e'.\exists z,z'\begin{pmatrix}\text{2 flowers}(z) \wedge \text{6 girls}(z') \wedge *Ag(y,e') \wedge *Th(z,e')\\ \wedge e' \leq e \wedge *\text{give}(e) \wedge *Go(z',e)\end{pmatrix}$$

This is true if, for instance, there are three subevents of e and every boy is the agent argument of one of the subevents and for each of the subevents there are two flowers that are the theme argument. Notice that even though the goal argument is in the syntactic scope of $\mathcal{D}$, it does not covary with the agent. Only the arguments that are related to the subevent e' show covariation. Thus, this system is useful for dealing with cases in which one argument syntactically scopes over another argument but does not induce covariation over it. For more discussion and details on the compositional analysis, see Dotlačil (2009).

3.3 Reciprocal sentences

We have seen that distributivity in reciprocal sentences should be limited in scope. The same strategy which allows us to combine distributive and cumulative readings in one clause could be used for reciprocals. Consider the sentence *Morris and Philip hated each other*. We let the agent and theme be related to the subevent e'. The two thematic roles combine and give us (19). (19) is parallel to the previous cases where thematic roles were related to subevents, the only difference is that now we abstract over the theme argument.

(19) $\lambda x \lambda y \lambda e' \lambda e. * Ag(x, e') \wedge *Th(y, e') \wedge *\text{hate}(e)$

We need to let *each other* apply to this function and express that it holds for distinct parts of a plural argument. We assume the following interpretation:

(20) $[\![\text{each other}]\!] = \lambda Q \lambda x \lambda e. * (\lambda y \lambda z \lambda e'. Q(y, z, e', e) \wedge$
$\wedge \text{ distinct}(y, z))(x, x, e)$

In standard accounts like Dalrymple et al. (1998), reciprocals take a relation as its argument and require that y, z, parts of the plural argument x, which apply to the relation are distinct. In the account here *each other* applies to Q, the relation of arity 4: this relates two individual arguments and two events. Q can be built up by letting thematic roles relate to the subevent e' and abstracting over the object argument of the relation. Thus, *each other* can apply to (19). Notice that I leave it open how the distinctness itself should be understood. For the purposes of this paper, assume that it is equivalent to non-overlap.

Letting *each other* apply to (19) and to the subject *Morris and Philip* we get (21). This formula is true if the plurality Morris and Philip can be split into parts and one part (say, Morris) hates the other, distinct, part (say, Philip) in some subevent of e, and the other way round, that is, Philip hates Morris in some other subevent of e. This is what we want.

(21) $$\lambda e. * \begin{pmatrix} \lambda x \lambda y \lambda e'. * Ag(x, e') \wedge *Th(y, e') \wedge \\ \wedge e' \leq e \wedge *\text{hate}(e) \wedge \text{distinct}(x, y) \end{pmatrix} (\text{m}\oplus\text{p}, \text{m}\oplus\text{p}, e)$$

Consider now (22), repeated from above. As we have discussed in Section 2, the interpretation in which the indefinite is distributed over is marked.

(22) Two children gave each other a Christmas present.
?? under the reading 'each child giving a different present'

We let the agent and goal be related to subevents, which gives us:

(23) $$\lambda x \lambda y \lambda e' \lambda e. \exists z \begin{pmatrix} \text{present}(z) \wedge *Ag(x, e') \wedge *Go(y, e') \\ \wedge e' \leq e * \text{give}(e) \wedge *Th(z, e) \end{pmatrix}$$

If we let *each other* apply to (23) and to the subject (notated as "2 c.") we get:

(24) $$\lambda e. * \begin{pmatrix} \lambda x \lambda y \lambda e'. \exists z (\text{present}(z) \wedge *Ag(x, e') \wedge *Go(y, e') \\ \wedge e' \leq e \wedge *\text{give}(e) \wedge *Th(z, e) \wedge \text{distinct}(x, y)) \end{pmatrix} (2 \text{ c.}, 2 \text{ c.}, e)$$

Even though *a present* is in scope of $*$ and thus, one might think, could be interpreted as varying with respect to each child, it does not. The reason is that unlike the agent and goal argument, the theme argument is related to the event e. Therefore, (24) is true if one child gave another child a present, and the other child gave the first child a present, and in total *one* present was exchanged. Thus, unlike every single analysis of reciprocals I know of (with the exception of Moltmann 1992) we do not derive the distributive reading as the default one. We can still derive the distributive reading if we assume that the theme argument is also related to the subevent e'. However, notice that this requires an extra operation, namely modification of the theme thematic role. It is likely that this extra operation makes the particular reading less likely. As we have seen above, it is also dispreferred to interpret *two children gave Mary a Christmas present* with Christmas presents varying for each kid. Here again, the dispreferred interpretation only follows if we let the theme argument be related to the subevent and the subject distribute over it. If these optional operations are dispreferred in this case we expect them to be dispreferred in (22) as well. Thus, unlike previous accounts, we correctly capture the parallelism between reciprocal and non-reciprocal sentences concerning distribution over indefinites.

We can also derive the reading of *Two children gave five presents to each other (in total)* in which two children gave each other some presents, such that in total five presents were given. This reading is in fact captured in the representation (24), the only difference is that 'a present' is substituted by 'five presents'. Finally, let me come back to reciprocal sentences with collective predicates, like (25a), repeated from above, which gets the interpretation (25b):

(25) a. Cooper and friends gather at each other's homes.

b. $$\lambda e.{*}\begin{pmatrix}\lambda y\lambda z\lambda e'. *Ag(y,e') \wedge *Th(\text{house of } z, e') \\ \wedge e' \leq e \wedge *\text{gather}(e) \wedge \text{distinct}(y,z)\end{pmatrix}(\text{C}\oplus\text{fr.}, \text{C}\oplus\text{fr.}, e)$$

(25b) is true if, for instance, each friend is the agent of gathering at his friends' homes. One might find this a non-sensical interpretation since it seems strange that a single person could be the agent of gathering. However, it has been argued in the work of Dowty and Brisson (see Brisson 2003 and references therein) that the agent of collective predicates like *gather* needs to satisfy only some general requirements that gathering might impose (getting to some particular place, for instance) and does not need to "undergo gathering" himself. This enables (25b) to have a possible interpretation. We furthermore expect that collective predicates which do not have such unspecific requirements on their agents should not combine with reciprocals. One test to distinguish the two types of collective predicates is using the quantifier headed by *all*. While *gather* is compatible with this quantifier, other collective predicates like *outnumber* are not. It turns out that collective predicates of the latter type cannot appear in reciprocal sentences either. For example, *The boys in our class outnumber each other's families* is uninterpretable. We expect this since reciprocals should only combine with collective predicates whose agents can be atomic individuals.

4 Conclusion

In order to accommodate the distinctness condition of *each other* we need to assume that reciprocal sentences include some sort of distributivity. I have shown that this distributivity is very local and has no effect on the predicate or other arguments in reciprocal sentences. This can be accommodated by using a very local version of distributivity which operates only between thematic roles hosting the reciprocal and its antecedent. The analysis gives an independent support to distributivity which does not scope over the whole clause but only over selected arguments.

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