Reciprocals with quantified antecedents

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Introduction In the literature on reciprocals, cases like (1) where the reciprocal takes a quantified antecedent constitutes a long-standing problem.

(1) Most members of this club know each other.

Part of the problem is that intuitions about the truth-conditions of such sentences are unclear. Kamp and Reyle (1993, 468–9) consider the two options "a) the largest set A of club members such that for any two distinct elements a and b of A, a knows b and b knows a, consists of more than half of the members of the club; (b) the set of club members a for which there is some other member b such that a knows b and b knows a consists of more than half of the members of the club".[1] They conclude that a) is too strong but b) is too weak and that such sentences might not have well-defined truth conditions applying to all situations. This indeterminacy is all the more surprising since such sentences consist of well-understood components. Although it is unclear exactly what (1) means, the meaning of (2a) and (2b) is perfectly clear.

(2) a. The members of this club know each other.
b. Most members of this club know the chairman.

Thus, the difficulty in judging (1) arises from the interaction of the quantifier and the reciprocal.

Plural CDRT The prominent previous accounts of quantified antecedents (Dalrymple *et al.*, 1998; Szymanik, 2016) are based on an approach to reciprocals as polyadic quantifiers. There may be independent reason to reject such an approach and here we follow Murray (2008) and Dotlačil (2013) in analyzing reciprocal pronouns as anaphors with a special referential relation to their antecedents: the reciprocal and its antecedent must be cumulatively identical, but pointwise distinct in each sub-situation verifying the reciprocal. Dotlačil's analysis is cast in plural compositional DRT (Brasoveanu, 2007) and a sample representation and verifying information state for *Two girls saw each other* are shown in (3a).

(3) a. $[x_1\ x_2 | 2\text{-}atoms(\cup x_1), girl(x_1), \cup x_1 = \cup x_2, x_1 \neq x_2, see(x_1, x_2)]$

b.

	x_1	x_2
o_1	$girl_1$	$girl_2$
o_2	$girl_2$	$girl_1$

In plural CDRT, DRSs are relations between *sets* of assignments. $\cup u_m = \cup u_n$ requires the sum of all referents of u_m and u_n across the assignments related by the DRS to be equal, whereas $u_m \neq u_n$ requires u_m and u_n to be distinct in each of the related assignments. (3a) shows a sample verifying set of assignments where both these constraints are satisfied. Notice that whenever the reciprocal set has more than two members, the two constraints associated with the reciprocal yields weak reciprocity; we assume that strong reciprocity arises through a principle of maximizing anaphoric connections subject to world knowledge. For more details we refer to Brasoveanu (2007) for the general framework and Dotlačil (2013) for its application to reciprocals.

Generalized quantifiers We follow Brasoveanu (2007, 211) in treating generalized quantifiers as externally dynamic, i.e. introducing discourse referents that can be picked up in the subsequent discourse. (4) gives the general scheme, where DET is a (static) relation between two sets of individuals.

(4) $\mathbf{max}^u P(u); \mathbf{max}^{u' \sqsubseteq u} P'(u'); DET(u, u')$

That is, we fill up u with the individuals that satisfy the restrictor property P. Next we fill up u' with the *subset* of u that satisfies the scope property P'. u and u' are the two discourse referents that a quantificational structure makes available for anaphoric uptake: they correspond to what Nouwen (2003, 14–15) calls the max set (the whole set denoted by the restrictor) and the reference set (the set denoted by the intersection of the scope and the restrictor).

[1] A third option would be to take *most* to quantify over pairs, but this was shown to be wrong by Roberts (1987).

Quantified antecedents Consider now the representation of (1) given in (5). z is the reciprocal's discourse referent and its antecedent is given as a question mark in the style of Kamp and Reyle (1993) (for a compositional, model-theoretic interpretation of this, see Haug 2014).

(5) $\mathbf{max}^x[\ |people(x)]\ ;\ \mathbf{max}^{y \sqsubseteq x}[z| \cup z = \cup ?, z \neq ?, know(y, z)]\ ;\ \mathbf{most}(x, y)$

Notice that the binding of the reciprocal by the quantifier *most people* can be interpreted either as cumulative coreference with the max set or the reference set. In fact, instantiating ? to y (the reference set) yields Kamp and Reyle's reading a): the largest set Y such that *know-each-other* holds over Y contains more than half the members. And instantiating ? to the max set yields Kamp and Reyle's reading b): the largest set X of members who know another member contains more than half the members.[2]

The proposal Instead of arguing that one of the two readings represent the correct truth conditions of (1), we take inspiration from recent work on plurals (Križ, 2015) and on donkey anaphora (Champollion *et al.*, 2019) to propose a supervaluationist account. Sentences where a reciprocal is bound by a quantifier has two precisifications according to whether the reciprocal ranges over the maximal set or the reference set. It is strictly true iff true under both precisifications, strictly false iff false under both precisifications; in other cases it can *count as true* in worlds which resolve the current Question Under Discussion (QUD) in the same way as worlds where the proposition is strictly true. This account predicts that whenever a quantifier binds the reciprocal we can get a weaker reading even when the predicate is compatible with (and hence under standard assumptions, requires) strong reciprocity (6).

(6) 36-year-old Kimberley revealed: "Cheryl comes to me for advice – *all mums ask each other for advice* and share stories about their babies." [News on the Web corpus]

At issue here is who mothers go to for advice, namely other mothers. It does not matter how many other mothers they ask: the sentence can be judged true even if not all mothers ask all other mothers for advice.

Our account also explains why we get weaker than normal reciprocity with downward entailing quantifiers

(7) Its members are so class conscious that *few have spoken to each other*, lest they accidentally commit a social faux pas.

As Dalrymple *et al.* (1998) observe, (7) "claims that few members have spoken to another one; it is clearly not a statement about the size of the largest group of members such that each pair of them have spoken." Dalrymple *et al.* (1998) ascribe this to a non-local (sentence-level) application of the strongest meaning hypothesis, but this is problematic because (as pointed out by Sauerland 2012)other downward entailing contexts do not yield weak reciprocity, e.g. (8) does not get the the overly weak meaning "If each team member knew some other team member in advance, they won".

(8) If the team members knew each other in advance, they won.

By contrast, our account locates the weak reciprocity in (7) in the quantified structure itself, because with downward entailing quantifiers, the sentence is definitely true iff true when the reciprocal ranges over the max set, which yields exactly the reading "few members have spoken to another one".

Conclusion Our proposal solves the problem of reciprocals with quantified antecedents in a way that does justice to the often unclear intuitions we have about the truth conditions of such sentences. It explains why weaker than normal reciprocal readings are often acceptable in such contexts, in particular with downward monotone quantifiers, but not in other downward entailing contexts. More generally, the account supports a relational view of reciprocals rather than one based on distributive quantification.

References ► Brasoveanu, A. (2007). *Structured Nominal and Modal Reference.* Ph.D. thesis, Rutgers University. ► Champollion, L., Bumford, D., and Henderson, R. (2019). Donkeys under discussion. *Semantics and Pragmatics.* Forthcoming. ► Dalrymple, M., Kanazawa, M., Kim, Y., Mchombo, S., and Peters, S. (1998). Reciprocal expressions and the concept of reciprocity. *Linguistics & Philosophy*, **21**, 159–210. ► Dotlačil, J. (2013). Reciprocals distribute over information states. *Journal of Semantics*, **30**(4), 423–477. ► Haug, D. T. T. (2014). Partial Dynamic Semantics for Anaphora: Compositionality without Syntactic Coindexation. *Journal of Semantics*, **31**(4), 457–511. ► Kamp, H. and Reyle, U. (1993). *From Discourse to Logic: An Introduction to Modeltheoretic Semantics of Natural Language, Formal Logic and Discourse Representation Theory.* Kluwer. ► Križ, M. (2015). Homogeneity, Non-Maximality, and all. *Journal of Semantics*, **33**(3), 493–539. ► Murray, S. E. (2008). Reflexivity and reciprocity with(out) underspecification. In A. Grønn, ed., *Proceedings of Sinn Und Bedeutung 12*, pp. 455–469. ► Nouwen, R. (2003). *Plural*

[2] Kamp and Reyle make the further natural assumption that knowing is symmetric.

Pronominal Anaphora in Context: Dynamic Aspects of Quantification. Ph.D. thesis, Utrecht University. ► Roberts, C. (1987). *Modal Subordination, Anaphora, and Distributivity.* Ph.D. thesis, University of Massachusetts, Amherst. ► Sauerland, U. (2012). Where does the strongest meaning hypothesis apply? *Snippets*, **25**, 13–14. ► Szymanik, J. (2016). *Quantifiers and Cognition: Logical and Computational Perspectives.* Springer.