

Reciprocal scope revisited*

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Abstract The most influential approaches to reciprocals (Heim, Lasnik & May 1991; Dalrymple, Kanazawa, Kim, Mchombo & Peters 1998) involve a scoping operator, but there are good arguments by Murray (2008) and Dotlačil (2013) that reciprocals do not involve distributive quantification but are instead pronouns with both coreference and noncoreference requirements. However, the latter analyses cannot straightforwardly account for apparent scopal variability in complex sentences with reciprocals. In this paper we extend the pronominal analysis of reciprocals to long distance cases by extending the original plural CDRT (Brasoveanu 2007) analysis with ideas from partial CDRT (Haug 2014).

Keywords: reciprocity, scope, dynamic semantics

1 Introduction

The most influential approaches to reciprocals (Heim et al. 1991; Dalrymple et al. 1998; Beck 2001) treat them – in one way or another – as strongly distributive quantifiers that can scope at various points in the sentence. On the face of it, these theories are well equipped to deal with what look like scope ambiguities in reciprocal sentences (1), and in particular the so-called long distance reciprocal reading that we see in (1b).

- (1) Two girls thought that they saw each other.
- a. Both girls thought: “We saw each other” (“narrow scope”)
 - b. Both girls thought: “I saw her (= the other)” (“wide scope”)

Nevertheless, more recent analyses (Murray 2008; Dotlačil 2013) bring evidence that reciprocals do not involve distributivity. Instead, these analyses view *each other* as a pronoun with both coreference requirements (identity of group) and noncoreference requirements (different individuals chosen in each verifying situation).

We find the evidence in favour of a pronominal analysis of *each other* compelling. But the resulting theories lack an account of the apparent scopal variability that

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we observe in (1). The goal of the present paper, then, is to extend the empirical coverage of Murray and Dotlačil’s theories to deal with the readings in (1). We do this by combining the framework used by Dotlačil (2013), Plural Compositional DRT (Brasoveanu 2007),¹ with Partial Compositional DRT (Haug 2014). This will allow us to pursue an analysis along the lines of the intuition expressed by Williams (1991) whereby the ambiguity we see in (1) is the same as the one we see in (2).

- (2) Two girls thought that they would win.
- a. Both girls thought: “We will win” (“narrow scope”)
 - b. Both girls thought: “I will win” (“wide scope”)

To our knowledge, no analysis based on this – to our mind compelling – intuition has ever been spelled out in detail. As we make the analysis precise, however, we will see that Williams’ claim that the two ambiguities are *exactly* the same cannot be upheld. On the reading in (1b), the embedded clause in (1) contains a reciprocal, although the beliefs that it reports do not. So our analysis will have to capture that fact.

The structure of the paper is as follows. In section 2, we go through the evidence against a scoping distributive quantifier in the semantics of reciprocals. In section 3, we introduce Plural CDRT and lay out Dotlačil’s analysis of basic reciprocal sentences. In section 4, we show how this analysis can be extended to account for apparent scopal variability by combining it with the analysis of anaphora from Haug (2014). Section 5 concludes.

2 Against scope in reciprocals

At first sight, accounts based on a scoping quantifier easily account for the data in (1). If, following Dalrymple et al. (1998), we take the reciprocal to be a polyadic quantifier **recip** that takes a plurality and a dyadic relation, we can schematically represent the two readings as in (2).

- (3) a. think(girls, **recip**(girls, $\lambda x.y.x$ saw y)
b. **recip**(girls, $\lambda x.y.x$ think that x saw y)

However, as has been pointed out a number of times (Williams 1991), things are not actually that simple. One fundamental problem is that there is a strict limitation on the scope of the reciprocal: it can never scope higher than the highest binder of its local antecedent, as illustrated in (4). Without further stipulations, the quantifier approaches have no account of this.

¹ Murray’s analysis is cast in the related framework Dynamic Plural Logic (van den Berg 1996).

- (4) Some think they like each other.
- a. Some think: “They like each other”.
 - b. *For each of them there are some who think: “He likes the other”.

Besides overpredicting scope possibilities, accounts based on a strongly distributive quantifier run into problems with elementary reciprocal sentences.

Limited scope of distributivity Already Williams (1991) argued that reciprocals pattern with plurals rather than with strongly distributive quantifiers when it comes to the availability of distributive readings. The facts are quite complicated, since ordinary plurals *can* give rise to distributive readings in many contexts. The best argument comes from examples like (5).

- (5) Two children gave each other five Christmas presents.

(5) has a cumulative reading where there are a total of five presents and for each of the presents, the first child gave it to the second child or vice versa. Accounts that rely on distributivity or quantification in reciprocal sentences cannot capture this reading.

It is also worth mentioning that *each other* does not behave like a quantifier with respect to other scope-taking items either, as discussed in Asudeh (1998: chapter 6). Perhaps the clearest examples involve modal verbs: *every* but not *each other* can scope over a modal verb (6).

- (6) a. John and Mary may beat everyone to the finish line. ($\forall > \text{may}$, $\text{may} > \forall$)
 b. #John and Mary may beat each other to the finish line. (**each other* > *may*, #*may* > *each other*)

Multiple reciprocals Another problem for accounts that rely on distributivity comes from sentences with multiple reciprocals (7).

- (7) John and Mary read each other’s books in each other’s languages. (Heim et al. 1991)
- (8) Two girls gave each other pictures of each other.

Because the higher *each other* distributes down to atoms, there is no plurality available for the lower *each other*. Distributivity accounts are therefore forced to postulate a mechanism of “absorption” (Heim et al. 1991: 94) whereby the multiple distributors fuse into one distributor binding several argument positions. Everything else equal, it would of course be preferable to do without this stipulation.

Cross-linguistic coverage In many languages, reciprocity and reflexivity are expressed by the same means, either a verbal affix (e.g. Cheyenne) or an independent word (e.g. German *sich*, as well as many Slavic and Romance languages). Importantly, such constructions typically also license ‘mixed’ readings between reciprocity and reflexivity (see Murray 2008: 466-67 for Cheyenne and Cable 2014: 4–5 for German and Romance), showing that they are not ambiguous but rather have a single, underspecified meaning. This is problematic for accounts that rely on a distributive quantifier, because there are no common meaning components between reflexivity and reciprocity, let alone a way of providing an underspecified semantics. On the other hand, we will see below how a plural DRT account can easily get the underspecified meaning, as argued by Murray (2008).²

3 Reciprocals through cumulation

3.1 Plural CDRT

To see how the cumulative analysis of reciprocals works in plural CDRT, we first briefly introduce the framework. Plural CDRT is built on top of CDRT, which is a way of making DRT compositional by introducing separate types for registers (aka discourse referents) and information states, and thereby handling assignments in the object language rather than in the metalanguage. The appeal of CDRT is that all this complexity can be hidden in abbreviations which look like ordinary DRSs which we can lambda abstract over. In this way, (9a) can get the semantic representation in (9b), which looks like an ordinary DRS but really is the abbreviation of (9c).

(9) a. A cat appeared.

	x_1
b.	$cat(x_1)$ $appear(x_1)$

c. $\lambda i.\lambda o.i[x_1]o \wedge cat(v(o)(x_1)) \wedge appear(v(o)(x_1))$

In (9c), i and o are information states, x_1 is a discourse referent, and v is a non-logical constant which interprets discourse referents in particular states, which means that $v(o)(x_1)$ denotes an individual. We write $i[x_1]o$ for ‘states i and o differ at most with respect to the individual assigned to x_1 ’, i.e. $\forall y.y \neq x_1 \rightarrow v(i)(y) = v(o)(y)$. (9c) therefore denotes a relation between states i and o such that they differ only in the

² Cable (2014) also notes that on the cumulative analysis of plurals, reflexives are in fact expected to be underspecified with respect to reciprocity, reflexivity and mixed readings.

interpretation of x_1 , and v assigns some individual to x_1 in o such that that individual is a cat and appears. For more details of how this works, we refer to [Muskins 1996](#). In this paper, we will mostly be able to stay at the abbreviated level, although we will make some references to the underlying type-logic in this section.

Plural CDRT adapts [van den Berg 1996](#) to the compositional CDRT setting. The leading idea is to model plurality by having DRSs be not relations between information states, but relations between *sets* of information states, which we will call plural information states. A plural information state satisfies a DRS condition iff its component information states pointwise satisfy the condition.

Having plural information states means that a single discourse referent can range over multiple individuals across the assignments in each plural state. This makes introduction of new discourse referents a little more complicated. Here we follow [Brasoveanu \(2007\)](#) and say that when a new discourse referent x is introduced, for each input assignment i there is an output assignment o that differs at most with respect to x ; and for each output assignment o there is an input assignment i that differs at most with respect to x . Moreover, because we are quantifying over assignments, we need to exclude the degenerate case where the set of output assignments is empty, so we include a condition $O \neq \emptyset$. We can then define the introduction of a discourse referent in a plural information state as in (10).

$$(10) \quad I[x_1]O =_{def} \forall i \in I. \exists o \in O. i[x_1]o \wedge \forall o \in O. \exists i \in I. i[x_1]o \wedge O \neq \emptyset.$$

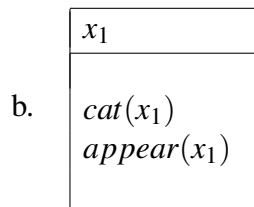
In the DRS language, $I[x_1]O$ will come out as the declaration of x_1 in the universe of the DRS.

We also need a notion of a plural information state satisfying a condition. Plural CDRT takes pointwise satisfaction of conditions as the default, i.e. for the plural information state O to satisfy a condition $R(x_1)$, every assignment in O must provide a value for x_1 such that $R(v(o)(x_1))$ holds. So, whenever a condition $R(x_1)$ appears in a DRS, this abbreviates the lambda expression in (11).

$$(11) \quad R(x_1) =_{abbr} \forall o \in O. R(v(o)(x_1))$$

Putting all this together, we can analyze a sentence with a plural as in (12).

(12) a. Cats appeared.



c. $\lambda I. \lambda O. I[x_1]O \wedge \forall o \in O. cat(v(o)(x_1)) \wedge appear(v(o)(x_1))$

Again, (12a) is assigned the DRS-like interpretation (12b), which conveniently hides the type theoretical expression (12c). A plural information state O will satisfy (12c) in case it extends an input assignment I with values for x_1 such that each individual in x_1 is a cat who appeared.

But how can we impose a plurality constraint e.g. for *two cats appeared*? The answer is that we need to sum across assignments. We define such collective satisfaction predicates in (13).

$$(13) \quad R(\cup x) =_{abbr} \lambda O. R(\bigcup_{o \in O} v(o)(x))$$

With this in place, we get (14).

(14) a. Two cats appeared.

b.

x_1
$cat(x_1)$ $2.atoms(\cup x_1)$ $appear(x_1)$

c. $\lambda I. \lambda O. I[x_1] O \wedge \forall o \in O. cat(v(o)(x_1)) \wedge 2.atoms(\bigcup_{o \in O} v(o)(x_1)) \wedge appear(v(o)(x_1))$

Notice that we get cumulative readings as the default case for polyadic predicates with two or more plural arguments, e.g. (15).

(15) a. Two cats ate three mice.

b.

$x_1 \ x_2$
$cat(x_1)$ $2.atoms(\cup x_1)$ $mouse(x_2)$ $3.atoms(\cup x_2)$ $eat(x_1, x_2)$

c. $\lambda I. \lambda O. I[x_1 \ x_2] O \wedge \forall o \in O. cat(v(o)(x_1)) \wedge 2.atoms(\bigcup_{o \in O} v(o)(x_1)) \wedge mouse(v(o)(x_2)) \wedge 3.atoms(\bigcup_{o \in O} v(o)(x_2)) \wedge eat(v(o)(x_1), v(o)(x_2))$

On this analysis, x_1 will range over two cats, x_2 over three mice, and in each assignment it is true that x_1 ate x_2 , so we get a cumulative reading.

3.2 Reciprocals in Plural CDRT

Because cumulative predication is the default case, we can capture reciprocity as cumulative identity between *each other* and its antecedent across assignments, combined with a distinctness condition inside each assignment. This yields the meaning in (16), from Dotlačil 2013.³

$$(16) \quad \llbracket \textit{each other}_{u_m}^{u_n} \rrbracket = \lambda P. \begin{array}{|l} u_n \\ \hline \cup u_m = \cup u_n \\ u_m \neq u_n \end{array} ; P(u_n)$$

That is, *each other* introduces a new discourse referent u_n , which is anaphoric to another referent u_m , and requires that u_n and u_m are sum equal across assignments, but different in each assignment. (17) shows how this works for an elementary reciprocal predication.

(17) a. Two girls¹ saw each other₁²

$$b. \begin{array}{|l} x_1 \ x_2 \\ \hline 2.\textit{atoms}(\cup x_1) \\ \textit{girl}(x_1) \\ \cup x_1 = \cup x_2 \\ x_1 \neq x_2 \\ \textit{see}(x_1, x_2) \end{array}$$

$$c. \begin{array}{c|c|c} & x_1 & x_2 \\ \hline j_1 & \textit{girl}_1 & \textit{girl}_2 \\ j_2 & \textit{girl}_2 & \textit{girl}_1 \end{array}$$

We see that the NP *two girls* introduces a discourse referent x_1 which must have two atoms in its denotation across assignments, and each atom must be a girl. *each other* then introduces a new discourse referent which ranges over the same individuals across assignments but is distinct in reference inside each assignment. Finally, each assignment must be such that x_1 sees x_2 . A sample output state is given in (17c).

The reciprocal, then, has two crucial components that link it to its antecedent: a coreference requirement which is interpreted cumulatively, and a distinctness criterion which is interpreted distributively.

³ In fact, Dotlačil (2013) formulates the semantics in a different way in terms of an explicit distribution operator, but the two definitions are equivalent.

This analysis solves all the problems that the scopal analysis has with basic reciprocal sentences which were illustrated in section 2. The analysis of the cumulative reading of (5) is as in (18b). (18c) gives a sample verifying output state (among many).

(18) a. Two children gave each other five Christmas presents

b.

x_1	x_2	x_3
$2.atoms(\cup x_1)$		
$child(x_1)$		
$\cup x_1 = \cup x_2$		
$x_1 \neq x_2$		
$presents(x_3)$		
$5.atoms(\cup x_3)$		
$give(x_1, x_2, x_3)$		

c.

	x_1	x_2	x_3
j_1	$child_1$	$child_2$	$pres_1$
j_2	$child_2$	$child_1$	$pres_2$
j_3	$child_1$	$child_2$	$pres_3$
j_4	$child_2$	$child_1$	$pres_4$
j_5	$child_1$	$child_2$	$pres_5$

Multiple reciprocals are also no problem. (19) gives the analysis of (8) on the reading where the second reciprocal takes the first one as its antecedent. (There is another reading, also unproblematic, where both reciprocals takes the subject as their antecedent.)

(19) a. Two girls¹ gave [each other]² pictures³ of [each other]⁴.

b.

x_1	x_2	x_3	x_4
$2.atoms(\cup x_1)$			
$girls(x_1)$			
$\cup x_1 = \cup x_2$			
$x_1 \neq x_2$			
$\cup x_2 = \cup x_4$			
$x_2 \neq x_4$			
$pictures.of(x_3, x_4)$			
$give(x_1, x_2, x_3)$			

	x_1	x_2	x_3	x_4
c. j_1	<i>girl</i> ₁	<i>girl</i> ₂	<i>pic</i> ₁	<i>girl</i> ₁
j_2	<i>girl</i> ₂	<i>girl</i> ₁	<i>pic</i> ₂	<i>girl</i> ₂

Finally, we note that, as observed by Murray (2008), the cumulative semantics makes it easy to model a meaning that is underspecified between reflexivity and reciprocity (as discussed above in section 2) by simply leaving out the distinctness criterion from (16), as shown in (20).

$$(20) \quad \llbracket \text{recip/refl}_{u_n}^{u_n} \rrbracket = \lambda P. \begin{array}{|c|} \hline u_n \\ \hline \cup u_m = \cup u_n \\ \hline \end{array} ; P(u_n)$$

In sum, we take these data to strongly favour the pronominal theory of the reciprocal, as developed by Murray and Dotlačil. We now pass to our own contribution, which is to develop an account of long distance readings within this setting.

4 Deriving scopal variability

As is standard in dynamic semantics, plural CDRT models anaphoric relations through identification of variables/discourse referents. Following CDRT this identification is assumed to arise from a pre-semantic coindexation mechanism. This means that our example (1) actually looks like (21) in the input to semantics.

(21) Two girls¹ said that they₁ saw each other₁².

Given (16), the only way to “parametrize” the meaning of the reciprocal is to vary the antecedent, but there is only one index available as antecedent in (21). So it should be clear that the account is not fine-grained enough to capture the apparent scopal variability that we see in (1a–b). We will now see how we can endow CDRT with a more fine-grained account of anaphoric dependencies which will be able to solve this problem.

4.1 Partial CDRT

There have been several uses of partiality in dynamic semantics. One conceptual reason is that it provides for a very natural notion of information growth: if assignments are partial we can model discourse referent introduction as *extension* of a state. $i[x]o$ as defined above is an equivalence relation partitioning the set of assignments, and its plural version $I[x]O$ inherits this behaviour. But the more natural notion of discourse referent introduction is arguably asymmetric. And indeed van den Berg’s

original Dynamic Plural Logic was partial, although Brasoveanu’s compositional version is not. In a partial setting, we can recast $i[x]o$ as in (22), which intuitively says that i extends o with a value for x .

$$(22) \quad i[x]o := \neg \exists y. v(i)(x) = y \wedge \exists y. v(o)(x) = y \wedge \forall z. z \neq x \rightarrow v(i)(z) = v(o)(z).$$

We can generalize this to the relation between sets of assignments $I[x]O$ in exactly the same way as before.

The particular partial logic we are basing ourselves on comes from Haug (2014). The prime motivation for partiality in that paper is the underspecification of anaphoric relationships. This is achieved by having states track *occurrences* of discourse referents rather than discourse referents themselves. That is, in partial CDRT, *Mary* and *she* will introduce different discourse referents even if they corefer, whereas in other versions of DRT, they will be the same discourse referent in that case. However, as an anaphoric expression, *she* is associated with a condition that it must corefer with an antecedent, whose identity is supplied by pragmatics and tracked by a function \mathcal{A} mapping anaphoric expressions to their antecedent. Consider (23).⁴

(23) a. Mary was happy. She had won.

$$\text{b. } \begin{array}{|l} x_1 \bar{x}_2 \\ \hline \text{Mary}(x_1) \\ \text{happy}(x_1) \\ \text{had.won}(x_2) \end{array} , \mathcal{A}(x_2) = x_1$$

$$\text{c. } \lambda i. \lambda o. \partial(i[x_1 x_2]o) \wedge \text{Mary}(v(o)(x_1)) \wedge \text{happy}(v(o)(x_1)) \wedge \text{had.won}(v(o)(x_2)) \wedge \partial(v(o)(x_2) = v(o)(\mathcal{A}(x_2)))$$

The overbar on \bar{x}_2 in the DRS in (23) abbreviates the condition $\partial(v(o)(x_2) = v(o)(\mathcal{A}(x_2)))$ (where ∂ is the presupposition connective of Beaver (1992), mapping True to True and other truth values to undefined) and the actual identity $\mathcal{A}(x_2)$ is supplied “on the side”, not as part of the semantic content because the grammar does not specify the antecedent. However, underspecification as such is not relevant for our purposes: what is relevant is that coreference is modeled not as reuse of variables but as an identity condition between variables. Therefore we will allow ourselves to abbreviate the DRS from (23) as (24), where we also ignore the presupposition operator and the overbar indicating anaphoricity.

⁴ Another aspect of PCDRT is that discourse referents are ordered, so that x_1 and x_2 in (23c) are the first free discourse referents in i and should be written x_{i_1} and x_{i_2} in the full representation. This aspect of the theory is not relevant here.

$x_1 \ x_2$
$Mary(x_1)$
$happy(x_1)$
$had.won(x_2)$
$x_2 = x_1$

(24)

From our perspective, this abbreviation has two advantages: we suppress the \mathcal{A} function since we are not interested in underspecification; and we bring to the fore the identity condition associated with anaphora. In the singular case, (24) has the same truth conditions as what we would get by substitution of identities, but in the plural case, the contribution of identity conditions is more interesting, especially in intensional contexts.

By default, an identity condition should be interpreted inside each assignment, just like other conditions. That is, the contribution of an anaphoric identity condition like $x_1 = x_2$ is as in (25).

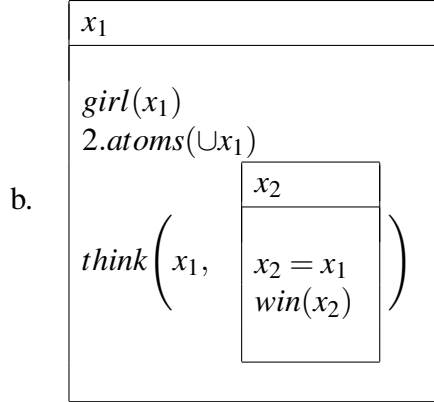
$$(25) \quad x_1 = x_2 : \forall o \in O. v(o)(x_1) = v(o)(x_2)$$

Let us now see how this plays out in embedded contexts like our original example (2). To deal with attitude verbs we will need to have an intensional language. Here we just assume that conditions have an implicit world argument and a DRS denotes a set of worlds such that all conditions in the DRS are satisfied. Moreover, we associate each individual x with a set of worlds dox_x which characterizes the contents of their thoughts (in a particular world). We can then define an interpretation of conditions like $think(x, K)$ where K is some DRS as in (26).

$$(26) \quad think(x, K) = \lambda O. \forall o \in O. \exists O'. \text{dox}_{v(o)(x)} \subseteq K(O)(O')$$

(26) says that $think(x, K)$ is true iff the thoughts of x are compatible with K as interpreted in the embedding plural information state O . That is, the embedded DRS has access to the entire plural information state of the matrix DRS, so that an anaphoric identity condition in the subordinate DRS pointing to a matrix discourse referent will make the anaphoric discourse referent range over *all* the values of the matrix discourse referent.

$$(27) \quad \text{a. Two girls}_1 \text{ thought they}_2 \text{ would win.}$$



This DRS is satisfied in the plural information state J_1 as illustrated in (28) iff each girl thinks that each girl will win, because (26) ensures that the embedded DRS is interpreted across the whole information state for each girl's thoughts.

$$(28) \quad \begin{array}{c|cc} & x_1 & x_2 \\ \hline J_1 & j_1 & girl_1 \quad girl_1 \\ & j_2 & girl_2 \quad girl_2 \end{array}$$

Although (28) may look like there is a binding relation between x_1 and x_2 , implying that each girl thinks only that she herself will win, the definition in (26) ensures that the whole information state J_1 must verify the embedded DRS in each girl's thought worlds, i.e. each girl thinks that each girl (= each value of x_2 across all of J_1) will win.

We assume, however, that there is another way of satisfying attitude predicates. The idea is that the thoughts of x are characterized by K only as interpreted in the discourse context O restricted to the assignments where x actually denotes the believer. This is shown in (29).

$$(29) \quad think_p(x, K) = \lambda O. \forall o \in O. \exists O'. dox_{v(o)(x)} \subseteq K(O|_{x=v(o)(x)})(O')$$

Here we write $O|_{x=v(o)(x)}$ for the subset of O which agrees with o on the value for x . If we interpret *think* in (27a) this way, we get the information state J_1 in (28). The reason is that only one value for x_1 goes into the embedded DRS, and so summing over that value yields the same result.

Notice that although we use *think* and *think_p* to abbreviate (26) and (29) we do not think of the difference as a lexical ambiguity. It is more like a transparent/opaque distinction for anaphoric conditions. Observe first that (26) and (29) yield exactly the same interpretation of non-anaphoric conditions, since the only way a variable in the embedded DRS can be bound in the input information state (rather than the output) is if it comes from an anaphoric condition. What (29) then does is to license a transparent interpretation of the anaphoric condition such that the whole identity condition only holds in the matrix DRS, whereas the subject's doxastic alternatives

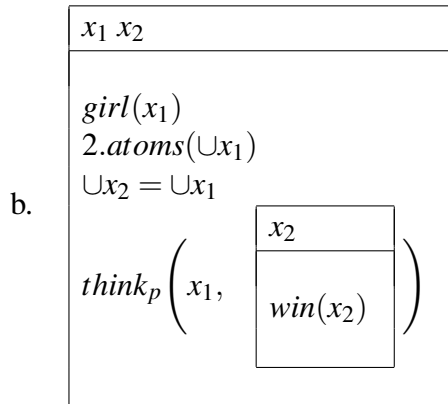
only contain parts of the identity conditions, namely the ones involving the subject him/herself.

There is one more reading that we would like to get. That is the so-called crossed reading where *girl*₁ thinks *girl*₂ will win and vice versa. This is not a salient reading of (2) and there are even claims in the literature that it does not exist. However, as we will see below, we believe this claim is incorrect. And in fact, our system *can* get the crossed reading. Two ingredients are crucial. First, we must interpret the anaphoric condition cumulatively, as defined in (30).

$$(30) \quad \cup x_1 = \cup x_2 : \bigcup_{o \in O} v(o)(x_1) = \bigcup_{o \in O} v(o)(x_2)$$

This is no different from the collective interpretation of other conditions, defined in (13). In addition, the introduction of the pronoun’s discourse referent must be lifted to the matrix DRS, since *think*_p does not give access to the whole matrix information state inside the embedded DRS. This yields the analysis in (31a).

(31) a. Two girls₁ thought they₂ would win.



(31a) is compatible with the information state J_2 from (32).

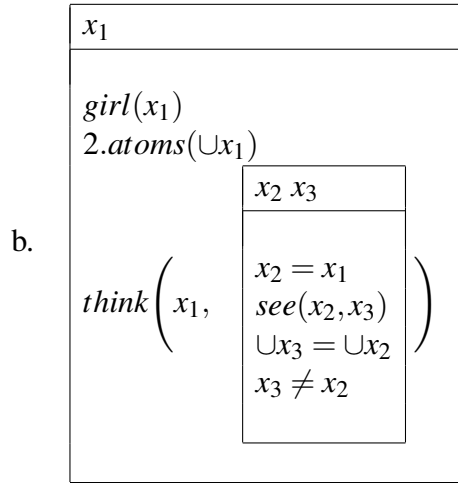
$$(32) \quad \begin{array}{cc|cc} & & x_1 & x_2 \\ J_2 & j_1 & girl_1 & girl_2 \\ & j_2 & girl_2 & girl_1 \end{array}$$

If we now interpret K in a partitioned manner, we get the crossed reading. We think that is a welcome result, but the rarity of such readings suggests that the cumulative interpretation of the anaphoric identity condition is a marked option.

4.2 Application to reciprocals

The analysis of the “narrow scope” reading (27a) above transfers directly to the “narrow scope” reading of the reciprocal in (1a), as shown in (33).

(33) a. Two girls₁ thought that they₂ had seen each other₃.



c.

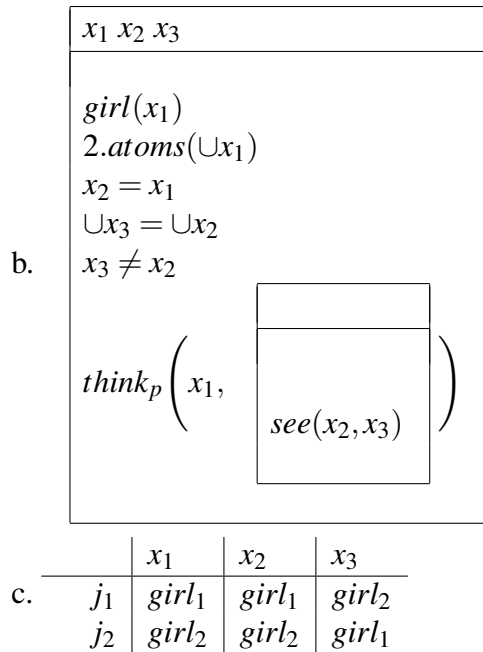
	x_1	x_2	x_3
j_1	$girl_1$	$girl_1$	$girl_2$
j_2	$girl_2$	$girl_2$	$girl_1$

We correctly capture that the two girls had the thought expressed by the embedded DRS as interpreted in whole plural information states, that is “we saw each other”.

Notice however that if we switch to $think_p$, it does not make sense to leave the reciprocal in the embedded DRS. That is because the partitioned information states are not guaranteed to contain a plurality which can serve as an appropriate antecedent for the reciprocal.⁵ The problem comes from the fact that on the wide scope reading, the sentence does not report on any reciprocal thought: both girls thought “I saw her”, so the reciprocity is the speaker’s responsibility and only exists at the level of the matrix DRS. The analysis then is as in (34).

(34) a. Two girls₁ thought that they₂ had seen each other₃.

⁵ Another way to think about this is that $think_p$ yields a transparent interpretation of anaphoric connections, as noted above, so it does not make sense to interpret the reciprocal in an opaque way in the embedded DRS.



This correctly gives us the wide scope reading. Moreover, if we interpret the coreference relation between x_1 and x_2 collectively (so $\cup x_1 = \cup x_2$), we get the crossed reading. Again, we think that the existence of the crossed reading is vindicated by the facts. (35–37) show some examples from the web.

- (35) Jennifer Lawrence & Emma Stone Reveal *They Thought They Catfished Each Other & More* in Hilarious Joint Interview⁶
- (36) Sometimes the two leads meet and become involved initially, then must confront challenges to their union. Sometimes they are hesitant to become romantically involved because *they believe that they do not like each other*, because one of them already has a partner, or because of social pressures. However, the screenwriters leave clues that suggest that the characters are, in fact, attracted to each other and that they would be a good love match.⁷
- (37) He thought she hated him. She thought he hated her. *They thought they hated each other.*⁸

In (37), admittedly, it is not clear whether the last sentence is intended to bring new information or to summarize the two previous sentences. But the fact that the latter reading is possible shows that it is possible to get a crossed reading of the reciprocal.

⁶ <http://www.shineon-media.com/2018/01/05/jennifer-lawrence-emma-stone-reveal-they-thought-they-catfished-each-other-more>

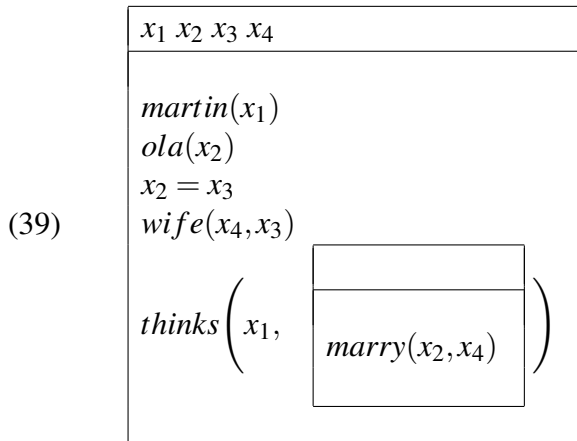
⁷ https://en.wikipedia.org/wiki/Romantic_comedy

⁸ <https://www.youtube.com/watch?v=RcKC7V-Thu4>

Our account of the wide scope reading relies on *each other* being interpreted *de re* in the matrix DRS. Hellan (1981: 70) already showed that this is needed in other cases of binding into an NP that is interpreted *de re*.

- (38) a. Martin tror Ola skal gifte seg med sin egen kone.
 Martin thinks Ola_i is going to marry his_i own wife.

On the most natural reading of (38), *sin egen kone* is interpreted *de re*, which means that we need to lift it to the matrix DRS.

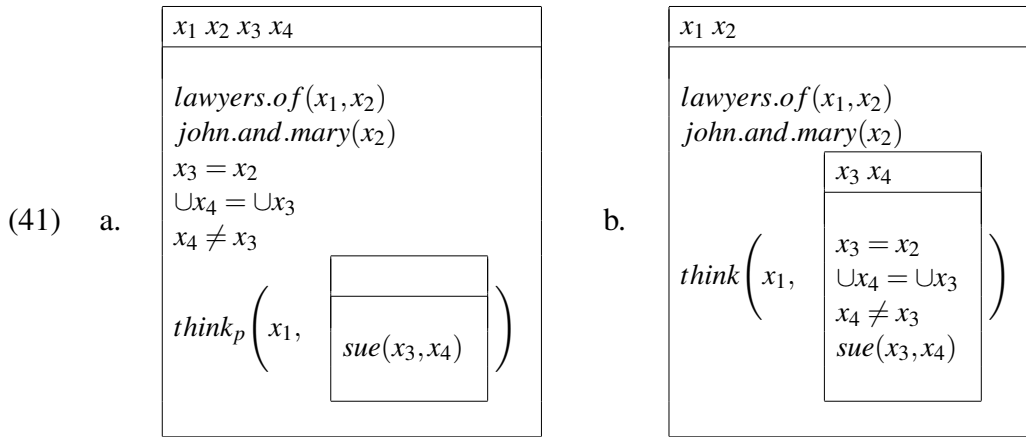


We conclude that lifting the interpretation of the coreference requirement associated with a bound anaphor is a legitimate and necessary operation. The details of how to implement this lifting will vary depending on what assumptions one makes about the syntax-semantics interface.

Because our account is based on dynamic binding, we correctly predict that long distance reciprocity does not require c-command. Consider (40) from Dimitriadis 2000: 58.

- (40) The lawyers who represent John and Mary think they will sue each other.

(40) has a long distance reading where John’s lawyer thinks “John will sue Mary” and Mary’s lawyer thinks “Mary will sue John”. We are only aware of one previous account that can get this reading, namely Dimitriadis 2000. Dimitriadis assumes that *they* in this sentence is a paycheck pronoun denoting a function from lawyers to their clients. Our analysis avoids that assumption, since John and Mary are accessible, ordinary antecedents for *they*, so we get the two readings in the same way as above, as illustrated in (41).



Both DRSs are compatible with the plural information state in (42).

(42)

	x_1	x_2	x_3	x_4
j_1	<i>lawyer</i> ₁	<i>john</i>	<i>john</i>	<i>mary</i>
j_2	<i>lawyer</i> ₂	<i>mary</i>	<i>mary</i>	<i>john</i>

For the wide scope reading, the effect of *think_p* is that the doxastic alternatives of *lawyer*₁ must be compatible with the embedded DRS as interpreted in $\{j_1\}$, and the doxastic alternatives of *lawyer*₂ must be compatible with the embedded DRS as interpreted in $\{j_2\}$, that is John’s lawyer must think John will sue Mary and Mary’s lawyer must think Mary will sue John. For the narrow scope reading, the doxastic alternatives of both lawyers must be consistent with the embedded DRS as interpreted in the whole plural information state $\{j_1, j_2\}$, i.e. both lawyers must think that Mary will sue John and John will sue Mary.

Moreover, unlike accounts based on a scoping quantifier, we do not predict that scope islands influence the availability of long distance readings. This is borne out by examples like (43).

- (43) It isn’t necessary for Israelis and Palestinians to get misty-eyed when they imagine each other’s suffering (though that might help).⁹
 ≈ It isn’t necessary for Israelis to get misty-eyed when they imagine the Palestinians’ suffering and it isn’t necessary for the Palestinians to get misty-eyed when they imagine the Israelis’ suffering.

5 Conclusions

Dotlačil and Murray convincingly argued that reciprocal pronouns are just pronouns, and not quantifiers, and showed that there is an elegant model of such pronouns in

⁹ <https://www.theatlantic.com/international/archive/2012/08/moral-imagination-and-the-fate-of-the-world/260789/>

plural CDRT. Long distance readings remained unaccounted for, however. Part of the problem is that the simple coindexation approach to anaphoric resolution is not fine-grained enough to model the two different readings without additional structure. We have shown that the more sophisticated account of anaphoricity that is found in partial CDRT directly gives us an account of long distance readings while preserving the advantages of the plural CDRT account of reciprocity.

Questions remain for the pronominal approach to reciprocals, however. Reciprocal sentences are famously associated with readings of different strength. For example, *The boys know each other* seems to entail that each boy knows all the others, whereas there is no such entailment in *The boys stared at each other*. In quantifier theories, this is typically modelled as variable strength of quantification. In the pronoun theory, there is no similarly obvious place to locate the ambiguity. We leave this matter for further research.

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