Introduction  Williams (1991) expressed the intuition that the ambiguity seen in (1) is not one of scope of the reciprocal but in fact the same ambiguity as we see in the two coreferential readings of (2) where there is no reciprocal.

(1) Two girls said that they saw each other.
   a. girl$_1$ said girl$_1$ saw girl$_2$ and girl$_2$ saw girl$_1$ and girl$_2$ said the same thing ("narrow scope")
   b. girl$_1$ said girl$_1$ saw girl$_2$ and girl$_2$ said girl$_2$ saw girl$_1$ ("wide scope")

(2) Two girls thought they should sit down.
   a. Each girl thought that each girl should sit down (∼ (1-a))
   b. Each girl thought that she herself should sit down (∼ (1-b))

This intuition was, however, never properly formalized. In this paper we do that by adopting a cumulative analysis of the reciprocal (along the lines of Sternefeld 1998, Dotlačil 2013) in a partial version of compositional DRT (Haug 2013) with plural information states (van den Berg 1996, Brasoveanu 2006). In this setting we can capture anaphoric relationships between occurrences of drefs without equating variables. This gives us a richer account of anaphoric dependencies than simple coindexation which, as pointed out by Higginbotham (1985) and Heim, Lasnik and May (1991a), is not (without additional structure) expressive enough to deal with the semantics of reciprocals. In both (1) and (2), then, the two readings in question result from the type of anaphoric relationship that they bears to its antecedent two girls.

Our analysis thereby avoids the problems facing scopal accounts of each other (Heim, Lasnik and May 1991ab, Sternefeld 1998), where as pointed out by Dimitriadis (2000) there are only ad hoc explanations for the principle A effects associated with reciprocals and for why the reciprocal can never scope higher than its highest binder. Furthermore, because the scope effects follow from (chains of) dynamic anaphoric binding relations we also correctly predict that the antecedent need not c-command the anaphor (3) and that the anaphoric relation can cross scope islands (4). Finally, our account straightforwardly generalizes to “chained” reciprocals (5), where a reciprocal antecedes another reciprocal. Dimitriadis (2000) shows that these cannot be derived in the system of Heim, Lasnik and May (1991) and they also cannot be derived in his modification of that system.

(3) The lawyers that represent John and Mary expect them to sue each other.

(4) They were engaged writing in journals that they gave each other on their wedding day.

(5) Two girls gave each other pictures of each other.

The framework  Drefs are interpreted by assignments, which are reified as objects of a separate type $s$. An update (dynamic proposition) is a relation between plural information states, i.e. sets of such assignments. Introduction of new drefs means that for all input assignments there is an output assignment that extends it and for all output assignments there is an input assignment that it extends (6-a), where the extension relation between partial assignments $(s_1[x_1]s_2)$ means that the first unused dref in $s_1$ has an inhabitant in $s_2$. Each assignment in the output state must satisfy all conditions in the DRS (6-b), which means that each assignment must assign inhabitants to the argument drefs such that the underlying static relation is true (6-c), where we write $j(x_1)$ for the inhabitant of $x_1$ in $j$ and $\bigcup j(x_1)$ for the sum of inhabitants of $x_1$ across all assignments $j \in J$. 

1
Notice how each argument position can be optionally interpreted pointwise or collectively across assignments. Finally, anaphoric drefs are associated with a presupposition that they corefer with their antecedent, \( \partial(x_1 = A(x_1)) \), which can be satisfied pointwise or collectively just like other conditions. The antecedent itself, viz. the resolution function \( A \) is pragmatically derived, although it is subject to the syntactic constraints of binding theory. In particular, each other must take a superior, local antecedent. For ease of exposition we resolve each other it is subject to the syntactic constraints of binding theory. In particular, assignments. Finally, anaphoric drefs are associated with a presupposition that they corefer with

\begin{align*}
&\text{(6) a. } [x_1] := \lambda x_1 \exists i \in I. \exists j \in J. x_1 \uparrow j \land \forall j \in J. \exists i \in I. x_1 \downarrow i \\
&\text{b. } [C_1(x_1 \ldots x_t) \ldots C_n(y_1 \ldots y_j)] := \lambda I. J. C_1(x_1 \ldots x_t)(J) \land \ldots \land (C_n(y_1 \ldots y_j)(J)) \\
&\text{c. } C(x_1, \ldots, x_t)(J) := \forall j \in J. C((\cup) j(x_1), \ldots (\cup) j(x_t))
\end{align*}

The analysis Along the lines of Sternefeld (1998) and Dotlačil (2013) we assume the lexical entry in (7) for each other.

\begin{align*}
&\text{(7) } \lambda P. [x_1 \cup x_1 = \cup A(x_1), x_1 \neq A(x_1)]
\end{align*}

In words, each other introduces a dref \( x_1 \) and imposes an identity condition between \( x_1 \) and its antecedent which is interpreted collectively in both arguments, i.e. across assignments, \( x_1 \) and its antecedent must range over the same domain. It also imposes a distinctness condition inside each assignment. (8) shows the DRS for a simple sentence with a reciprocal. The first two conditions make sure that there are two individual girls in \( \cup j(x_1) \). The next condition makes sure the same girls are found in \( \cup j(x_2) \). The third condition says that in each assignment \( j \in J, j(x_1) \neq j(x_2) \). Finally, the seeing relation must hold between the inhabitants of \( x_1 \) and \( x_2 \) in all assignments. This gives us so-called weak reciprocity,\(^1\) as illustrated in the sample output state in (8-b).

In the long-distance case (9), we still have two individual girls in \( \cup j(x_1) \). The interesting thing is what happens in the embedded DRS, which is an extension \( K \) of \( J \) with two new drefs \( x_2 \) and \( x_3 \). The three last conditions of the embedded DRS require the same plural info state as in (8). If we then also take in the condition that \( x_2 \) must corefer with its antecedent (i.e. \( x_1 = x_2 \) in every state there is only one way to have \( K \) extend \( J \), as shown in the first two rows of (9). However, if we instead interpret the antecedency condition collectively, we get a different reading as shown on the bottom in (9). For the sentence to be true, \( \cup x_1 = \cup x_2 \) must hold in all worlds compatible with what each girl says, and in addition global equality and pointwise distinctness must hold between each other and its antecedent. Notice that the collective/non-collective ambiguity in the antecedency condition is independently motivated by (2).

Conclusion On our approach long distance readings result directly from a dependent reading of the reciprocal’s antecedent pronoun. A dependent reading, in turn, results from the pointwise interpretation of a standard antecedency condition. We therefore correctly predict long-distance reciprocity with a non c-commanding antecedent (unlike approaches based on distributivity operators) and out of scope islands (unlike approaches based on movement of each other), as shown in (3)–(4), cf. (10). Finally, unlike in most approaches we are aware of, no special problems arise in interpreting chained reciprocals (5), cf. (11).


\(^1\)There are several other readings for the reciprocal which we cannot discuss here, as the focus is on “scope” effects.
(8) a. Two girls\(^1\) saw [each other]\(^2\)

\[
\begin{array}{c|c|c}
    x_1 & x_2 \\
\hline
    2.\text{atoms}(\cup x_1) & x_1 & x_2 \\
    \text{girl}(x_1) & j_1 & \text{girl}_1 \\
    \cup x_1 = \cup x_2 & j_2 & \text{girl}_2 \\
    x_1 \neq x_2 & \text{girl}(x_1) & \text{girl}_1 \\
    \text{see}(x_1, x_2) & \text{girl}_2 & \text{girl}_1 \\
\end{array}
\]

b.

\[
\begin{array}{c|c|c|c|c}
    x_1 & x_2 & x_3 \\
\hline
    2.\text{atoms}(\cup x_1) & x_1 & x_2 & x_3 \\
    \text{girl}(x_1) & j_1 & \text{girl}_1 & \text{girl}_1 & \text{girl}_2 \\
    \cup x_1 = \cup x_2 & j_2 & \text{girl}_2 & \text{girl}_2 & \text{girl}_1 \\
    x_1 \neq x_2 & \text{girl}(x_1) & \text{girl}_1 & \text{girl}_2 & \text{girl}_2 \\
    \text{see}(x_2, x_3) & j_3 & \text{girl}_2 & \text{girl}_1 & \text{girl}_2 \\
\end{array}
\]

(9) a. Two girls\(^1\) said that they\(^2\) saw [each other]\(^3\).

\[
\begin{array}{c|c|c|c}
    x_1 & x_2 & x_3 \\
\hline
    2.\text{atoms}(\cup x_1) & x_1 & x_2 & x_3 \\
    \text{girl}(x_1) & j_1 & \text{girl}_1 & \text{girl}_1 & \text{girl}_2 \\
    \cup x_2 = \cup x_1 & j_2 & \text{girl}_2 & \text{girl}_2 & \text{girl}_1 \\
    \cup x_3 = \cup x_2 & j_3 & \text{girl}_1 & \text{girl}_2 & \text{girl}_1 \\
    x_3 \neq x_2 & \text{girl}(x_1) & \text{girl}_1 & \text{girl}_2 & \text{girl}_2 \\
    \text{say}(x_1, x_2, x_3) & j_4 & \text{girl}_2 & \text{girl}_1 & \text{girl}_1 \\
\end{array}
\]

b.

\[
\begin{array}{c|c|c|c|c|c|c}
    x_1 & x_2 & x_3 & x_4 \\
\hline
    \text{lawyer}(x_1) & \text{John-and-Mary}(\cup x_2) & \text{represent}(x_1, x_2) & x_1 & x_2 & x_3 & x_4 \\
    \text{girl}(x_1) & j_1 & \text{John} & \text{Mary} & \text{John} & \text{Mary} & \text{John} \\
    \cup x_2 = \cup x_1 & j_2 & \text{Mary} & \text{Mary} & \text{John} & \text{John} & \text{John} \\
    \cup x_3 = \cup x_2 & j_3 & \text{John} & \text{Mary} & \text{Mary} & \text{John} & \text{John} \\
\end{array}
\]

(10) a. The\(^1\) lawyers that represent [John and Mary]\(^2\) expect them\(^3\) to sue [each other]\(^4\).

\[
\begin{array}{c|c|c|c|c|c|c|c}
    x_1 & x_2 & x_3 & x_4 \\
\hline
    \text{lawyer}(x_1) & \text{John-and-Mary}(\cup x_2) & \text{represent}(x_1, x_2) & x_1 & x_2 & x_3 & x_4 \\
    \text{girl}(x_1) & j_1 & \text{John} & \text{Mary} & \text{John} & \text{Mary} & \text{John} \\
    \cup x_2 = \cup x_1 & j_2 & \text{Mary} & \text{Mary} & \text{John} & \text{John} & \text{John} \\
    \cup x_3 = \cup x_2 & j_3 & \text{John} & \text{Mary} & \text{Mary} & \text{John} & \text{John} \\
    \cup x_4 = \cup x_2 & j_4 & \text{John} & \text{Mary} & \text{Mary} & \text{John} & \text{John} \\
\end{array}
\]

b.

\[
\begin{array}{c|c|c|c|c|c|c|c}
    x_1 & x_2 & x_3 & x_4 \\
\hline
    \text{lawyer}(x_1) & \text{John-and-Mary}(\cup x_2) & \text{represent}(x_1, x_2) & x_1 & x_2 & x_3 & x_4 \\
    \text{girl}(x_1) & j_1 & \text{John} & \text{Mary} & \text{John} & \text{Mary} & \text{John} \\
    \cup x_2 = \cup x_1 & j_2 & \text{Mary} & \text{Mary} & \text{John} & \text{John} & \text{John} \\
    \cup x_3 = \cup x_2 & j_3 & \text{John} & \text{Mary} & \text{Mary} & \text{John} & \text{John} \\
    \cup x_4 = \cup x_2 & j_4 & \text{John} & \text{Mary} & \text{Mary} & \text{John} & \text{John} \\
\end{array}
\]

(11) a. Two girls\(^1\) gave [each other]\(^2\) pictures\(^3\) of [each other]\(^4\).

\[
\begin{array}{c|c|c|c|c}
    x_1 & x_2 & x_3 & x_4 \\
\hline
    2.\text{atoms}(\cup x_1) & x_1 & x_2 & x_3 & x_4 \\
    \text{girl}(x_1) & j_1 & \text{girl}_1 & \text{girl}_2 & \text{pic}_1 & \text{girl}_1 \\
    \cup x_1 = \cup x_2 & j_2 & \text{girl}_2 & \text{girl}_1 & \text{pic}_1 & \text{girl}_2 \\
    x_1 \neq x_2 & \text{girl}(x_1) & \text{girl}_1 & \text{girl}_2 & \text{pic}_1 & \text{girl}_2 \\
    \text{see}(x_1, x_2, x_3) & j_3 & \text{girl}_2 & \text{girl}_1 & \text{pic}_1 & \text{girl}_1 \\
    \text{say}(x_2, x_3) & j_4 & \text{girl}_1 & \text{girl}_2 & \text{pic}_1 & \text{girl}_1 \\
\end{array}
\]

b.

\[
\begin{array}{c|c|c|c|c|c|c|c}
    x_1 & x_2 & x_3 & x_4 \\
\hline
    2.\text{atoms}(\cup x_1) & x_1 & x_2 & x_3 & x_4 \\
    \text{girl}(x_1) & j_1 & \text{girl}_1 & \text{girl}_2 & \text{pic}_1 & \text{girl}_1 \\
    \cup x_1 = \cup x_2 & j_2 & \text{girl}_2 & \text{girl}_1 & \text{pic}_1 & \text{girl}_2 \\
    x_1 \neq x_2 & \text{girl}(x_1) & \text{girl}_1 & \text{girl}_2 & \text{pic}_1 & \text{girl}_2 \\
    \text{see}(x_1, x_2, x_3) & j_3 & \text{girl}_2 & \text{girl}_1 & \text{pic}_1 & \text{girl}_1 \\
    \text{say}(x_2, x_3) & j_4 & \text{girl}_1 & \text{girl}_2 & \text{pic}_1 & \text{girl}_1 \\
\end{array}
\]