Reciprocal scope at the syntax-semantics interface

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Abstract

We present an analysis of the compositional semantics of reciprocals and reciprocal scope. Our analysis of the semantics of reciprocals is based on Haug and Dalrymple (2020), with Partial Plural Compositional DRT as the meaning language (Brasoveanu 2007, Haug 2014). We augment this analysis with an explicit syntax-semantics interface in an LFG+Glue setting, and extend our treatment to scope-fixing reciprocal constructions such as the Japanese reciprocal affix *aw*.

1 Overview

Haug and Dalrymple (2020) propose that sentence (1) has the f-structure and meaning shown.

(1) a. The girls saw each other.

b.
$$
{}_{s}\left[\begin{array}{ll}
\text{PRED} & \text{`SEE}\langle\text{SUBJ,OBJ}\rangle\text{'} \\
\text{SUBJ} & {}_{g}\left[\text{PRED `GIRL'}\right] \\
\text{OBJ} & {}_{eo}\left[\begin{array}{ll}\text{PRED} & \text{`PRO'} \\ \text{PRONTYPE} & \text{RECIP}\end{array}\right]
\end{array}\right]
$$

c.
$$
\begin{array}{|l|}
\hline
u_1\ u_2 \\
\hline
girl(u_1) \\
see(u_1, u_2) \\
\cup u_2 \rightarrow \cup u_1 \\
u_2 \neq u_1 \\
\hline
\end{array}
$$

A reciprocal expression like *each other* requires the presence of a local antecedent which denotes a group. Semantically, a reciprocal predication says that some relation (here, *see*) holds among members of the group (here, *the girls*): each member of the group must see another member of the group, and each member must be seen by another member of the group. We will see how the DRS in (1c) captures this meaning.

Our semantic analysis is cast within the theory of Partial Plural Compositional Discourse Representation Theory (PPCDRT). In Section 2, we provide background on PPCDRT, and in Section 3, we provide a full exposition of our treatment of simple examples like (1). We present a compositional (LFG+Glue) analysis of simple reciprocals in Section 4. In Section 5 we present our compositional analysis of reciprocal scope in English, a language in which there is no morphological or syntactic marking to indicate reciprocal scope, and in Section 6 we provide an

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account of Japanese, in which reciprocal scope is morphologically marked on the verb. Section 7 concludes.

2 Background on PPCDRT

Discourse Representation Theory (DRT: Kamp and Reyle 1993) is a dynamic semantic theory which provides an account of the introduction of discourse referents and subsequent reference to them via anaphoric expressions. In its original formulation, DRT was not compositional in the strict Montagovian sense because it relied on a unification-based construction algorithm rather than function application and abstraction. This means that original DRT does not combine well with Glue semantics, which requires the meaning language to support function application and abstraction.

Compositional DRT (CDRT, Muskens 1996) made DRT compositional by introducing types for discourse referents (often called registers) and information states (assignments). In this approach, assignments are handled in the object language rather than in the metalanguage. CDRT did not deal with plural semantics, but Plural CDRT (Brasoveanu 2007) adapted the plural dynamic logic of van den Berg (1996) to the compositional DRT setting.

In Plural CDRT, DRSs are not relations between information states, but relations between *sets* of information states: that is, plural information states. For example, we can informally say that the DRS in (1c) denotes a relation between two sets of information states I (the input state) and O (the output state) such that O extends I with two new discourse referents u_1 and u_2 that satisfy the conditions in the DRS. To formalize this, we need to pinpoint exactly what we mean by saying that O extends I with one or more discourse referents, and exactly what it means that the conditions in the DRS are satisfied.

To define the introduction of a new discourse referent u in a plural information state, we first need the notion of two singular information states differing at most with respect to u. This is given in (2), where ν is the function that, given a state and a discourse referent, interprets the state as an assignment by returning the individual that the discourse referent refers to in that state.[1]

(2) $i[u_1]o$ in Compositional DRT, Muskens (1996):

$$i[u_1]o =_{def} \forall u.u \neq u_1 \rightarrow \nu(i)(u) = \nu(o)(u)$$

[1]We use the following notational conventions:

x, y, z	first-order variables
$P, P', R, \mathcal{Q}$	higher-order variables
$u, u_1, u_2...$	discourse referents
$s, i, o, o_1, o_2...$	information states
S, I, O	sets of information states/plural information states
d	individual
D	plural individual
K	Discourse Representation Structure

From this definition, Brasoveanu (2007) defined introduction of discourse referents in plural assignments I and O such that O extends I with the discourse referent u iff for each input assignment $i \in I$ there is an output assignment $o \in O$ that differs at most with respect to u; and for each output assignment o there is an input assignment i that differs at most with respect to u. In addition, because we are quantifying over assignments, we must exclude the degenerate case where the set of output assignments is empty. This gives the definition in (3).

(3) $I[u]O$ in Plural CDRT (Dotlačil 2013, example 43, see also Brasoveanu 2007, 142):

$$I[u]O =_{def} \forall i \in I.\exists o \in O.i[u]o \wedge \forall o \in O.\exists i \in I.i[u]o \wedge O \neq \emptyset$$

Next, we need to define what it means for a plural information state to satisfy a condition. In Plural CDRT, *pointwise* satisfaction of conditions is the default: i.e. for a plural information state S to satisfy a condition $R(u)$, *each* assignment $s \in S$ must provide a value for u such that $R(\nu(s)(u))$ holds. The condition $R(u)$ therefore abbreviates the expression in (4).

(4) Distributive satisfaction of conditions in Plural CDRT (Dotlačil 2013, example 39b, see also Brasoveanu 2007, 136):

$$R(u) =_{abbr} \lambda S.S \neq \emptyset \wedge \forall s \in S.R(\nu(s)(u))$$

With all this in place, we can give a DRS for a sentence with a plural noun phrase and expand that DRS following our definitions above.

(5) a. Cats appeared.

b. $$\begin{array}{|l|}\hline u_1 \\ \hline \\ cat(u_1) \\ appear(u_1) \\ \\ \hline \end{array}$$

c. $\lambda I.\lambda O.I[u_1]O \wedge \forall o \in O.cat(\nu(o)(u_1)) \wedge appear(\nu(o)(u_1))$

(5a) is assigned the DRS interpretation (5b), which abbreviates the type theoretical expression (5c). A plural information state O satisfies (5c) just in case it extends an input assignment I with values for u_1 such that each individual in u_1 is a cat who appeared. Notice that we follow the standard 'inclusive' view of plurality, according to which a plural form is compatible with singular reference. Thus, (5) does not say explicitly that u_1 refers to more than one cat.

However, for a sentence like *two cats appeared* we clearly need to require that u_1 refers to two cats, and for that we need a notion of *collective* satisfaction of assignments. This is given in (6).

(6) Collective satisfaction of conditions in Plural CDRT (Dotlačil 2013, example 39a):

$$R(\cup u) =_{abbr} \lambda S.S \neq \emptyset \wedge R(\bigcup_{s \in S} \nu(s)(u))$$

The idea is that, instead of saying that *each* information state should provide a value for u such that $R(u)$ is true, we take the *union* $\cup u$ of the values for u across information states and check whether $R(\cup u)$ holds. This is illustrated in (7).

(7) a. Two cats appeared.

b. $$\begin{array}{|l|}\hline u_1 \\ \hline cat(u_1) \\ 2\text{-}atoms(\cup u_1) \\ appear(u_1) \\ \hline \end{array}$$

c. $\lambda I.\lambda O.I[u_1]O \wedge \forall o \in O.cat(\nu(o)(u_1)) \wedge 2\text{-}atoms(\bigcup_{o \in O} \nu(o)(u_1)) \wedge appear(\nu(o)(u_1))$

A plural information state O satisfies (7c) iff it extends an input assignment I with values for u_1 such that within each assignment, each individual in u_1 is a cat who appeared, and summing across assignments, there are two individuals in u_1.

In addition to cardinality contraints such as in (7), collective satisfaction is also used for collective verbal predicates such as *meet* (8).

(8) a. Two cats met.

b. $$\begin{array}{|l|}\hline u_1 \\ \hline cat(u_1) \\ 2\text{-}atoms(\cup u_1) \\ meet(\cup u_1) \\ \hline \end{array}$$

In each assignment, u_1 ranges over atomic cats: it is only by summing the values of u_1 across assignments that we get a plurality.[2]

For the analysis of reciprocals, a crucial aspect of Plural CDRT is that so-called *cumulative* readings are the default for predicates with two or more plural arguments. Consider the example in (9).

(9) a. Two cats ate three mice.

[2]Brasoveanu (2007, 352–3) calls this a *discourse-level plurality*. Brasoveanu (2007, chapter 8) also countenances *domain-level pluralities*, but they play no role here.

b. $$\begin{array}{|l|}\hline u_1\ u_2 \\ \hline cat(u_1) \\ 2\text{-}atoms(\cup u_1) \\ mouse(u_2) \\ 3\text{-}atoms(\cup u_2) \\ eat(u_1, u_2) \\ \hline \end{array}$$

c. $$\lambda I.\lambda O.I[u_1\ u_2]O \wedge \forall o \in O.cat(\nu(o)(u_1)) \wedge 2\text{-}atoms(\textstyle\bigcup_{o\in O} \nu(o)(u_1)) \wedge mouse(\nu(o)(u_2)) \wedge 3\text{-}atoms(\textstyle\bigcup_{o\in O} \nu(o)(u_2)) \wedge eat(\nu(o)(u_1), \nu(o)(u_2))$$

Here u_1 ranges over two cats, u_2 over three mice, and in each assignment it is true that u_1 ate u_2, so we get a cumulative reading without any extra machinery. This differs from the relational analyses of Sternefeld (1998) and Beck (2001), where a cumulative reading is derived by the application of a cumulation operator to a predicate. In Plural CDRT it is instead the distributive reading of (9a), where each cat ate three mice, which requires a special mechanism in the form of a distributivity operator. We do not discuss this further here, as it does not affect the analysis of reciprocity which we will present.

3 Reciprocity in PPCDRT

As we saw in the introduction, Haug and Dalrymple (2020), building on related work in the Plural CDRT framework by Dotlačil (2013), proposed that the meaning of an elementary reciprocal sentence is as in (10), repeated from (1).

(10) a. The girls saw each other.

b. $$\begin{array}{|l|}\hline u_1\ u_2 \\ \hline girl(u_1) \\ \cup u_2 \rightarrow \cup u_1 \\ u_1 \neq u_2 \\ see(u_1, u_2) \\ \hline \end{array}$$

According to this analysis, the subject *the girls* contributes the discourse referent u_1, and the reciprocal contributes the discourse referent u_2. The reciprocal takes *the girls* as its antecedent, but bears a special kind of coreference relation to the antecedent, namely *collective identity* ($\cup u_2 \rightarrow \cup u_1$ requires the sum of u_1 and u_2 across assignments to be equal), but *case-wise distinctness* ($u_1 \neq u_2$ requires u_1 and u_2 to be different within each assignment). The fourth condition requires u_1 to see u_2 in each assignment. These requirements are met in the sample information state in (11).

(11)

	u_1	u_2
s_1	$girl1$	$girl2$
s_2	$girl2$	$girl1$

(11) makes clear how close reciprocal and cumulative predication are on this analysis. In effect we are saying that the set of girls stands in a cumulative seeing relation to itself, with the additional requirement that any "self-seeing" events do not count for this: that is, (10) does not rule out that some girls saw themselves, but it requires that, even discounting such situations, there are enough seeing events to ensure that every girl saw some other girl, and every girl was seen by some other girl. This is exactly the reading known in the literature on reciprocals as *weak reciprocity*. There are also other reciprocal readings: see Haug and Dalrymple (2020, section 6) for a discussion of how they can be accounted for in this framework.

An important aspect of this analysis is that the reciprocal is *not* treated like a quantifier (unlike e.g. in the approaches of Heim et al. 1991 or Dalrymple et al. 1998), but as a pronoun which fills an argument position and bears a special coreference relation to its antecedent. Concretely, Haug and Dalrymple (2020) assume the meaning in (12) for *each other*.

(12) $$[\![\textit{each other}]\!] = \lambda P. \begin{array}{|l|}\hline u \\ \hline \cup u \rightarrow \cup\mathcal{A}(u) \\ u \neq \mathcal{A}(u) \\ \hline \end{array} ; P(u)$$

$\mathcal{A}$ here is the function that takes anaphoric discourse referents to their antecedents. This is a crucial aspect of Partial CDRT (Haug 2014) – anaphoric expressions such as pronouns are not simply variables bound by coindexation with their antecedent, but introduce their own discourse referents that come with a condition that requires them to be identified with their antecedents. A simple case is shown in (13).

(13) Anaphoric relations in Partial CDRT:

a. Chris[1] was happy. He[2] had won.

b. $$\begin{array}{|l|}\hline u_1\ u_2 \\ \hline Chris(u_1) \\ happy(u_1) \\ had.won(u_2) \\ u_2 \rightarrow \mathcal{A}(u_2) \\ \hline \end{array} , \mathcal{A}(u_2) = u_1$$

c. $\lambda I.\lambda O.I[u_1\ u_2]O \wedge \forall o \in O.Chris(\nu(o)(u_1)) \wedge happy(\nu(o)(u_1))$
$\wedge\ had.won(\nu(o)(u_2)) \wedge \partial(\nu(o)(u_2) = \nu(o)(\mathcal{A}(u_2)))$

In (13), *he* introduces a discourse referent u_2. This discourse referent takes an antecedent $\mathcal{A}(u_2)$ which is *not* spelled out in the semantics but instead supplied by the context. We represent this on the right-hand side of (13b). However, the semantics *does* require coreference between u_2 and $\mathcal{A}(u_2)$ by the condition $u_2 \rightarrow \mathcal{A}(u_2)$, which requires coreference in each assignment. In the unabbreviated expression in (13c), this is expressed as $\partial(\nu(o)(u_2) = \nu(o)(\mathcal{A}(u_2)))$. ∂ is Beaver's presupposition operator (Beaver 1992), reflecting that this meaning is presuppositional. To avoid clutter we do not use ∂ explicitly in the DRSs, but all anaphoric constraints are to be understood as presuppositional.

In a plural context, it is also possible to require only global coference, $\cup u_1 \rightarrow \cup\mathcal{A}(u_1)$. This is what happens with the reciprocal pronoun in (12), and we will see that it can also happen with ordinary plural pronouns. However, the reciprocal is special in that in addition to global coreference, it also requires case-wise distinctness, $u \neq \mathcal{A}(u)$.

4 Glue premises

In an LFG+Glue setting (Dalrymple et al. 1993, Dalrymple 1999, Asudeh 2012), the components of a sentence contribute meaning constructors: pairs consisting of a left-hand side representing a meaning, here an expression of Partial Plural Discourse Representation Theory, and a right-hand side representing a logical formula over semantic structures corresponding to that meaning. The right-hand side constitutes 'assembly instructions' specifying how the meaning contributions of the parts of the sentence can be combined.

Our compositional analysis of English reciprocals assumes the meaning constructors in (15) (abstracting away from the individual contributions of *the* and *girls*). As discussed above, in the lexicon we represent the antecedent of the reciprocal pronoun with discourse referent x as $\mathcal{A}(x)$; for clarity, we have explicitly resolved the antecedent of u_2 to u_1 in the DRS in (1), repeated here as (14). The derivation tree is given in Figure 1 at the end of the paper. To simplify the tree, we do not show how the subject resource g_σ is temporarily ignored by hypothetical reasoning as is standard in Glue: for a discussion of hypothetical reasoning in a Glue setting, see Dalrymple et al. (2019, chapter 8).

(14) a. The girls saw each other.

b. $${}_{s}\left[\begin{array}{ll} \text{PRED} & \text{`SEE}\langle\text{SUBJ,OBJ}\rangle\text{'} \\ \text{SUBJ} & {}_{g}\left[\begin{array}{ll} \text{SPEC} & \text{`THE'} \\ \text{PRED} & \text{`GIRL'} \end{array}\right] \\ \text{OBJ} & {}_{eo}\left[\begin{array}{ll} \text{PRED} & \text{`PRO'} \\ \text{PRONTYPE} & \text{RECIP} \end{array}\right] \end{array}\right]$$

c. $$\begin{array}{|l|}\hline u_1\ u_2 \\ \hline girl(u_1) \\ see(u_1,u_2) \\ \cup u_2 \rightarrow \cup u_1 \\ u_2 \neq u_1 \\ \hline \end{array}$$

(15) a. *the girls* $\lambda P.[x|girl(x)]; P(x) : \forall F.(g_\sigma \multimap F) \multimap F$

b. *saw* $\lambda x.\lambda y.[\ |see(x,y)] : g_\sigma \multimap [eo_\sigma \multimap s_\sigma]$

c. *each other* $\lambda P.[x| \cup x \rightarrow \cup \mathcal{A}(x), x \neq \mathcal{A}(x)]; P(x) : \forall F.(eo_\sigma \multimap F) \multimap F$

Hurst (2012) also presents an LFG+Glue analysis of reciprocals which differs from ours in several ways. First, he does not quantify over possible reciprocal scopes, since scope is not a focus of his discussion, and so his analysis accounts only for the narrow scope reading. Second, he adopts an analysis of the reciprocal as a polyadic quantifier; as discussed in the previous section, our analysis is not quantificational in this sense. See Haug and Dalrymple (2020) for further discussion and motivation for the relational analysis which we adopt.

5 Reciprocal scope

Complex sentences containing a reciprocal expression are often ambiguous, exhibiting a narrow scope reading which Heim et al. (1991) call an "I-reading", and a wide scope or "we-reading".

(16) The girls think they saw each other.

a. Each girl thinks: "We saw each other." (narrow scope/"we"-reading)

b. Each girl thinks: "I saw her." (wide scope/"I"-reading)

On natural LFG assumptions, wide/narrow reciprocal scope does not correlate with a syntactic ambiguity, and there is only one f-structure for example (16).

(17) $$_{t}\begin{bmatrix} \text{PRED} & \text{`THINK}\langle\text{SUBJ,COMP}\rangle\text{'} \\ \text{SUBJ} & _{g}\begin{bmatrix} \text{SPEC} & \text{`THE'} \\ \text{PRED} & \text{`GIRL'} \end{bmatrix} \\ \text{COMP} & _{s}\begin{bmatrix} \text{PRED} & \text{`SEE}\langle\text{SUBJ,OBJ}\rangle\text{'} \\ \text{SUBJ} & _{p}\begin{bmatrix} \text{PRED} & \text{`PRO'} \end{bmatrix} \\ \text{OBJ} & _{eo}\begin{bmatrix} \text{PRED} & \text{`PRO'} \\ \text{PRONTYPE} & \text{RECIP} \end{bmatrix} \end{bmatrix} \end{bmatrix}$$

Haug and Dalrymple (2020) provide the representations in (18) for the narrow scope (16a) and wide scope (16b) readings.

(18) a.
$$\begin{array}{|l|}\hline u_1 \\ \hline girl(u_1) \\ think\left(u_1, \begin{array}{|l|}\hline u_2\ u_3 \\ \hline \cup u_2 \rightarrow \cup u_1 \\ \cup u_3 \rightarrow \cup u_2 \\ u_3 \neq u_2 \\ see(u_2, u_3) \\ \hline \end{array}\right) \\ \hline \end{array}$$

b.
$$\begin{array}{|l|}\hline u_1\ u_2\ u_3 \\ \hline girl(u_1) \\ u_2 \rightarrow u_1 \\ \cup u_3 \rightarrow \cup u_2 \\ u_3 \neq u_2 \\ think\left(u_1, \begin{array}{|l|}\hline \\ \hline see(u_2, u_3) \\ \hline \end{array}\right) \\ \hline \end{array}$$

According to this analysis, there are two differences between the narrow and wide scope readings. First, in the narrow scope reading, the local antecedent of the reciprocal, in this case *they*, is group identical to its antecedent *the girls*, as expressed by $\cup u_2 \rightarrow \cup u_1$, whereas in the wide scope reading, *they* is bound by its antecedent *the girls*, as expressed with $u_2 \rightarrow u_1$. Second, in the narrow scope reading, the constraints on the reciprocal and its antecedent appear in the subordinate clause, whereas in the wide scope reading, they appear in the main clause.[3]

To simplify matters, we treat the difference between group identity and a bound reading as a lexical ambiguity in *they* (although it is more properly an ambiguity in the anaphoric resolution), as shown in (19).

(19) a. *they*$_{cumul}$ $\lambda P.[x| \cup x \rightarrow \cup\mathcal{A}(x)]; P(x) : \forall F.(p_\sigma \multimap F) \multimap F$
b. *they*$_{dist}$ $\lambda P.[x|x \rightarrow \mathcal{A}(x)]; P(x) : \forall F.(p_\sigma \multimap F) \multimap F$

[3]There are two more logical possibilities: We could have a bound reading appearing in the lower clause. This yields a contradiction because the bound reading does not supply the reciprocal with the plurality that it needs. We could also have a group identity reading in the higher clause. This yields a so-called crossed reading, which we do not further discuss here. See Haug and Dalrymple (2020) for more details.

c. *think* $\lambda x.\lambda K.[\,|think(x, K)] : g_\sigma \multimap [s_\sigma \multimap t_\sigma]$

The narrow scope reading is derived as shown in Figure 2, and the derivation for the wide scope reading is shown in Figure 3.

Because we give the reciprocal and the pronoun the type of generalized quantifiers, LFG+Glue directly allows the contribution of the reciprocal and the pronoun to float up (Dalrymple et al. 2019, chapter 8). This means it is straightforward to account for the English data, as we would expect, because English does not constrain reciprocal scope at the syntax-semantics interface.[4]

6 Scope marking: Japanese verbal affix *aw*

Nishigauchi (1992) analyzes the Japanese reciprocal verbal affix *aw* as marking reciprocal scope. In example (20), the reciprocal affix *aw* appears on the subordinate verb, and only a narrow scope reading is available.

(20) John to Mary ga [zibun-tati ga kizutuke-**aw**-ta to] sakkakusi-ta
and NOM self-PL NOM hurt-AW-PST that illusion-PST
'John and Mary had the illusion that [selves hurt.AW each other].' (narrow scope only)

$$\begin{array}{|l|}\hline u_1 \\ \hline John.and.Mary(\cup u_1) \\ have.illusion\left(u_1,\ \begin{array}{|l|}\hline u_2\ u_3 \\ \hline \cup u_2 \rightarrow \cup u_1 \\ \cup u_3 \rightarrow \cup u_2 \\ u_3 \neq u_2 \\ hurt(u_2, u_3) \\ \hline \end{array}\right) \\ \hline \end{array}$$

In (21), where the reciprocal *aw* appears on the main clause verb, only a wide scope reading is available.

(21) John to Mary ga [zibun ga kizutuke-ta to] sakkakusi-**aw**-ta
and NOM self NOM hurt-PST that illusion-AW-PST
'John and Mary had-the-illusion.AW that self hurt each other.' (wide scope only)

[4] On the other hand, there are semantic constraints on scope in the sense that however high the reciprocal appears, the interpretation will always be the same as if it appeared in the same DRS as the highest discourse referent in its antecedent chain: see Haug and Dalrymple (2020, 3.4).

$$\begin{array}{|l|}\hline u_1\ u_2\ u_3 \\ \hline John.and.Mary(\cup u_1) \\ u_2 \to u_1 \\ \cup u_3 \to \cup u_2 \\ u_3 \neq u_2 \\ have.illusion\left(u_1, \begin{array}{|l|}\hline \\ \hline hurt(u_2, u_3) \\ \hline \end{array}\right) \\ \hline \end{array}$$

This illustrates what Nishigauchi (1992, 166) calls the "'scope-indicator' flavor" of *aw*: the reciprocal's scope is the clause in which the affix appears.

Examples (20) and (21) share the same basic f-structure; they differ only in placement of the reciprocal affix.

(22)
$$ {}_{i}\left[\begin{array}{ll} \text{PRED} & \text{`HAVE.ILLUSION}\langle\text{SUBJ,COMP}\rangle\text{'} \\ \text{SUBJ} & {}_{jm}\left\{\begin{array}{l} \left[\text{PRED `JOHN'}\right] \\ \left[\text{PRED `MARY'}\right] \end{array}\right\} \\ \text{COMP} & {}_{h}\left[\begin{array}{ll} \text{PRED} & \text{`HURT}\langle\text{SUBJ,OBJ}\rangle\text{'} \\ \text{SUBJ} & {}_{z}\left[\begin{array}{ll} \text{PRED} & \text{`PRO'} \\ \text{PRONTYPE} & \text{REFL} \end{array}\right] \\ \text{OBJ} & {}_{eo}\left[\begin{array}{ll} \text{PRED} & \text{`PRO'} \\ \text{PRONTYPE} & \text{RECIP} \end{array}\right] \end{array}\right] \end{array}\right] $$

We propose that there are two crucial differences between the meaning constructors for the English pronominal reciprocal *each other* and the Japanese affixal reciprocal *aw*. The first difference is that *aw*'s scope is fixed as the clause in which it appears ($\uparrow_\sigma$ in the lexical entry for *aw* in (23)): there is no quantification over possible scope sites, as there is in English. The second difference has to do with the reciprocal argument, which is filled by the reciprocal pronoun in English. The reciprocal argument of Japanese *aw* is not fixed, and may be either in the same clause or in a lower clause relative to the reciprocal affix. In both of the examples under discussion, it is the OBJ argument of the verb 'hurt': in (20) this is the OBJ of the verb with reciprocal marking, and in (21) it is the COMP OBJ of the verb with reciprocal marking. In the lexical entry for the reciprocal affix in (23), we use a functional uncertainty to identify this argument: $(\uparrow \text{GF}^{+})_\sigma$.[5] Both of these differences affect the Glue side of the meaning constructor; the meaning side is the same as in English. Compare the meaning constructor for the English reciprocal *each other* given in (12), repeated in (24), with the meaning constructor for the

[5]We leave aside the question of whether there are additional constraints on the syntactic role of the reciprocal argument.

Japanese reciprocal affix *aw* in (23): the left-hand side representing the meaning is the same in both meaning constructors, while the right-hand side is different.

(23) $[\![aw]\!] = \quad \lambda P. \begin{array}{|l|}\hline u \\ \hline \cup u \rightarrow \cup \mathcal{A}(u) \\ u \neq \mathcal{A}(u) \\ \hline \end{array} ; P(u) : ((\uparrow \text{GF}^{+})_{\sigma} \multimap \uparrow_{\sigma}) \multimap \uparrow_{\sigma}$

(24) $[\![\textit{each other}]\!] = \quad \lambda P. \begin{array}{|l|}\hline u \\ \hline \cup u \rightarrow \cup \mathcal{A}(u) \\ u \neq \mathcal{A}(u) \\ \hline \end{array} ; P(u) : \forall F.(eo_{\sigma} \multimap F) \multimap F$

We assume the following additional meaning constructors for the sentences in (20) and (21):

(25) a. *John and Mary* $\lambda P.[x|John.and.Mary(\cup x)]; P(x) : \forall F.(jm_{\sigma} \multimap F) \multimap F$
b. *kizutuke-ta* $\lambda x.\lambda y.[\,|hurt(x, y)] : z_{\sigma} \multimap [eo_{\sigma} \multimap h_{\sigma}]$
c. *sakkakusi-ta* $\lambda x.\lambda K.[\,|have.illusion(x, K)] : jm_{\sigma} \multimap [h_{\sigma} \multimap i_{\sigma}]$

Notice that there is an important difference in the expression of the subordinate clause subject in examples (20) and (21): example (20), with narrow scope, requires the plural reflexive *zibun-tati* 'self-PL', while example (21), with wide scope, requires the unmarked reflexive *zibun* 'self'. As discussed by Nishigauchi (1992) (see also Kawasaki 1989), the unmarked reflexive *zibun* is obligatorily distributive, and must be used in the context of the wide scope reading. In contrast, Nishigauchi (1992, 195) observes that the plural reflexive *zibun-tati* "apparently cannot serve as a variable bound by the distributive operator associated with the matrix subject", and so is incompatible with a wide scope reading. Kawasaki (1989) analyzes *zibun-tati* as denoting a group associated with its antecedent: in support of this view, she notes that *zibun-tati* may have a singular antecedent:

(26) John wa zibun-tati ni tuite hanasi-ta
TOP self-PL about talk-PST
'John talked about the group including John.' (Kawasaki 1989, 116)

Example (27) can be interpreted either collectively or distributively:

(27) John to Mary ga zibun-tati ni tuite hanasi-ta
and NOM self-PL about talk-PST
'John and Mary talked about their group.' [collective or distributive]
(Kawasaki 1989, 128)

In line with the distributive reading of (27), we predict that example (20) also has a reading "John has the illusion that John and his group hurt each other and Mary has the illusion that Mary and her group hurt each other". Because *zibun-tati* on the collective reading can mean "the group containing John and Mary" we also predict that (20) has a reading "John and Mary have the illusion that their group hurt each other". We leave for future research to see whether these predictions are borne out.

Here we only focus on the simplest reading of *zibun-tati*, which indicates group identity with the antecedent. We propose the following meaning constructors for *zibun* and *zibun-tati*:

(28) a. $zibun_{dist}$ $\lambda P.[x|x \rightarrow \mathcal{A}(x)]; P(x) : \forall F.(z_\sigma \multimap F) \multimap F$
b. *zibun-tati* $\lambda P.[x| \cup x \rightarrow \cup\mathcal{A}(x)]; P(x) : \forall F.(z_\sigma \multimap F) \multimap F$

In Figures 4 and 5, we show the derivation trees for examples (20) and (21).

The Japanese and English reciprocal constructions illustrate two different strategies for encoding reciprocity and reciprocal scope. Our analysis takes advantage of functional uncertainty and the resource-sensitivity of Glue to produce all and only the available readings for the English reciprocal pronoun and the Japanese reciprocal affix *aw*. The *aw* affix does not fix the reciprocal argument: this is captured with a functional uncertainty. On the other hand, *aw* does fix scope to the clause in which it appears: this is captured by the absence of quantification over possible scope sites in the linear logic.

7 Conclusion

In this paper, we have augmented the semantic analysis of reciprocals and reciprocal scope from Haug and Dalrymple (2020) with an explicit interface to LFG syntax using Glue semantics. The difference between English and Japanese is but one case of how different reciprocal constructions put different constraints on reciprocal scope. Other morphosyntactic constraints on reciprocal scope are largely unexplored in the literature; in future work, we hope to examine other means of expressing reciprocity and how reciprocal scope is constrained cross-linguistically.

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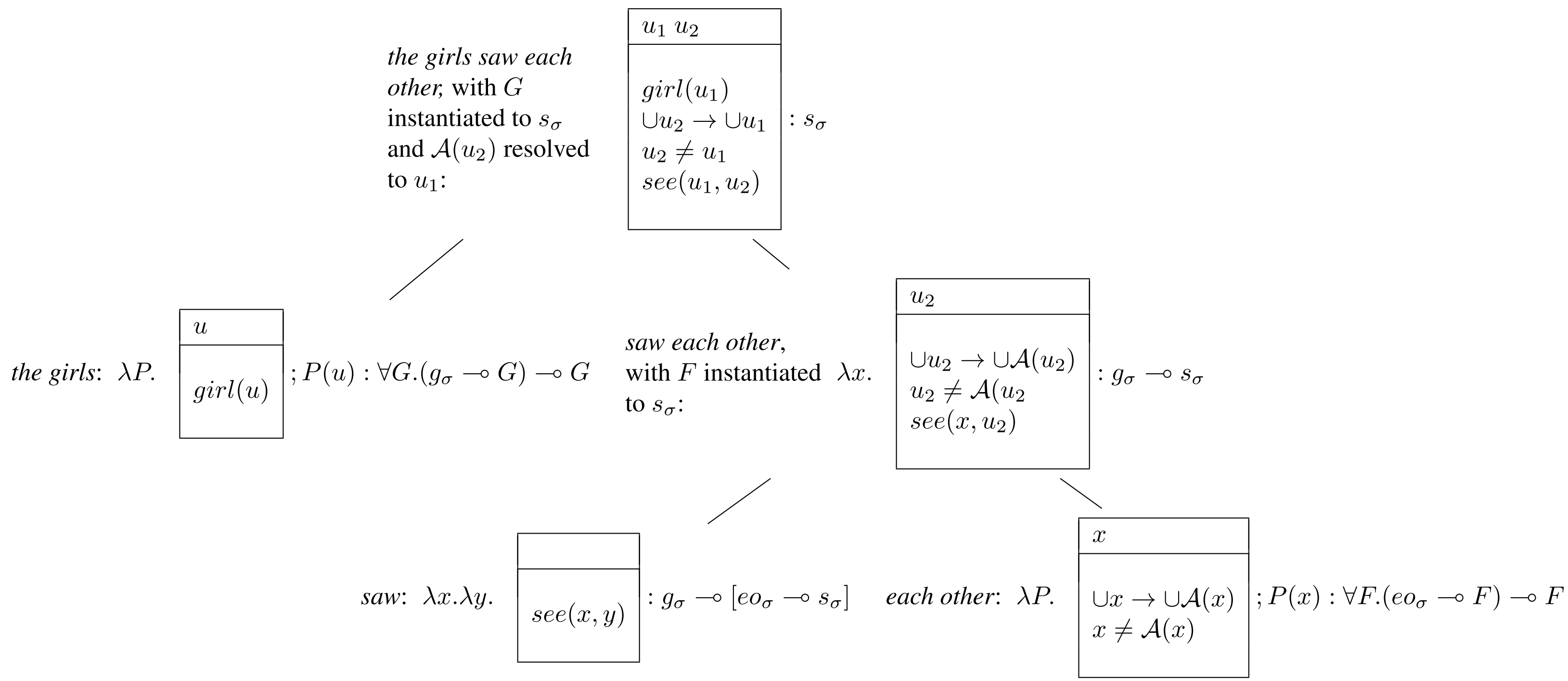

Figure 1: Derivation tree for *The girls saw each other*

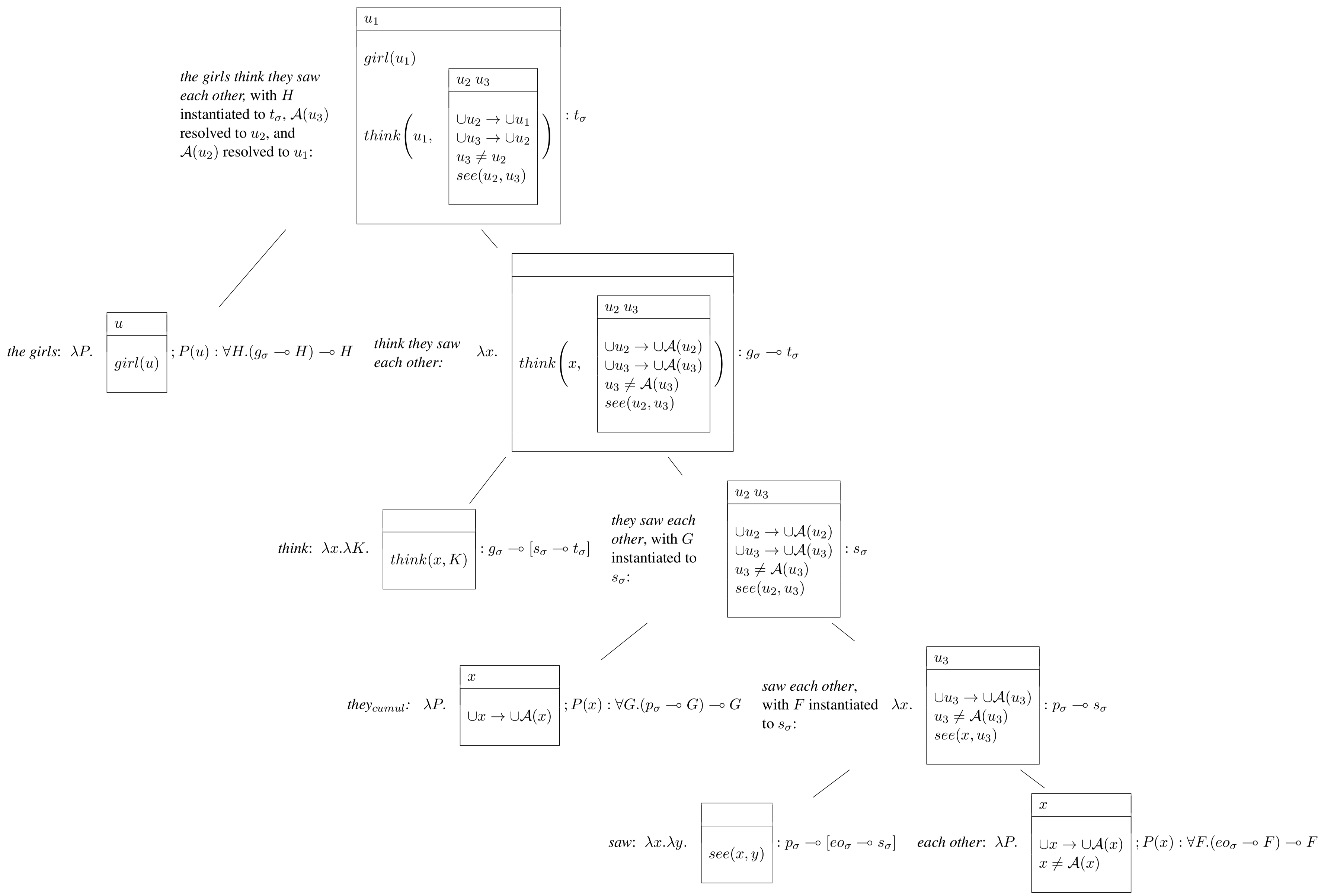

Figure 2: Derivation tree for the narrow scope reading of *The girls think they saw each other*

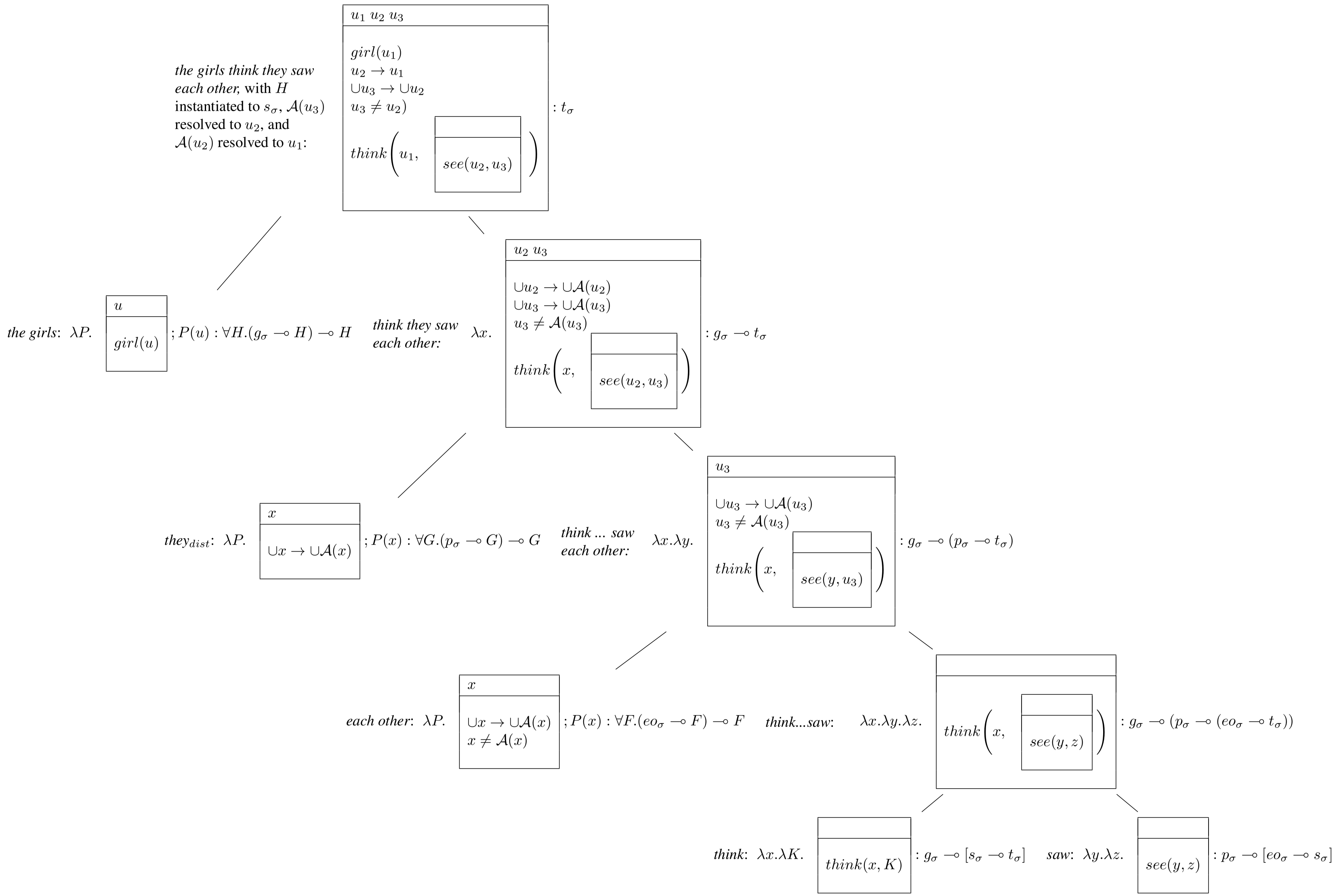

Figure 3: Derivation tree for the wide scope reading of *The girls think they saw each other*

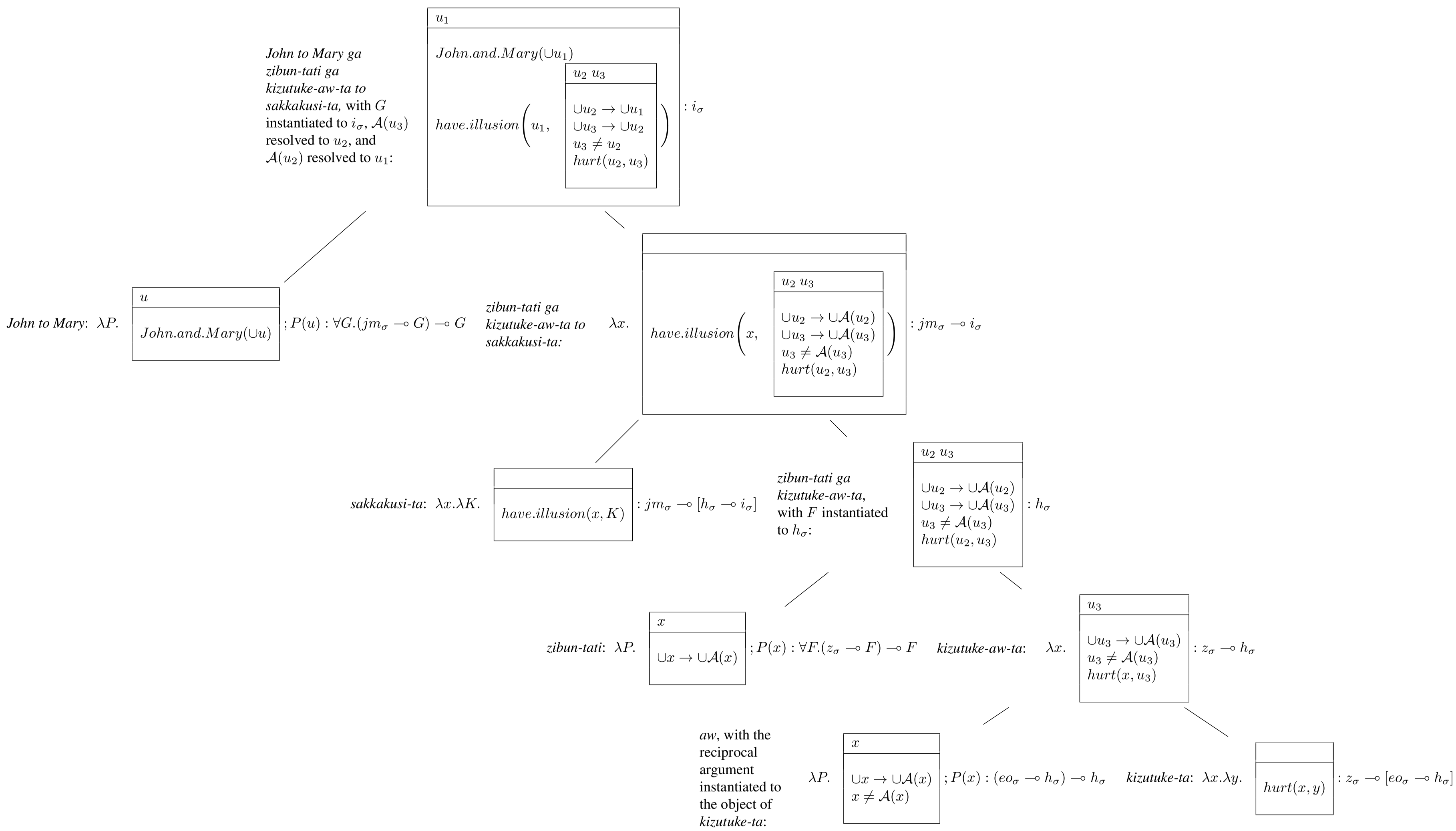

Figure 4: Derivation tree for *John to Mary ga zibun-tati ga kizutuke-aw-ta to sakkakusi-ta* (narrow scope)

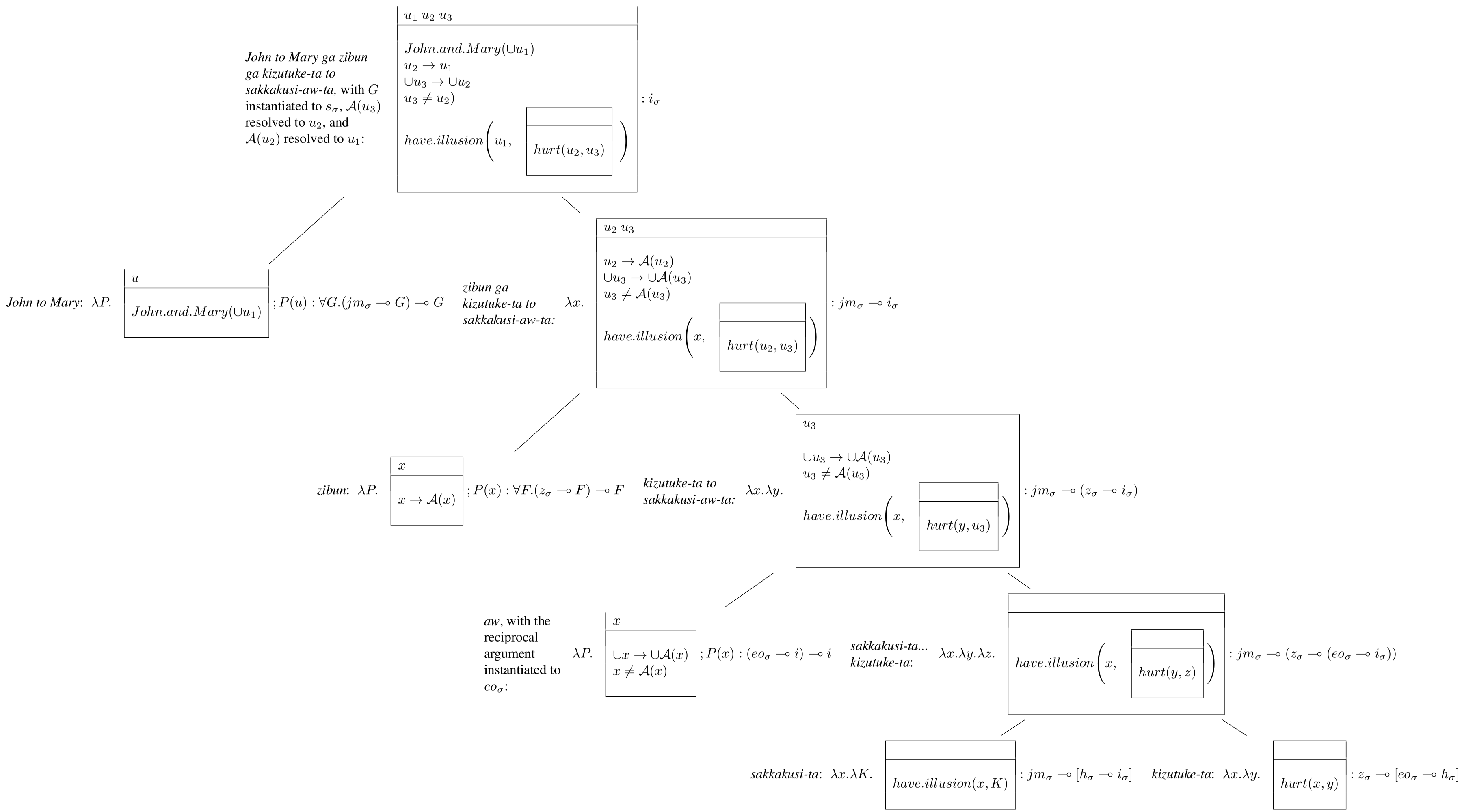

Figure 5: Derivation tree for *John to Mary ga zibun ga kizutuke-ta to sakkakusi-aw-ta* (wide scope)