A null theory of long-distance reciprocity in English

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1. Introduction

Higginbotham (1981) discusses sentences like (1), which are ambiguous between the two readings indicated in (1a,b). Henceforth, we will refer to the (1b) reading of (1) and similar sentences as *long distance reciprocity* or LDR, for short.[1]

(1) John and Mary think they like each other.
   a. John and Mary each think: "We like each other."
   b. John thinks he likes Mary and Mary thinks she likes John.

LDR can be accounted for if the reciprocal either takes scope at the matrix clause or takes the matrix subject as its antecedent. This is assumed in the analyses of LDR in Higginbotham (1981), Heim et al. (1991a), Heim et al. (1991b), Dalrymple et al. (1998). But there is a problem with these accounts. Binding of reciprocals is governed by local principles, Condition A, and reciprocals should not be able to look for antecedents outside of their clause, and quantifier scope normally cannot cross boundaries of a finite clause. To see the problem, take, as an example, Heim et al. (1991b). In their account, reciprocals are interpreted as *someone among* x_{range} *different from* $x_{contrast}$, where $x_{contrast}$ is bound by a distributive operator *D* (see (2) for its definition), and x_{range} is bound by the plural individual to which the distributive operator applies.

(2) *D:* $\lambda P.\lambda x.(\forall a \leq x)(a \text{ is an individual} \rightarrow Pa)$

In (1) the *D* that binds $x_{contrast}$ takes scope at the matrix clause. If we furthermore assume that this *D* binds the pronoun *they* we get the interpretation in (3). It should be clear that this is LDR.

[1] We intend the term as a purely descriptive label, and do not want to imply that LDR involves reciprocals with non-local antecedents, or that scope of the reciprocal is involved in the ambiguity.

(3) ($\forall a \leq$ John and Mary)(a is an individual$\rightarrow$ a thinks that a likes someone among John and Mary different from a)

LDR is captured but only at the cost of allowing non-local antecedents for reciprocals. This does not concern $x_{contrast}$, which has a local antecedent in this case (the embedded subject *they*) but it is problematic for x_{range}. In order to avoid over-generation , Heim et al. (1991a) constrain non-local binding of x_{range}. These add extra stipulations on binding and preferably, we should look for a way to avoid them. Furthermore, Dimitriadis (2000) shows that reciprocals always find its antecedents locally. Consider (4).

(4) The lawyers who represent John and Mary think they will sue each other. [Dimitriadis (2000), p. 58]

(4) has as one of its interpretations that 'John's lawyer thinks John will Sue May, and Mary's lawyer thinks Mary will sue John'. Let us see how Heim et al. (1991b) could deal with (4). Following their treatment of other cases of LDR, we could assume the embedded subject *they* and $x_{contrast}$ are bound by a matrix *D*. This gives us (5a) which means that the lawyers think that they (=the lawyers) will sue each other. This is a possible interpretation but not the one we want. Assume, instead, that pronouns are interpreted as functions. These could be functions from situations and descriptions to individuals (Elbourne, 2006) but to simplify the matter let us assume that the function is from individuals to individuals. In particular, such a function can be applied to a lawyer and give, as its value, say, the individual that the lawyer represents (notated below as $f(a)$). Furtermore, assume that $x_{contrast}$ can be interpreted in the same manner. If so, (4) is interpreted as (5b), which is also wrong. The reason is that x_{range} is still bound non-locally, and therefore, its value is *the lawyers*, which leads to the non-existent reading that John and Mary's lawyers think John and Mary will sue the lawyers. Now, there might be ways to exclude this reading. However, we still did not derive the reading we want. Clearly, we need the value of x_{range} to be *John and Mary*. Where could the reciprocal pick this antecedent? Not in the relative clause because the plural *John and Mary* does not c-command *each other*. The only other option the functional pronoun *they*, whose range is *John and Mary*. But that means that *each other* finds antecedents for both $x_{contrast}$ and x_{range} locally. Dimitriadis adds a mechanism to retrieve the range of functional pronouns and shows that this allows us to account for other cases of LDR, like (1), as well. Therefore, there is no need to analyze LDR as a case of non-local binding.

(5) a. $\forall a \leq$the lawyers(a is an individual$\rightarrow$ a thinks that a will sue someone among the lawyers different from a)

b. $\forall a \leq$the lawyers(a is an individual$\rightarrow$ a thinks that $f(a)$ will sue someone among the lawyers different from $f(a)$)

In this paper we present a new analysis of LDR in which reciprocals find their antecedents locally. We differ from Dimitriadis' account in the following respect: while he assumed that LDR should be analyzed on par with distributive readings we argue that they should be

analyzed on par with cumulative readings. This analysis has been briefly considered and rejected by Dimitriadis. We think his arguments against such an analysis are inconclusive. Moreover, treating LDR as a case of cumulation brings in advantages. It seems that LDR is restricted to the cases in which the reciprocal is in a complement clause of an attitude verb. For example, LDR is not possible when the reciprocal is embedded in a relative clause. (6) does not mean the same as 'each of Ron, Tom and John read the book that they gave the others. It is only interpretable if Ron, Tom and John each read some book, that they had mutually exchanged as presents. This is a relative-clause-internal reading of the reciprocal.

(6) Ron, Tom, and John read the book that they gave each other.

This is problematic for Dimitriadis (2000) and others who try to derive LDR by binding of a pronoun and/or reciprocal by a distributive operator because binding can span clause and island boundaries. For example, in (7) *they* can be interpreted as a bound pronoun. On the other hand, cumulative readings are more restricted, and usually are clause-bounded (Beck and Sauerland, 2000).

(7) Ron, Tom, and John read the book that they had bought.

Since LDR shows up only with attitude verbs this suggets that the reciprocal is in fact interpreted locally, and we get the effect of long-distance reciprocity just because of some properties of attitude verbs. This is the analysis that we are going to pursue here. In a way this analysis of LDR is minimal since it does not postulate any special mechanism to allow for non-local antecedents, or special interpretations for pronouns, as is assumed in Dimitriadis (2000).

Before we move to the body of the analysis, we want to clarify one last issue. One might not be convinced from what we said above that LDR exists as an independent reading. Recall (1). The LDR reading might be thought to be implied by the non-LDR reading (1a). Clearly, if John thinks that he and Mary like each other, he must also think that he likes Mary. Could this be the reason that we find (1b) possible here? Higginbotham (1981) does not think so. One of the arguments against this conclusion is that we would then expect many more 'readings' of (1). For example:

(8) a. "John thinks he likes Mary and Mary thinks they like each other."
b. "John thinks they like each other and Mary thinks John likes her."

But intuitively, these readings are missing in our interpretation of (1). We conclude that LDR does not arise just because it is implied by other readings, and should be accounted for in a different manner. The rest of the paper discusses how.

The paper is organized as follows. In the next section we introduce our background assumptions: semantics with pluralities, and semantics of attitude verbs. As semantics of pluralities, we pick one which is tied to event semantics (Landman, 2000). Why we need event semantics will become obvious once we move to LDR. In section 3 we show how the semantics of attitude verbs combines with the semantics of pluralities to mimick readings

that are normally analyzed by postulating bound pronouns. In section 4 we show how the same mechanism derives LDR.

2. Background Assumptions

2.1 Event Semantics with Pluralities (Landman, 2000)

We assume that the interpretive model contains D_i, the domain of individuals, and D_e, the domain of events. We assume that these domains are structured as in Landman (2000). Both singular and plural individuals are in D_i, similarly for events and D_e. D_i and D_e are ordered by 'sum', $\oplus$. Any plural individual is sum of singular individuals, while any singular individual is sum of itself and nothing else. For example, John$\oplus$Bill is a plural individual John and Bill. We can furthemore define $\leq$, where $a \oplus b = b$ iff $a \leq b$. Another operator that will be useful later is $*$. $*$ generates a sublattice. Intuitively, $*$ behaves like a pluralizer. For example, $*$(boy) gives us a sublattice in which each element is one boy or more.

D_i and D_e are free i-join semilattices (with $\oplus$ being the join) and they are isomorphic to Boolean lattices with the minimal element cut off. Landman (1991) shows why this is what we want for interpretation of individuals and events. To distinguish between count nouns and mass nouns, or quantizied and cumulative events, we only need to add that the structure is atomic for count nouns and quantizied events, and non-atomic for mass nouns and cumulative events.

Sentences are interpreted in neo-Davidsonian framework: verbs are predicates of events, and arguments are introduced through separate thematic roles. For example, *Burt and Greg kissed Clara and Lisa* is interpreted as (9).

(9) $\exists e(*\text{kiss}(e) \wedge *Ag(e) = \text{Burt} \oplus \text{Greg} \wedge *Th(e) = \text{Clara} \oplus \text{Lisa})$

Notice that, as is standard in event semantics, predicates and thematic roles are pluralized by $*$. Thus, the event e is possibly a plural event that has subevents in which parts of Burt $\oplus$ Greg kissed parts of 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 a cumulative reading (Krifka, 1986). We believe that cumulative readings are crucial for obtaining LDR.

Now, we are in a position to give the semantics for *each other*. We treat *each other* as a polyadic quantifier. Basically, it takes a relation and some plural individual and says that for every two subparts of the plural individual, if the the two subparts are not the same they must be related by the relation. This semantics then gives us the meaning of *Burt and Clara kissed each other* as in (10b), i.e., the sentence means Burt kissed Clara and Clara kissed Burt.

(10) a. $[\![\text{each other}]\!] = \lambda R.\lambda x.\lambda e.(\forall y, z \leq x)(\exists e' \leq e)(y \neq z \rightarrow R(y, z, e'))$

b. $(\exists e)(\forall y, z \leq \text{b} \oplus \text{c})(\exists e' \leq e) \left(\begin{array}{l} y \neq z \rightarrow *kiss(e') \wedge *Ag(e') = y \wedge \\ *Th(e') = z \end{array} \right)$

This semantics can't account for weaker readings of reciprocal sentences, discussed most thoroughly in Dalrymple et al. (1998). Since we treat reciprocals as polyadic quantifiers, as Dalrymple et al. (1998) do, this could be easily amended by extending the readings in the way they do. Since the range of reciprocal readings is not the topic of this paper, we will ignore this issue here.

2.2 Semantics of Attitude Verbs (Cresswell and von Stechow, 1982)

Perhaps the most obvious analysis of verbs like *believe* and the way they relate to the embedded clause was proposed by Hintikka (1962). According to this analysis, the embedded clause simply denotes the set of worlds where it is true, and a sentence like *John believes that* p means that all the worlds which John considers as candidates for the actual world satisfy p. The set of worlds John takes to be such candidates in world w is usually referred to as DOX_j^w, John's doxastic alternatives in w. Thus, for *John believes that p* we get $DOX_j^w \subseteq p$. However, as has been widely discussed in the literature, this propositional account is not fine-grained enough to distinguish between the three modes of attitude, *de dicto*, *de re* and *de se*.

As Lewis (1979) showed, the differences between *de dicto* and *de se* can be captured if we switch from propositions (sets of worlds) to properties (sets of functions from worlds to individuals, or, equivalently, world-individual pairs). Let us use $\mathcal{L}_a^w$ as the notation for the set of world-individual pairs $\langle w', b\rangle$ such that a keeps open the possibility that he is b living in w'. According to this analysis, a sentence like *John believes that* P means that $\mathcal{L}_{John}^w \subseteq P$. Cresswell and von Stechow (1982) show how Lewis' approach can deal with *de re* when combined with Kaplan's insights on acquaintance relations (Kaplan, 1969). In Cresswell and von Stechow (1982), a *de re* believes of b that P must satisfy three conditions:

(11) a. There is a vivid acquaintance relation R (notation: $\mathcal{A}(R)$)
b. R relates the agent of belief, a, and *res*, b
c. $\mathcal{L}_a^w \subseteq \{\langle w', x\rangle : x$ is related by R to y in w' and Py is true in $w'\}$

Let us see how this works on one example. Ralph sees Ortcutt walking down the street. Ortcutt is well dressed so Ralph forms a belief right away: Ortcutt must be a professor. We can report on this situation:

(12) Ralph believes that Ortcutt is a professor.

This is a *de re* belief. In Cresswell and von Stechow's analysis (12) is true if the following holds:

(13) $$(\exists R)\left(\begin{array}{l}\mathcal{A}(R) \wedge R(\text{Ralph, Ortcutt}) \wedge \\ \mathcal{L}_{Ralph}^w \subseteq \{\langle w', x\rangle : professor(\iota b'.R(x, b'))\}\end{array}\right)$$

(13) requires that there is some cognitively vivid acquaintance relation R which relates Ralph and Ortcutt. It is commonly assumed that direct cognitive relations (seeing, hearing

etc.) satisfy this condition. Since in our case Ralph saw Ortcutt, we can take R to be 'x sees y walk down the street'. (13) says that Ralph believes that the person he is related to by R is a professor. Since this is Ortcutt in our case, (13) is true in the scenario described.

In Cresswell and von Stechow's analysis, attitude verbs are transitive and their internal argument is a structured proposition. A structured proposition is a pair $\langle\langle\alpha_1, \ldots \alpha_n\rangle, \eta\rangle$ s.t. $\eta(\alpha_1, \ldots \alpha_{n-1})$ is a proposition. To be able to read the formula bear in mind that $\alpha_1, \ldots \alpha_n$ are *res*, and η is the property that one believes to hold of these objects. To create a structured proposition one needs to assume a polymorphic functor that takes any number of arguments and a predicate and combines them into a structured proposition. Cresswell and von Stechow (1982) assume that *that* is the relevant polymorphic functor. Notice that in order to make this work *that* needs to be supplied with *res* separately from the predicate that applies to *res*. To achieve that one needs to assume movement into the position where the *res* and the property can be taken as arguments of the polymorphic *that*. *That* then returns a structured proposition.

(14) $[\![\text{that}]\!]$=$\lambda a_1 \ldots a_n \lambda\eta.\langle\langle a_1, \ldots, a_n\rangle, \eta\rangle$, if $\eta(a_1, \ldots a_n)$ is a proposition, undefined otherwise

The structured proposition is the internal argument of the attitude verb. In our event semantics, then, the sentence (12) comes out as follows:

(15) $$(\exists e)\left(\begin{array}{l} *\text{believe}(e) \wedge *Ag(e) = \text{Ralph} \wedge \\ *Th(e) = \langle \text{Ortcutt}, \lambda x.\text{professor}(x)\rangle \end{array}\right)$$

In (15) we introduced the internal argument of *believe* through the thematic role *Theme*. This is just a convenient label and might be substituted by some others if one wishes so. What is more crucial, *believe* and other attitude verbs induce lexical requirements on this argument. This is similar to other verbs. For example, *kiss* requires that the agent touches the theme with her lips. In case of attitude verbs, the requirement is that the theme must be a structured proposition, where the first member is a *res*, and the second member is a property. The *res* and the property must satisfy requirements we discussed above (11). These, as we have seen, are the right conditions for *de re* belief.

Now, notice that thematic role *Theme* is pluralized. Of course we could block the pluralization but since the $*$ operator is normally taken to apply freely, this would be an extra assumption. If we allow it, we expect to get cumulative readings with attitude verbs, similar to the one that we discussed before (9). This, as we are going to see, allow us to derive LDR.

3. Cumulation in *de re* Attitudes – Dependent Readings

We believe that LDR readings can be accounted for by applying cumulation between individuals and their beliefs. In fact, cumulation is not restricted to LDR readings. It can be detected in other sentences with attitude verbs embedding plural arguments. (16) has as one

possible reading (16b). We follow Heim et al. (1991a) and refer to (16b) as a 'dependent reading'.

(16) John and Bill think they will win.

a. John and Bill think: "We'll win."

b. Each of John and Bill thinks: "I'll win."

The dependent reading of (16) falls out from what we assume so far about the semantics of attitude verbs, events and pluralities. Since this example is simpler than LDR readings we start with it.

(16) can be translated into the formula (17) (disregarding tense) which gives us a *de re* reading in which the pronoun is the res.

(17) $(\exists e)(*\text{think}(e) \wedge *Ag(e) = \text{John} \oplus \text{Bill} \wedge *Th(e) = \langle \text{they}, \text{win} \rangle)$

How is *they* interpreted? There are various options but to get the dependent reading, the simplest one suffices here. *They* is interpreted as John$\oplus$Bill. The agent role, which relates e to John and Bill, is pluralized. That means that e could have subevents one of which has John as the agent and another one which has Bill as the agent. Similarly, the theme role is pluralized, so e could have subevents which have parts of the structured proposition as their theme. The most straightforward way to define subparts of structured propositions is a pointwise definition:

$$\langle \alpha, \beta \rangle \leq \langle \alpha', \beta' \rangle \text{ iff } \alpha \leq \alpha' \text{ and } \beta \leq \beta'$$

Then, the subparts of $\langle \text{they}, \text{win} \rangle$ are $\langle \text{John}, \text{win} \rangle$ and $\langle \text{Bill}, \text{win} \rangle$ (provided *they* is interpreted as John and Bill, as we said above). Is there any other way to split the structured proposition, in particular, could we find subparts of the property *win*? Probably not because an atomic property has no readily available subparts (this does not mean that we cannot define part of relation which would split a property, only that the subparts might not be available in this case, in which respect it is similar to atomic individuals). Even if we did have subparts of the property available it would not matter much. The reason is that the property plays a role only in one condition of *de re* beliefs (see (11c)). This condition states that the agent's belief set ($\mathcal{L}_a^w$) is a subset of the set of $\langle w', x \rangle$, where x is related by R to someone who has the relevant property (*winning* here). Let us notate the set of $\langle w', x \rangle$ as Q. If we split the property *winning* into *win$_1$* and *win$_2$* and x is related by R to someone who *win$_1$* in Q', then Q' is a subset of Q. Now, let us say that a *de re* believes of b that *win$_1$*. Then, a's belief properties are a subset of Q'. But because *subset of* is a transitive relation, it holds that a's belief properties are a subset of Q, therefore, a *de re* believes of b that *win*. Thus, splitting a property into subparts, even if we allow it, would add no new readings to the one we have, and the only relevant way of splitting the structured proposition is by looking at the subpart of the res.

Here is a situation in which (17) is true: there is a plural event, which consists of subevents e_1 and e_2. e_1 is an event of thinking, which has John as the agent, and $\langle \text{John}, \text{win} \rangle$

as the theme. Thus, John is the res, and winning is the property. In other words, John thinks he will win. Furthermore, e_2 is an event of thinking, which has Bill as the agent, Bill as the res, and winning as the property. In other words, Bill thinks he will win. This is the dependent reading of (16). Notice that it falls out just from the combination of standard semantics of attitude verbs with Landman's semantics for pluralities. In fact, *any* semantics that can derive cumulation between co-arguments could derive this result.

Dimitriadis (2000) argues that one should not tie dependent readings to cumulation. According to him it should be treated as a distributive reading (cf. also Heim et al. 1991a,b). In (18), we define the distributive operator *D* with events.

(18) $[\![\text{D}]\!] = \lambda P.\lambda x.\lambda e.(\forall y \leq x)(\exists e' \leq e)(ATOM(y) \rightarrow P(x, e'))$

To get the dependent reading of (16) Dimitriadis assumes that *D* is in the matrix clause and *they* is bound by the *D*. This gives us the following formula, which captures the dependent reading of (16).

(19) $(\exists e)(\forall y \leq \text{j} \oplus \text{b})(\exists e' \leq e) \left(\begin{array}{l} *\text{think}(e') \wedge *Ag(e') = y \wedge \\ *Theme(e') = \langle y, \text{win} \rangle \end{array} \right)$

Dimitriadis' main reason to derive the dependent reading as a distributive reading is that this mechanism does not overgenerate. If one assumes cumulative readings for (16) as we do, Dimitriadis argues that one can't distinguish between the two following readings of (20):

(20) John and Bill think they will win.
  a. Each of John and Bill thinks: "I will win."
  b. John thinks: "Bill will win", and Bill thinks: "John will win."

While the first reading is attested (this is the dependent reading we just accounted for), the second "crossed" reading is missing, at least according to Heim et al. (1991a) and Dimitriadis (2000). Let us see why we derive the crossed reading. (17) only requires that John and Bill are agents and reses of the event e. But it says nothing about who of the two is the agent in a subevent and who of the two is the res in a subevent. Thus, e could be split into two subevents e_1 and e_2, where e_1 has John as the agent, Bill as the res (=John thinks Bill will win), and e_2 has Bill as the agent, John as the res (=Bill thinks John will win).

However, we want to point out that there is a difference between (20a) and (20b) on our account, too. In the crossed reading, John is the agent of one subevent, and Bill is the res (and Bill is the agent of the other subevent, of which John is the res). On the other hand, in the dependent reading, John is both the agent and res of one subevent, and similarly for Bill. That means that the acquaintance relations between the res and agent are different in the two cases. In the dependent reading, we can have the relation of identity. In the crossed reading, another cognitive relation must be supplied that would connect John and Bill but would not connect John with himself. It has been noticed that the identity relation is the most prominent acquaintance relation and that this relation can be present out-of-the-blue (Maier, 2006). This can explain the preference for dependent readings. Alternatively,

the dependent reading might be preferred because the subevents that make the dependent reading true are simpler than the subevents that make the crossed reading true. In the first case, a simple partition on John and Bill suffices. This is not true for the latter case where partition is not possible. If this reasoning is correct we might expect that in some contexts, the crossed reading becomes possible. While such cases are not that easy to find, they do exist. The following example was found on Google:

(21) Just about ten minutes ago I was talking to a Russian guy who was visiting his Uncle and cousin in Aktau. He is from a Russian city about 150 kilometers from the border with Kazakhstan. **We both thought that we were spies**. He was asking me if I had documents and where was I from. How did I get to Aktau...
http://www.travelblog.org/Asia/Kazakhstan/blog-6884.html

This example is from a weblog of an American who travels in Kazakhstan. The author is *not* a spy (neither does he think that), though he encounters local people who suspect him. Thus, the reading corresponding to (16a) ('I thought we were spies and he thought the same') does not make sense in this context. For the same reason the dependent reading corresponding to (16b) ('I thought I was a spy and he thought the same about himself') is excluded in this context. The only reading that is reasonable here is the 'crossed reading' ('I thought he was a spy and he thought the same about me'). Notice that in this case we have a vivid acquaintance relation, roughly, *meeting and talking to*. We think that this is the reason that the crossed reading emerges in this scenario. Dimitriadis (2000) offers the following minimal pair:

(22) a. The voters who voted for Street and Weinberg thought that they would lose.

b. The voters who voted against Street and Weinberg thought that they would win.

(22a) can be paraphrased as 'the voters of Street thought that Street would lose, and the voters of Weinberg thought that Weinberg would lose'. (22b) can be paraphrased as 'the voters voting against Street thought that Street would win, and the voters voting against Weinberg thought that Weinberg would win'. These readings contradict our world-knowledge about voters, namely, that they commonly believe that *their* candidates would win. Still, they are available while the readings conforming to our world-knowledge are absent. Dimitriadis (2000) notes that the embedded pronoun must bear some salient relation to the matrix subject, the argument of an attitude verb. He takes this to be a problem for a cumulative approach to dependent readings. But in fact, under our, cumulative, account we expect this state of affairs since the matrix subject must be related to the *res* (*they*) by some vivid acquaintance relation provided in the context, and *voting for* or *voting against* can do exactly that. All in all, we do make very similar predictions to Dimitriadis (2000). Apart from cases of identity, crossed readings only arise if *res* is related to the subject by some

contextually prominent relation.[2]

Even if we ignore such examples as (21), we think that the argument of Dimitriadis (2000) or Heim et al. (1991a,b) against cumulation is incomplete. In order to derive the dependent reading and block the derivation of the crossed reading it does not suffice to assume that this is a case of distributive reading. One also needs to show that other readings, and in particular, a cumulative reading, are impossible here. By what mechanism would it be blocked? Dimitriadis (2000) suggests that, for some reason, pronouns cannot enter cumulative readings. Consider the following pair, from Dimitriadis (2000). Both sentences can get a dependent reading: each father coached his son(s). But only (23a) can also get what looks like a crossed reading: each father coached sons of other fathers. This is clear if we try the continuation 'For reasons of fairness, nobody coached his own son'. This is possible in (23a) but in (23b) it does sound like a contradiction.

(23) a. The fathers coached the sons in Little League baseball.
b. The fathers coached their sons in Little League baseball.

This could be an argument that pronouns never enter cumulative readings. But consider the folowing example (24). It seems that here, too, the pronoun blocks the crossed reading. It is hard to understand (24b) as 'John's kids kissed Bill and Bill's kids kissed John', and this is easier in (24a).

(24) a. The kids kissed John and Bill.
b. Their kids kissed John and Bill.

However, we cannot derive the dependent reading of (24b) ('John's kids kissed John and Bill's kids kissed Bill') as a distributive reading because that would lead to weak crossover violation. Thus, to derive the dependent reading in (24b) we are left only with one option, namely, this must be a cumulative reading. But since the crossed reading is still missing in this case that must mean that cumulative readings do distinguish between crossed and dependent readings with pronouns. The latter is strongly preferred. As we suggested above, this might have to with the fact that in case of dependent readings the splitting of the plural event is more natural than in case of crossed readings. But if that is true then the missing crossed reading in cases like (16) tells us nothing. In particular, it does not argue against analyzing dependent readings as cumulative. Notice that we reach this conclusion even if examples like (21) are disregarded.

4. Cumulation in *de re* Attitudes – LDR Readings

To recapitulate, the LDR reading of (25) is represented by the paraphrase (25b).

(25) Burt and Clara think they like each other.
a. Burt and Clara think: "We like each other."

[2] In Dimitriadis (2000) the contextually salient relation must relate the subject and the embedded pronoun.

b. Burt and Clara each think: "I like the other."

The first option to derive (25b) that comes to mind is to try the same strategy as with dependent readings, where the subject pronoun (interpreted as Burt⊕Clara) was the res:

(26) $$(\exists e)\left(\begin{array}{l} *\text{think}(e) \wedge *Ag(e) = \text{b} \oplus \text{c} \wedge \\ *Th(e) = \langle \text{they, like each other} \rangle \end{array}\right)$$

However, this will not work. We will get the following: there is a plural event e which consists of subevents e_1 and e_2. e_1 is an event of thinking, which has Burt as the agent, Burt is the res, and liking each other is the property. In other words, Burt thinks he likes each other. e_2 is an event of thinking, which has Clara as the agent, Clara as the res, and liking each other as the property, i.e., Clara thinks she likes each other. This could be true if, for example, Burt and Clara suffer from schizophrenia. Of course, this is not really we wanted to get.

Fortunately, this is not our only option. There is no reason why the res in (25) should be restricted to the subject pronoun. We suggest that what is needed is *de re* belief about events. This is close in spirit to Cresswell and von Stechow (1982) who, in fact, argue that many different kinds of objects, including properties can function as a res to explain why e.g. *Poirot believes that 59 is 59* does not necessarily entail *Poirot believes that 59 is a prime number* (for the details, see Cresswell and von Stechow, 1982, Section 3). Moreover, Abusch (1997) proposes an analysis in which one forms *de re* beliefs about times.

Recall that, on our approach a simple reciprocal sentence like (27a) is interpreted as (27b).

(27) a. Burt and Clara like each other.

b. $(\exists e)(\forall y, z \leq \text{b} \oplus \text{c})(\exists e' \leq e)(y \neq z \rightarrow *like(e') \wedge *Ag(e') = y \wedge *Th(e') = z)$

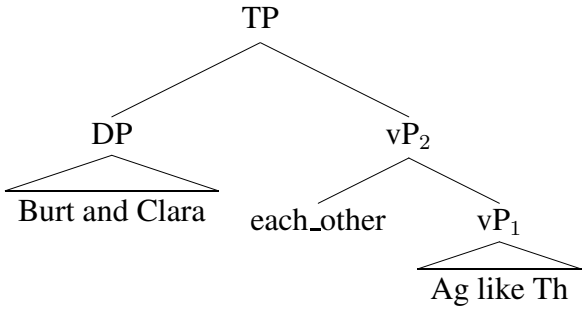
Here, then, is our idea. In LDR, the res is some event in which Burt and Clara stand in some relation to each other. The property of the attitude is the embedded verb itself, which specifies what relation Burt and Clara have.

(28) a. Property: $\lambda e.like(e)$

b. Res: $\iota e.(\forall y, z \leq x)(\exists e' \leq e)(y \neq z \rightarrow *Ag(e') = y \wedge *Th(e') = z)$

More formally now. To get (27b) we assume the following derivation. The thematic arguments are introduced independently of the verb. *Each other* applies to the relation and the plural subject. The predicate of events is existentially closed at the clausal level.

(29) a.



b. $[\![\text{vP}_1]\!]=\lambda y.\lambda x.\lambda e. * kiss(e) \wedge *Ag(e) = x \wedge *Th(e) = y$

c. $[\![\text{vP}_2]\!]=\lambda x.\lambda e.(\forall y, z \leq x)(\exists e' \leq e)(y \neq z \rightarrow *like(e') \wedge *Ag(e') = y \wedge *Th(e') = z)$

d. $[\![\text{TP}]\!]=\lambda e.(\forall y, z \leq \text{b} \oplus \text{c})(\exists e' \leq e)(y \neq z \rightarrow *like(e') \wedge *Ag(e') = y \wedge *Th(e') = z)$

In case of LDR 'like' moves outside of the TP. The remnant TP is then the following:

(30) $\lambda e.(\forall y, z \leq \text{b} \oplus \text{c})(\exists e' \leq e)(y \neq z \rightarrow *Ag(e') = y \wedge *Th(e') = z)$

The iota operator applies to (30), and this gives us one specific event. The application of the iota operator looks like a stipulation but is necessary as long as we want to allow the possibility that an event can be a res, which we might, independently of LDR. Finally, the event and the verb are combined into the structured proposition (31):

(31) $\left\langle \iota e.(\forall y, z \leq \text{b} \oplus \text{c})(\exists e' \leq e) \left(\begin{array}{l} y \neq z \rightarrow *Ag(e') = y \wedge \\ *Th(e') = z \end{array} \right), \lambda e. * like(e) \right\rangle$

(31) is taken as the argument Theme of *think*:

(32) $(\exists e'') \left(\begin{array}{l} *think(e'') \wedge *Ag(e'') = \text{b} \oplus \text{c} \wedge *Th(e'') = \\ \left\langle \iota e.(\forall y, z \leq \text{b} \oplus \text{c})(\exists e' \leq e) \left(\begin{array}{l} y \neq z \rightarrow *Ag(e') = y \wedge \\ *Th(e') = z \end{array} \right), \lambda e. * like(e) \right\rangle \end{array} \right)$

In (32) we have a plural event of thinking, with agents Burt and Clara, where the reses of the thinking are (sub-)events which jointly form one event e' in which Burt and Clara are somehow related to each other, and the property is *liking*. Now, (32) is true, for example, if e can be split into e_1 and e_2, where in e_1, Burt is the agent of thinking, the res is one part of event e', namely the one in which Burt is the agent and Clara is the theme, and e' is an event of liking. Furthemore, in e_2, Clara is the agent of thinking, the res is one part of event e', namely the one in which Clara is the agent and Burt is the theme, and e' is an event of liking. This corresponds to LDR.

Apart from this reading, our setup gives us another reading: Burt thinks Clara likes him, and Clara thinks Burt likes her. This is again the crossed reading discussed in the previous section, and we can get it by simply splitting the res in a different way. In this case e would consist of two subevents, e_1 and e_2, where in e_1, Burt is the agent of thinking, the res is one part of event e', namely the one in which *Clara* is the agent and *Burt* is the theme, and e' is an event of liking, parallely for e_2 and Clara. Heim et al. (1991a) and Dimitriadis (2000) claimed that this reading does not exist but once again, we did find examples of it:

(33) a. We didn't work together but we met and he's shy, not unlike me, and so I think **we both thought we hated each other**, but were just too shy to really talk. http://movies.about.com/od/theproducers/a/prodnl121405.htm

b. I never really fell out of love with her, and I constantly thought about her. She tells me the same thing and that she always wanted to get back together. We would always talk to each other uncomfortably because she thought I hated her and I thought she hated me.(. . .) **During the time that we thought we hated each other** . . .
http://www.loveshack.org/forums/t23746/

In (33a), the context makes clear that the two people were in love with each other, and that the were unaware that the other person loved them back. Hence, we take it to be very unlikely that the highlighted text is intended to mean that *he thought he hated her and she thought she hated him.* It's also extremely unlikely that it should be read on a local construal of the reciprocal, i.e. they both thought: "We hate each other."

Similarly, in (33b), the context specifies that *she thought he hated her and he thought she hated him.* The time referred to by the highlighted text definitely refers to a time when this was true, but that would give us the crossed reading with LDR. In this case, a local construal (*the time that each of us thought: "We hate each other"*) would flatly contradict the preceding context.

These examples show that deriving crossed readings is rather than a problem a virtue of an analysis that connects LDR to cumulative readings.

5. Conclusion

We have shown how a combination of a standard semantics for attitude verbs (Cresswell and von Stechow, 1982) with common assumptions on pluralities (Landman, 2000) derives dependent readings in complements of attitude verbs and LDR. This analysis has several advantages over alternative approaches that derive LDR as non-local scope/binding. In particular, it obviates the need for ad hoc constraints on binding configurations for free variables (Heim et al., 1991b), and LDR-specific mechanisms for interpretation of functional pronouns (Dimitriadis, 2000). Furthermore, it is preferable to Dimitriadis (2000) because it restricts LDR to clausal complements of attitude verbs, which seems correct, while it can still derive the results that motivated his analysis.

Finally, it is worth pointing out that most of the previous analyses of LDR were based on a semantics for *each other* which was identical or at least very close to the semantics one might postulate for *the others*. On the other hand, our approach is fully compatible with the treatment of reciprocals in terms of polyadic quantification. This is a good thing if one accepts the arguments in Dotlačil and Nilsen (to app.) against the former analysis of the semantics of reciprocals.

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