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The Reciprocity-Symmetry Generalization: Proto-Roles and the Organization of Lexical Meanings

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Abstract This paper systematically analyzes the relations between logical symmetry and lexical reciprocity. A new generalization about these phenomena is uncovered, which is referred to as the *Reciprocity-Symmetry Generalization* (RSG). To analyze the RSG in full generality, we develop a new formal theory of lexical reciprocity building on Dowty's notion of *proto-roles*. Because of its foundational nature and plausibility for other languages besides English, the RSG is conjectured to be a language universal. Some general implications of this conjecture are discussed, especially regarding the organization of lexical meanings in different languages, and their relations with cognitive systems of concepts and categorization. Although the RSG is new with this paper, it appears to have been silently sensed since early transformational works in the 1960s, without any general analysis. By uncovering this generalization and accounting for it, the present work removes considerable confusion surrounding the pertinent semantic questions.

Keywords reciprocity · collectivity · symmetry · plurals · thematic role

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1 Introduction

A binary predicate R is standardly called **symmetric** if for every x and y, the statement $R(x,y)$ is logically equivalent to $R(y,x)$. Examples for symmetric predicates in English include relational adjectives, nouns and verbs as in the following equivalent sentences.

(1) a. Rectangle A is identical to Rectangle B $\Leftrightarrow$ Rectangle B is identical to Rectangle A.
b. Mary is John's cousin $\Leftrightarrow$ John is Mary's cousin.
c. Sue collaborated with Dan $\Leftrightarrow$ Dan collaborated with Sue.

Because of such truth-conditional equivalences, formal semantic accounts classify the binary predicates *identical to*, *cousin* (*of*), and *collaborate with* as symmetric.

A fascinating property of symmetric binary predicates is their systematic homonymy with **reciprocal** predicates. For instance, the binary predicates in (1a-c) all have unary alternates that give rise to the following plural sentences.

(2) a. Rectangle A and Rectangle B are identical.
b. Mary and John are cousins.
c. Sue and Dan collaborated.

Almost all symmetric binary predicates like *identical to*, *cousin* (*of*) and *collaborate* (*with*) have unary alternates as illustrated in (2).[1] However, the converse is not true. There is a considerable class of unary predicates that are intuitively reciprocal, but have a binary alternate that is not symmetric. For instance, consider the following sentences.

(3) a. Sue hugged/kissed Dan.
Sue collided with Dan.
b. Sue and Dan hugged/kissed/collided.

The binary predicates in (3a) are obviously non-symmetric. For instance, Sue may have hugged or kissed Dan without him ever hugging or kissing her back. Similarly, *collide with* is also a non-symmetric relation: if Sue's car hit the rear of Dan's car while it was parked and he was sleeping on its back seat, you may truthfully assert that Sue's car collided with Dan's car, but not that Dan's car collided with Sue's car. Despite their non-symmetric behavior, the predicates *hug*, *kiss* and *collide* have reciprocal-looking collective usages, as illustrated in (3b). This fact challenges the common intuition that lexical reciprocity is somehow related to logical symmetry. Due to this challenge, and perhaps owing something to the exuberance in which the problem was introduced in Dong (1971), the semantic connections between symmetry and lexical reciprocity have remained somewhat obscure. This paper aims to remove a big part of the empirical obscurity and account for the emerging picture.

[1] English only has a handful of symmetric predicates that do not have such alternates: *near*, *far from* and *resemble* are notable examples, which are discussed later in this paper.

The paper is structured as follows. Section 2 makes some preliminary remarks about symmetry and reciprocity in language, and in truth-conditional semantics. Section 3 introduces a new empirical generalization about reciprocal alternations and their connections with (non-)symmetry. One kind of lexical reciprocity is characterized by "plain" equivalences, as between (1a-c) and (2a-c). By contrast, with non-symmetric predicates, we show that the connections between sentences as in (3a) and the corresponding collective sentences in (3b) are not logical but preferential. These connections are referred to as "pseudo-reciprocity". The distinction between plain reciprocity and pseudo-reciprocity leads to a new empirical generalization, referred to as the *Reciprocity-Symmetry Generalization* (RSG): a reciprocal alternation shows a plain equivalence *if and only if* the binary form is symmetric.

Section 4 discusses some previous accounts and argues that they do not account for the RSG. Addressing this problem, section 5 develops a new theory of reciprocal alternations following Dowty's (1991) analysis of *proto-roles*. In this theory, reciprocity alternations are viewed as the result of a derivational stage that intermediates between mental concepts and predicate meanings in the lexicon. Proto-roles are used for defining this intermediate level, by defining abstract predicates referred to as *proto-predicates*. Such protopredicates are used for specifying the denotations of predicate forms. Denotations of lexical predicates in plain alternations are derived by protopredicates that are associated with *collective concepts* like "Identity", "Cousinhood" or "Collaboration", which specify sets of entities. The respective protopredicate connects the two lexical predicates – the unary-collective predicate and the binary predicate – by a rule that explains the symmetry of the latter. By contrast, pseudo-reciprocal alternations are derived by protopredicates that are associated with two concepts: a collective concept and a binary concept. Such pairs of concepts – e.g. a collective Hug vs. a binary-directional Hug – are logically independent. The two homonymous entries of verbs like *hug* are associated with one protopredicate, but this does not result in any logical semantic relations between those entities. New evidence for this theory is shown from predicates like *be in love with*, *talk to* and *know*, irreducible collectivity (Goodman 1951, Lasersohn 1995), and Hebrew reciprocal comitatives (Siloni 2012).

Section 6 concludes that the alternations known as "reciprocal" do not involve reciprocal quantification, but constitute a unique probe into the lexical semantics of collective and symmetric predicates across languages. The RSG is strengthened into a speculation about a language universal: all symmetric binary predicates are logically derived from collective concepts. Non-symmetric binary predicates are related to collective concepts by "softer" preferential relations. These relations are based on systematic strategies of polysemy, but due to the inherent vagueness of mental concepts, it is argued that such strategies resist any formalization in standard two-valued logic.

2 On the linguistic expression of symmetry and reciprocity

The claim that pairs of sentences as in (1a-c) are "equivalences" invites a clarification about the difference between truth-conditional semantics and information structuring in natural language. Clearly, each of the two sentences in such pairs conveys something different about the participants' involvement. Thus, *A collaborated with B* implies that, from the point of view of the speaker, A and B have different capacities or statures. The implication is reversed in the sentence *B collaborated with A*. More vividly, perhaps: *Podolsky collaborated with Einstein* is a natural way of highlighting the work of the physicist Boris Podolsky on the EPR paradox. By contrast, *Einstein collaborated with Podolsky* might not convey the importance of the collaboration for Podolsky's career. Plausibly, such differences are not truth-conditional: it is hard to come up with contexts in which one of the sentences in such pairs is clearly true while the other one is clearly false. The differences between sentence pairs as in (1a-c) is commonly related to Figure-Ground effects and other non-truth-conditional phenomena (Talmy 1975, 2000, Tversky 1977, Dowty 1991, Gleitman et al. 1996). Thus, our claim that binary predicates as in (1a-c) are symmetric, as they are normally considered in formal logic, does not stand in opposition to further pragmatic considerations in cognitive semantics and cognitive psychology.

A similar remark holds with respect to the claim that the reciprocal sentences (2a-c) are equivalent to the respective sentences in (1a-c). For the same reasons discussed above, to say that *Podolsky collaborated with Einstein* is surely different than saying than the two physicists collaborated. And for the same reasons, the claim about the "equivalence" between the reciprocal sentences and their transitive correlates concerns the truth-conditions of these sentences, not their full informational content.

As a further clarification, it should be noted that the label "reciprocal" for sentences (2a-c) should not be understood as implying that they are somehow derived from equivalent reciprocal sentences like the following.

(4) Rectangle A and Rectangle B are identical to *each other*.

The relation between the binary use of the adjective *identical* in (1a) and its collective use in (2a) is a non-trivial lexical fact: the same phonological material – the word *identical* – has two syntactic and semantic functions. By contrast, the ability to use the pronominal expression *each other* in (4) as an argument of the relational adjective *identical to* is a simple fact about the way this pronoun works, which tells us little about the word *identical*. Virtually all binary predicates appear in reciprocal sentences like (4), whether or not they have a lexical-reciprocal entry. For instance, sentences like *Sue and Dan forgot each other* are perfectly OK due to the general properties of *each other* as a syntactic argument. However, the binary predicate *forget* has no lexical reciprocal correlate: strings like *Sue and Dan forgot*, to the extent that they are acceptable, involve not reciprocity, but an implicit argument (e.g. "forgot something relevant to the context of utterance"). This is only one of many distinctions between lexical reciprocity as in (2) and quantificational reciprocity as in (4). Some further distinctions are discussed in Carlson (1998), Dimitriadis (2008) and Siloni (2012), among others. Despite these distinctions, some confusions surrounding the term "reciprocity" are still widespread. Indeed, early transformational accounts, notably Gleitman (1965), assumed that a sentence like (2a) has (4) in its derivational history. Apparently, convictions that there must be some derivational relation between such sentences have persisted for over half a century. As a matter of fact, at present there is little evidence to support such views, which are also not represented in most recent work on quantificational reciprocity (Dalrymple et al. 1998, Kerem et al. 2009, Sabato & Winter 2012, Mari 2014, Poortman et al. 2016). The possible relation between lexical reciprocity as in (2) and quantificational reciprocity as in (4) is a complex topic, which is still poorly understood. Studying this problem is supplementary to, and partly dependent on, the main tenets of the present work.

3 The Reciprocity-Symmetry Generalization

To address the challenges for the theory of reciprocal predicates, we introduce a formal semantic criterion that distinguishes two sub-classes of such predicates. Reciprocal alternations with predicates like *identical*, *cousin* and *collaborate* are referred to as *plain reciprocity*. For instance, when characterizing the semantic relation between the predicates (*are*) *identical* and *identical to* as plain reciprocity, we rely on the following equivalence:

(5) A and B are identical
$\Leftrightarrow$ A is identical to B and B is identical to A

The repetition of two "identical to" statements in (5) may seem unnecessary due to the symmetry of this predicate. However, it is required for generality, as explained below. To generalize the plain reciprocity pattern in (5), suppose that P is a unary-collective predicate and R is a binary predicate, such that both P and R are associated with the same morphological form. Due to the morphological relation between them, we classify P and R as *alternates*. For instance, for the adjective *identical*, P is the plural collective usage as in *A&B are identical*, whereas R is the alternate binary form *identical to*. To characterize the semantic alternation between P and R as plain reciprocity, we require the following:

(6) **Plain reciprocity** (plainR): For all x,y such that $x \neq y$:
$P(\{x,y\}) \Leftrightarrow R(x,y) \wedge R(y,x)$

In words: we say that plainR obtains between P and R if for every pair of entities x and y, the collective predicate P holds of the doubleton $\{x,y\}$ if and only if the binary predicate R holds between x and y in both directions.[2] Thus, due to the definition in (6), the equivalence in (5) characterizes the alternation of the predicate *identical* as plain reciprocity, where P is the collective-unary use of the predicate and R is the binary form *identical to*.

After stating the general condition of plainR alternations, let us now return to the redundancy we feel in (5). This redundancy is due to the symmetry of the binary predicate *identical to*. However, the general definition of plainR alternations in (6) does not assume anything about symmetry of the binary predicate R (footnote 2). This is deliberately so, for symmetry of a binary predicate R should analytically be distinguished from the sort of

[2] Note that this does not mean that R is symmetric: it only means that the predicate R holds "symmetrically" between the x's and y's that satisfy $P(\{x,y\})$. For other x's and y's, the predicate R may hold in one direction only, hence (6) does not require R to be symmetric.

reciprocity we see in the corresponding collective predicate *P*. As we shall see below, it is possible to define artificial collective predicates that stand in plain reciprocity to non-symmetric binary predicates. Since we want the notion of plain reciprocity in (6) to be well-defined for all binary predicates, we do not assume anything about *R*'s symmetry.

Notwithstanding, a deep connection between symmetry and reciprocity has been maintained by most previous works on the topic (section 4 below). Here it is claimed that in fact, such a connection only exists for the reciprocal alternations that we classified as *plain* reciprocity. Since logic alone cannot account for such connections, we propose that equivalences as in (5) are *linguistically* related to symmetry of binary predicates. One part of the proposed relation is stated below.

(7) **Reciprocity-Symmetry Generalization (RSG, part 1):** All binary predicates in natural language that take part in plainR alternations are truth-conditionally symmetric.

This generalization states that symmetry is an *empirical property* of all binary predicates in natural language that stand in plainR alternations. A major aim of this paper is to substantiate this generalization and account for it.

More examples for predicates that give rise to plainR alternations are given below.

(8) **Predicates in plR alternations**:

Verbs: collaborate (with), talk (with), meet (with), marry, debate, match, rhyme (with)

Nouns: cousin (of), twin (of), sibling (of), neighbor (of), partner (of)

Adjectives: identical (to), similar (to), parallel (to), adjacent (to)

As expected by the RSG, the binary guises of all these predicates are logically symmetric. Note that some collective predicates in such alternations also have non-symmetric variants. For instance, unlike *talk with*, the form *talk to* is not symmetric, because Sue may be talking to Dan when he is not talking to her. As will be demonstrated below, the alternation between collective *talk* and *talk to* is not plainR. By contrast, the alternation between collective *talk* and *talk with* is plainR: in any sentence *A&B talk*, the reciprocal interpretation is equivalent with *A is talking with B and B is talking with A*.

Note further many reciprocal predicates – *talk*, *collaborate*, *similar*, among others – also have a distributive interpretation (Ginzburg 1990). For instance, *Sue and Dan are talking* can be true when each of the two people is talking, but they are not talking with each other. This distributive use of intransitive *talk* should be analyzed as distinct from its reciprocal use. To see that, consider for instance the following example:

(9) Dan and Sue haven't been talking for ages.

Sentence (9) can be interpreted as true if Dan and Sue haven't had mutual communication for a long time, even if each of them has constantly been talking to other people. This means that the reciprocal interpretation of (9) can be true when the distributive interpretation is false: a sign of a genuine ambiguity between two readings. This ambiguity is plausibly related to the acceptability of sentences like *Sue is talking*. By contrast, when reciprocal sentences are unacceptable in the singular – as in **Sue met* – the reciprocal reading is the only reading of the plural intransitive: *Sue and Dan met* can only mean that the two people met with each other. Thus, while intransitive *talk* is ambiguous between a reciprocal and a distributive reading, intransitive *meet* is unambiguously reciprocal. The reason for this contrast between different reciprocal predicates is not our main problem here, but it is useful to keep it in mind (see also Ginzburg 1990).

Let us now get back to generalization (7). One important caveat about this generalization concerns the lack of symmetry in gender with binary predicates like *sister* and *brother*, which support plainR alternations. For instance: A and B are sisters if and only if A is B's sister and B is A's sister. This means that the *sister* (*of*) alternation must be classified as plainR. However, the relation *sister of* clearly has non-symmetric usages: if Mary is some boy's sister, he obviously cannot be considered to be "Mary's sister". Schwarz (2006) and Partee (2008) show motivations for analyzing gender as a presupposition of kinship nouns, rather than as a truth-condition.[3] Similar proposals have been made for gender marking on other items (Sudo 2012). This means that the symmetry tests of the RSG should be applied to what Von Fintel (1999) calls "Strawson entailments": entailments that hold between sentences provided

[3]Schwarz argues that *Kim isn't his sister* implies that Kim is a female as much as *Kim is his sister* does, and suggests that the gender implication scopes over negation like other presuppositions.

that their presuppositions are satisfied. Indeed, Schwarz and Partee analyze *sister* and *brother* as "Strawson-symmetric": symmetric in situations that satisfy their gender presuppositions. This removes the potential challenge to part 1 of the RSG, which only relies on truth-conditional symmetry. A similar caveat holds for any language that marks gender on predicates.[4]

We now move on to one outstanding challenge for theories of lexical reciprocity: the behavior of verbs like *hug*, *kiss* and *collide* as in (3). To show that such verbs do not support plainR, we should consider the following question: what are the semantic relations between the following two sentences?

(10) Sue and Dan hugged.

(11) Sue hugged Dan and Dan hugged Sue.

To be sure, sentence (11) does not entail (10) (Dong 1971, Carlson 1998): suppose that Sue hugged Dan while he was sleeping; then, after Dan woke up, Sue fell asleep and he hugged her while she was sleeping. In such a scenario (11) is true while (10) is false.

Figure 1

Furthermore, the opposite situation may also exist. As Winter et al. (2016) experimentally show, under certain circumstances, Dutch speakers may judge a sentence like (10) as true while judging (11) to be false. For example, in the situation of Figure 1, many speakers judged the Dutch translation of "the girl and the woman are hugging" as true, while judging "the woman is hugging the girl" as false. According to the standard semantics of conjunction, this judgement renders (11) false for such speakers, even though they accept (10) as true.

We conclude that it is hardly possible to derive the meaning of (10) from a conjunction like (11) of binary statements. Although there is much to say

[4]In English there are not many gender-sensitive binary predicates that may be classified as plainR in this way (though this phenomenon may have also developed with plural terms like *girlfriends*, *boyfriends*, *wives* and *husbands* when applied to gay couples). Gender-sensitive plainR alternations are more common in languages with grammatical gender. For instance, in Hebrew even the predicates *zehe le* (identical-sg.masc to) and *zeha le* (identical-sg.fem to) are gender marked. Nevertheless, the Hebrew concept of identity is as symmetric as it can get in other languages: *Sue zeha le-Dan* holds iff *Dan zehe le-Sue* does. Similarly, both English and Hebrew support equivalences like *Sue is Dan's sister*⟺*Dan is Sue's brother*. Reasonably, this happens because the symmetry of the concept "Sibling" is independent of its realization by a gender-neutral noun (which doesn't exist in Hebrew).

about the semantic relations between collective usages of verbs like *hug* and their binary usages, these relations are not fully definable using standard two-valued logic. The full semantic connection between the two forms of *hug* is more likely to be described by "soft" cognitive-conceptual principles, rather than by classical logical rules. We will return to this question in section 6.

We refer to all collective-binary alternations that do not satisfy the plainR characterization in (6) as **pseudo-reciprocity** (pseudoR). The relation between the two usages of *hug*, *kiss* and *collide* is an example for this kind of alternation. Another example is the predicate *be in love*. If A is in love with B and B is in love with A, neither of them has to be aware of the other's feelings, or even know that the other one knows her. In such situations, the love relations between the two people are not accompanied by "collective intentionality" (a term due to Searle 1990). Thus, the sentence *A&B are in love* misses a critical ingredient of its collective interpretation, and can hardly be considered true. In such an "independent love" situation, the sentence is only true under its distributive-existential interpretation "A is in love (with someone) and B is in love (with someone)". Similarly, if A is talking to B and B is talking to A, the collective interpretation of sentence *A&B are talking* is unacceptable if A and B are not intentionally engaged in a talk, e.g. because they are not listening to each other.[5] Thus, the collective reading of intransitive *talk* and the binary form *talk to* are in a pseudoR alternation. The *talk* (*with*/*to*) case illustrates that the same unary-collective predicate – in this case *talk* – may show different plainR/pseudoR alternations with different binary predicates. Some languages support such multiple plainR/pseudoR alternations more regularly than English (see section 6).[6]

Another example for a pseudoR alternation appears with the Hebrew verb *makir* ("knows", "is familiar with", "has heard of"). Consider for instance the following sentence.

(12) morrissey *makir et* hod ma'alata, ve-hod ma'alata *makira et* morris-

[5]Roberto Zamparelli (p.c.) suggests imagining a situation in which A is talking to B and B is talking to A over the phone, in an attempt to conduct a phone talk. Suppose that the line is bad and neither of them is hearing the other, while neither of them is aware of the problem. In such a situation the collective reading of the sentence *A&B are talking* is likely to be judged as false.

[6]In English, a similar but subtler contrast is found between transitive *meet* and *meet with*. Witness the contrast in *A met (with) B at the station* (Dixon 2005:361-2).

sey
"Morrissey *knows-masc acc* Her Majesty, and Her Majesty *knows-fem acc* Morrissey"

Sentence (12) is most probably true of the two celebrities, at least when *makir* is interpreted in the sense of "has heard of".[7] However, this does not yet support the truth of the following sentence.

(13) morrissey ve-hod ma'alata *makirim*
"Morrissey and Her Majesty *know*-pl (=are acquainted with each other)"

Sentence (13) entails a personal acquaintance between Morrissey and Her Majesty, whereas (12) does not: if Morrissey and the queen have never met or talked, (13) is false while (12) is still likely be true. Note that unlike what we saw with the English predicates *be in love* and *talk*, sentences like (13) only have a collective interpretation and no distributive interpretation. This is because the verb *makir* does not tolerate singular subjects with null objects (wit. **morrissey makir* "Morrissey knows"). Therefore, the plural intransitive use of the verb *makir* in (13) is unambiguously collective, and only has the sense "be in an acquaintance relation".

To sum up, pseudoR alternations are distinguished from plainR alternations in that they do not show the equivalence in (6). Furthermore, for most of the predicates showing pseudo-reciprocity, it is questionable if there is any complete logical description of the semantic relations between the two forms. This lack of regularity hardly deserves the title "reciprocal". The label *pseudo-Reciprocity* is intended to underline this point.

The list below summarizes some of the predicates that show the pseudoR alternation.

(14) **Predicates in pseudoR alternations**: talk (to), (fall/be) in love (with), hug, touch, embrace, pet, fuck, fondle, box, *makir* (Hebrew 'know')

All the binary usages of these pseudoR predicates are non-symmetric. This justifies the following strengthening of the generalization in (7).

[7] Morrissey himself used this sense of *know* in a song from 1986: "So I broke into the Palace/With a sponge and a rusty spanner/She said: 'Eh, I know you, and you cannot sing'/I said: 'that's nothing – you should hear me play piano'" (The Smiths, The Queen is Dead).

(15) **Reciprocity-Symmetry Generalization (RSG, final version):** *A reciprocal alternation between a collective-unary predicate P and a binary predicate R is* plainR *if and only if R is truth-conditionally symmetric.*

This strengthened version of the RSG adds to (7) the requirement that if the reciprocity alternation between *P* and *R* is not plainR – i.e. it is qualified as pseudo-reciprocity – then *R* is not symmetric. Thus, plainR alternations characterize precisely those symmetric binary relations that have a reciprocal alternate.[8]

The RSG is linguistically revealing because it is not logically necessary. A way to show it is by inventing artificial predicate meanings that would violate this principle. For instance, suppose that the transitive verb *hug* had a morphological alternate *Xhug* with the unary-collective meaning defined in (16) below.

(16) Let *Xhug* have the meaning "hug each other, but not necessarily at the same time".

This collective predicate would be in a plainR alternation to the non-symmetric transitive verb *hug*. This is because of the equivalence *A&B Xhugged* ⟺ *A hugged B and B hugged A*. Having such a plainR alternation with a non-symmetric predicate like *hug* would violate the first part of the RSG (the "only if" direction of (15)). Conversely, we can also define a hypothetical symmetric binary predicate in a pseudoR alternation to a unary-collective predicate. For instance, consider a hypothetical transitive construction *Xtalk to*, which would stand in a morphological alternation to the collective intransitive verb *talk*. Suppose that such a *talk* construction had the meaning of the binary predicate defined in (17).

(17) Let *x Xtalk to y* mean "*x* talks to *y* and *y* talks to *x* (without necessarily listening to each other)".

[8]The RSG in its formulation in (15) is neutral with respect to symmetric binary predicates like *resemble*, *near* and *far from*, which have no reciprocal alternates in English. In section 6 we speculate on a stronger generalization: that *all* binary predicates stem from collective concepts, even when those concepts are not realized as collective predicates in the language under consideration. As will be shown, Greek and Hebrew do have reciprocal correlates to some of these symmetric predicates in English.

The sentence *A Xtalked to B and B Xtalked to A* would not entail the collective reading of *A&B talked*. Such a case of pseudoR alternation with a symmetric binary predicate like *Xtalk* would also go against the RSG (the "if" direction of (15)).

These two artificial cases illustrate that both directions of the RSG are not logically necessary. Thus, relying on our assumption that the RSG generally holds, we should look for a linguistic theory of the correlation that it describes. This is the topic of the next sections.

4 Previous accounts and the RSG

Early transformational accounts proposed two different strategies for reciprocal alternations. Gleitman (1965) proposed a deletion rule, where eliminating *each other* in binary constructions leads to the unary-collective entry. Lakoff & Peters (1969) proposed a conjunct movement rule that maps *and* conjuncts to PP adjuncts. Semantically, we can describe Gleitman's rule as an operator **U** that maps any binary relation R to the following unary-collective predicate:

(18) $\mathbf{U}(R) = \lambda A.\forall x, y \in A.x \neq y \rightarrow R(x, y)$

Lakoff & Peters' proposal can be mimicked by an operator **B** that maps any unary-collective predicate P to the following binary predicate:

(19) $\mathbf{B}(P) = \lambda x.\lambda y.P(\{x, y\})$

Both operators analyze plainR alternations like (5) correctly. In both works it was (incorrectly) assumed that all binary predicates in reciprocal alternations are symmetric. This prediction is in agreement with the RSG in all that concerns plainR alternations. Furthermore, while Gleitman's account has to stipulate logical symmetry, Lakoff & Peters's rule successfully predicts symmetry as a corollary: trivially, $\mathbf{B}(P)$ is symmetric for every collective predicate P. Somewhat unfortunately, in subsequent linguistic work, the logical term "symmetric predicate" has often been confused with the much vaguer linguistic notion of "standing in a reciprocal alternation" (see Partee 2008 for remarks on some of the terminological issues). This confusion obscured the observation, originally made in Dong (1971), that neither Gleitman (1965) nor Lakoff & Peters (1969) treat the alternations that we here classify as pseudoR. For instance, the **U** operator would wrongly analyze

A&B hugged as meaning “A&B hugged each other”, ignoring the simultaneity requirement of intransitive *hug*.[9] Conversely, the **B** operator would analyze *A hugged B* as meaning “A&B hugged”, ignoring the non-symmetry of the former. Gleitman and Lakoff & Peters did not consider such cases of pseudoR, and as a result, their theories are empirically incomplete. In a later work, Ginzburg (1990) treated plainR alternations using rules similar to **U** and **B**, proposing linguistic criteria for determining which of them should be used in each case: (in)felicity with reflexive arguments (*A is similar to/*met herself*) and null complements (*A is similar/*met*). Ginzburg did not discuss predicates like *hug* and *kiss*, and his criteria are orthogonal to the plainR/pseudoR distinction. Like the transformational works from the 1960s, Ginzburg’s proposal does not account for pseudoR alternations or the plainR/pseudoR distinction.

Later in the 1990s, non-symmetric predicates like *hug* and *kiss* have regained considerable linguistic attention. Gleitman et al.’s (1996) experimental study involved two experiments asking participants to (i) grade various predicates for symmetry, and (ii) indicate how close in meaning reciprocal sentences like *A&B met/kissed* are to the same sentences with an overt *each other*. Gleitman et al. report no correlation between the results, but note that “it becomes progressively harder to find distinguishing events and states [between the unary predicate and the binary predicate with an overt reciprocal – Y.W.] as we ascend the symmetry ladder” (p.354). This intuition also underlies the RSG. Gleitman et al. do not develop the point further than that. Rather, they conclude that “symmetry” is a lexical-semantic property of certain predicates, distinct from standard logical symmetry. Gleitman et al. illustrate this claim by pairs of binary predicates like *kiss/love* and *collide with/hit*, which are all logically non-symmetric, but where only the first predicate in each pair takes part in reciprocal alternations. Gleitman et al. propose (pp.355-6) that because verbs like *kiss* and *collide* show the alternation, their binary guises are perceived as “more symmetric” than predicates like *love* and *hit*. While this may be correct, it does not explain why the non-symmetric predicates like *hug* and *kiss* show different reciprocal alternations

[9] With Hebrew *makir* (“know”) the counterexample to Gleitman’s account would not rely on tense: *A&B makirim* (“A&B are acquainted with each other”) would be interpreted by the **U** as equivalent to “A knows B and B knows A”. As examples (12)-(13) demonstrate, such an analysis would be inadequate.

than the logically symmetric predicates like *marry* or *match*.

More recent works have concentrated on the connection between thematic roles, reciprocity and events (Carlson 1998, Dimitriadis 2008, Siloni 2012). These works all find interesting distinctions between binary predicates and collective predicates in pseudoR alternations. Notably, as Carlson observes, sentences like *A&B hugged each other five times* are interpreted differently than *A&B hugged five times*. Carlson concludes that the unary-collective predicate must be treated as basic, rather than as derived from the binary predicate. As we show below, this insight, which also underlies Lakoff & Peters' older work, is useful as a basis for analyzing the origins for the RSG, but without further assumptions it does not explain it. Dimitriadis (2008) and Siloni (2012) propose different rules for interpreting reciprocal predicates. These rules are meant as general accounts of the alternation. Therefore, they also do not account for the RSG or the plainR/pseudoR distinction.

In another semantic study of reciprocity, Mari (2014) analyzes sentences like *the boys followed* each other *into the room*. The non-symmetric predicate *follow into* is furthermore *a*symmetric.[10] Mari's work argues for systematic generalizations about asymmetry with overt reciprocals like *each other*, but it does not address lexical reciprocity. Asymmetric predicates like *follow* usually reject reciprocal alternations in the lexicon, wit. the unavailability of reciprocity in *the boys followed into the room*.[11] Like Mari's work, other recent works on *each other* (e.g. Dalrymple et al. 1998, Kerem et al. 2009, Sabato & Winter 2012, Poortman et al. 2016) also do not address the relations between such quantifiers and lexically reciprocal predicates.

[10] Asymmetric binary predicates like the transitive verb *follow* require non-symmetry under all situations. Thus, a situation in which A follows B into the room must be a situation in which B is not following A into the room. Non-symmetric verbs like *hug* are not asymmetric: it is of course possible (and even likely) for A to hug B at the same time when B hugs A.

[11] One asymmetric predicate that does appear in English as a collective entry is *stacked*, as in *the two chairs are stacked*. Hebrew has another asymmetric predicate that can act collectively: *okev* ('consecutive'), as in *3 ve-4 hem misparim okvim* (3 and-4 are numbers consecutive-plu, "one of the numbers 3 and 4 precedes the other"). This rare kind of example has not been studied in previous work, and remains a challenge for further research.

5 Proto-predicates and the RSG

Dowty (1991) suggests that reciprocal alternations stem from properties of the participants in eventualities that predicates classify. Those properties are specified according to what Dowty calls *proto-roles*: sets of "entailments of a group of predicates with respect to one of the arguments or each". This section develops Dowty's intuitive proposal into a formal account of reciprocal alternations, which derives the RSG as a corollary.

Natural language predicates – verbs, nouns and adjectives – can all be seen as names of *concepts*. Speakers use those names for categorizing situations in their environment as they perceive them. Dowty's notion of protoroles is based on the typical properties of participants in different situations. For instance, one of the participants in a situation that we may call an *attack* is active, hostile, forceful, violent etc. The other participant in an attack is viewed as more passive, or even idle. Participants of the first kind are "agent-like", and participants of second kind are "patient-like". To avoid prejudice, we here follow Dowty and do without classical notions like *agent* and *patient*. What is important for our purposes is that any situation that we might classify as an *attack* invites us to distinguish between two "protoroles" of the participants. Addressing the precise nature of such distinctions would involve big questions like the specification of what falls under the concept "Attack". More generally: Dowty's use of protoroles invites us to study the mental representations of verbal concepts. This enterprise is far beyond the focus of this paper. Fortunately, to adapt Dowty's theory for our needs, we only need to acknowledge the mere existence of protorole distinctions. Thus, we assume that in any situation that is categorized as falling under the concept "Attack", there are two designated objects, which are distinguished by their "role" in that situation. More concretely, in any situation that is described by the transitive verb *attack* we can recognize participants according to two different protoroles: an "agent-like" protorole and a "patient-like" protorole. For generality, we here use the abstract labels "$\mathbf{r}_1$" and "$\mathbf{r}_2$" for these two protoroles. Further specifics about the conceptual-semantic content of these labels are irrelevant for our purposes here, and schematic protorole distinctions between participants are sufficient for distinguishing the arguments of all non-symmetric transitive verbs, adjectives and nouns. As claimed below, these assumptions on protoroles are also useful for analyzing the reciprocal predicates that are the focus of this paper.

In general, each situation that is categorized by a given concept must have one or more participant in some or other protorole specified by that concept. Thus, in principle there may be overlaps between the sets of participants of different protoroles. For instance: with a binary predicate like *attack*, a person may attack herself, in which case two different roles are assigned to the same entity.[12]

For further illustration, in (20) below we give some different attack situations, with participants A, B, C and D, and their assumed protoroles.

(20) Attack 1: A has role $\mathbf{r}_1$ ("agent"); B has role $\mathbf{r}_2$ ("patient").
Attack 2: D has role $\mathbf{r}_1$; C has role $\mathbf{r}_2$.
Attack 3: E has both roles $\mathbf{r}_1$ and $\mathbf{r}_2$.

These situations support the following sentences, respectively.

(21) a. A attacked B.
b. D attacked C.
c. E attacked herself.

To describe situations as in (20), we define what we here call a *proto-predicate*. A protopredicate is a relation that relates participants in situations according to their protoroles. The protopredicate that corresponds to the situations in (20) is simply the following binary relation.

(22) $\{\langle A, B\rangle, \langle D, C\rangle, \langle E, E\rangle\}$

This is the traditional analysis using binary relations for transitive verbs like *attack*. Accordingly, with all non-symmetric binary predicates, we assign the type b ("binary"') to the corresponding protopredicates. We use the general notation $\mathbf{P}^b$ to indicate that a protopredicate $\mathbf{P}$ is of type b. Thus, the meaning

[12] A more complicated case of overlap between roles appears when Sue and Dan form a group that attacks itself. To simplify the analysis of reciprocity, we here ignore such situations that involve group arguments. The question of the right representation of such situations using collective protopredicates is related to the general semantic question of how to classify groups and plurals in the lexicon, which goes beyond the scope of this paper. See Dowty (1987), Winter (2002) for a distinction between two types of collectivity. The present paper only addresses the type of collectivity that is invoked by with reciprocal predicates.

of the verb *attack* is described by a binary protopredicate $\textbf{attack}^b$.[13] The binary relation in (22) is one possible denotation of the protopredicate $\textbf{attack}^b$. Other non-symmetric transitive verbs (*admire, see*) and non-symmetric relational nouns and adjectives (*boss of*, *fond of*) receive a similar treatment using binary protopredicates.

As Dowty points out, something quite different must be said on relational expressions like the verb *marry*, the noun *friend* (*of*) or the adjective *identical* (*to*). The situations that these relational expressions categorize are "inherently symmetric": the participants in them cannot be distinguished in terms of their protoroles. For instance, in monogamic *marriage* events, the bride and the groom participants are singled out as having equal protoroles: they are both "agent-like" and "patient-like" to the same degree.[14] In situations that instantiate the concepts of Friendship and Identity we see a similar kind of "protorole symmetry" imposed on the participants. In such cases, both participants are equally agent-like and patient-like. With such concepts and situations there is no point in distinguishing different protoroles. Accordingly, in such cases we let each participant receive one and the same role, which we denote "$\mathbf{r}_{1\text{-}2}$" (see Siloni 2012 for a similar proposal).

To illustrate, consider the following marriage situations.

(23) Marriage 1: Each of A and B has the role $\mathbf{r}_{1\text{-}2}$.
Marriage 2: Each of C and D has the role $\mathbf{r}_{1\text{-}2}$.

This describes marriages between A and B and between C and D, which are described by the following sentences.

(24) a. A&B married (alternatively: *A married B*, or *B married A*).
b. C&D married (alternatively: *C married D*, or *C married D*).

The protopredicate corresponding to these two marriages is the following:

(25) $\{\{A,B\},\{C,D\}\}$

[13] The same protopredicate would also be useful for nouns like *attack* (*of*) and *attacker*. The analysis should be adjusted to deal with event arguments, a point that is ignored here for the sake of simplicity. However, events fit into the current framework without special problems (Winter & Zwarts 2013).

[14] Of course, in actual marriages there may be notable asymmetry in the actual roles of these two participants, e.g. in some religious ceremonies, in forced marriages etc. However, this is irrelevant for the analysis of the verb *to marry*.

More generally, in each marriage situation, we assume that the bride and groom form one set of participants, whose members are not distinguished by their protoroles. Such protopredicates are called "collective" and are assigned the type c. Accordingly, a protopredicate **P** of type c is denoted $\mathbf{P}^c$. For both intransitive and transitive guises of the verb *marry*, we employ one and the same collective protopredicate, denoted $\mathbf{marry}^c$. The collectivity of the protopredicate $\mathbf{marry}^c$ is viewed as the origin for the inherent symmetry of the transitive verb *marry*: since the protopredicate does not distinguish different roles, we expect all participants to be equally licensed in different argument positions.

Here it should be noted that b-type protopredicates like **attack** do definitely *allow* situations that do not distinguish participants in terms of their protoroles. For instance, in one of the situations described in (22) above, E attacked herself. In this situation, E has both roles $\mathbf{r}_1$ and $\mathbf{r}_2$, hence the two protoroles are not extensionally distinguished. However, as illustrated by the other situations in (22), there is no restriction that *forces* b-type protopredicates to show "protorole symmetry". For this reason, transitive verbs like *attack* are correctly treated as non-symmetric: in some models (though not in all models) their denotations are non-symmetric binary relations.

As we shall see below, the postulation of collective protopredicates allows us to immediately derive plainR alternations, similarly to Lakoff & Peters' proposal. How about pseudoR alternations? To account for these alternations using Dowty's notion of protoroles, we need to also characterize protopredicates for verbs like *hug*. We view such protopredicates as unions of b-type and c-type protopredicates. To see what that means, let us reconsider the two guises of the verb *hug*. In its collective guise, it is very much like *marry*: it has two participants with no difference in their protoroles. Thus, when we say that *Sue and Dan hugged*, we do not grammatically convey any difference between their activities. By contrast, when using the sentence *Sue hugged Dan*, we report a protorole distinction: Sue was active and Dan was (possibly) passive. For our system to describe situations with the two different senses of *hug*, we employ a "mixed" collective-binary type for protopredicates. Protopredicates of this type describe hugs like the following, where $\mathbf{r}_1$="agent-like", $\mathbf{r}_2$="patient-like", and $\mathbf{r}_{1\text{-}2}$="collective".

(26) Hug 1: A has role $\mathbf{r}_1$ and B has role $\mathbf{r}_2$.

Hug 2: B has role $\mathbf{r}_1$ and A has role $\mathbf{r}_2$.
Hug 3: Each of C and D has three roles: $\mathbf{r}_1$, $\mathbf{r}_2$ and $\mathbf{r}_{1\text{-}2}$.
Hug 4: Each of E and F has role $\mathbf{r}_{1\text{-}2}$, and in addition, E has role $\mathbf{r}_1$, and F has role $\mathbf{r}_2$.

In Hugs 1 and 2, one participant is active and the other is passive. Hug 3 is a prototypical "collective-reciprocal hug": the two participants are collectively engaged, and they are both actively engaged and passively engaged. Therefore, both of them have the collective role $\mathbf{r}_{1\text{-}2}$ as well as the roles $\mathbf{r}_1$ and $\mathbf{r}_2$. By contrast, Hug 4 is an atypical "collective hug" without reciprocity: both participants still have the collective role, but only one of them is actively hugging the other one (see e.g. Figure 1). The situations described in (26) support the following sentences, respectively.

(27) a. A hugged B.
b. B hugged A.
c. C&D hugged; C hugged D; D hugged C.
d. E&F hugged; E hugged F.

The protopredicate corresponding to the situations in (26) is made of the following items, possibly mixing sets and ordered pairs:

Hug 1 corresponds to the ordered pair $\langle A, B\rangle$.
Hug 2 corresponds to the ordered pair $\langle B, A\rangle$.
Hug 3 corresponds to the set $\{C, D\}$ and the ordered pairs $\langle C, D\rangle$ and $\langle D, C\rangle$.
Hug 4 corresponds to the set $\{E, F\}$ and the ordered pair $\langle E, F\rangle$.

In sum, we get the following protopredicate:

(28) $\{\langle A, B\rangle, \langle B, A\rangle, \{C, D\}, \langle C, D\rangle, \langle D, C\rangle, \{E, F\}, \langle E, F\rangle\}$

The example in (28) mimics "collective-nondirectional hugs" using sets such as $\{C, D\}$ and $\{E, F\}$, and "binary-directional hugs" using ordered pairs such as $\langle A, B\rangle$ and $\langle C, D\rangle$. To distinguish such "mixed" protopredicates from *b* and *c* protopredicates, we use the type *bc*. Thus, for the verb *hug*, in both its transitive and intransitive guises, we employ the protopredicate $\mathbf{hug}^{bc}$.[15]

[15] Note that unlike binary and collective protopredicates, a "mixed" binary/collective protopredicate may have a couple of items per situation, as it is the case for the collective Hugs 3 and 4 in (26), which contribute both sets (e.g. $\{C, D\}$) and ordered pairs (e.g. $\langle C, D\rangle$) to

So far we have described three types of protopredicates: b, c and bc. To explain how such protopredicates are interpreted, and derive denotations of lexical predicates, we define their denotations in a general way. Definition (29) below specifies protopredicate denotations. In this definition, the notation $\wp^2(E)$ stands for the set $\{A \subseteq E : |A| = 2\}$ of all doubleton subsets of E, i.e. all the subsets of E that are made of precisely two members.

(29) Let **P** be protopredicate of type b, c or bc. Let E be a non-empty set of entities. A **denotation** of **P** over E contains at least one of two parts: a Binary part and Collective part, denoted $[\![\mathbf{P}]\!]^B$ and $[\![\mathbf{P}]\!]^C$, respectively. These parts are defined below for protopredicates of the three types b, c and bc.

$\mathbf{P}^b$:	$[\![\mathbf{P}^b]\!]^B \subseteq E^2$	$[\![\mathbf{P}^b]\!]^C$ is undefined
$\mathbf{P}^c$:	$[\![\mathbf{P}^c]\!]^B$ is undefined	$[\![\mathbf{P}^c]\!]^C \subseteq \wp^2(E)$
$\mathbf{P}^{bc}$:	$[\![\mathbf{P}^{bc}]\!]^B \subseteq E^2$	$[\![\mathbf{P}^{bc}]\!]^C \subseteq \wp^2(E)$

This definition generalizes what is illustrated in (22), (25) and (28) above. For the predicate $\mathbf{attack}^b$, the denotation (22) only contains pairs, and no collections. For the predicate $\mathbf{marry}^c$, the denotation (25) only contains collections, and no pairs. For the predicate $\mathbf{hug}^{bc}$, the denotation (28) contains both collections and pairs.

From denotations of protopredicates we derive denotations of actual predicates in the lexicon. Specifically: from the denotation of the protopredicate **attack**, we derive a denotation for the transitive verb *attack*; from the denotation of **marry**, we derive denotations for the transitive and intransitive guises of the verb *marry*; from the denotation of **hug**, we derive denotations for the transitive and intransitive guises of the verb *hug*. In most cases this is quite straightforward, as illustrated below.

1. *Collective predicates*: The intransitive verb *marry* denotes the C part of the denotation of **marry**, i.e. the whole denotation. The intransitive verb *hug* denotes the C part of the denotation of **hug**. For example,

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the protopredicate denotation in (28). This multiple use of situations is not represented in the collection in (28). However, when we add events to the protopredicate, we should index items like $\{C, D\}$, $\langle C, D\rangle$ and $\langle D, C\rangle$ using the same event – the one entity that corresponds to Hug 3 in (26). By contrast, the pairs $\langle A, B\rangle$ and $\langle B, A\rangle$ in Hugs 1 and 2 should be indexed by different events.

from (28) we only select the sets {C, D} and {E, F} for the intransitive guise of *hug*.

2. *Binary non-symmetric predicates*: The transitive verb *attack* denotes the *B* part of the denotation of **attack**, i.e. the whole denotation. The transitive verb *hug* denotes the *B* part of the denotation of **hug**. For example, from (28) we select the pairs ⟨A, B⟩, ⟨B, A⟩, ⟨C, D⟩, ⟨D, C⟩ and ⟨E, F⟩ for the transitive guise of *hug*.

The *b* protopredicate **attack** derives no intransitive collective entry, since its *C* part is undefined. By contrast, for the *c* protopredicate **marry** we do have a method for deriving a transitive entry from the *C* part. This illustrates a third strategy for *binary symmetric predicates*. It is similar to the transformational rule proposed by Lakoff & Peters (cf. (19)):

3. The transitive verb *marry* denotes the set of pairs: $\{\langle x, y\rangle : \{x, y\} \in [\![\mathbf{marry}^c]\!]^C\}$.

In words, these are the pairs whose elements constitute doubletons in the denotation of the protopredicate **marry**. In (25), those pairs are ⟨A, B⟩, ⟨B, A⟩, ⟨C, D⟩ and ⟨D, C⟩. Note that such a denotation is by definition symmetric, as explained in section 4 in relation to Lakoff & Peters's proposal.

The last strategy above, which was illustrated for the *c*-type protopredicate **marry**, is also useful for *bc* protopredicates like **hug**. In other languages, pseudo-reciprocals like *hug* are associated with an entry "hug with", where "A hugs with B" means the same as *A&B hug*. For English, we observed a similar strategy with the verb *talk with*: in contrast to the non-symmetric item *talk to*, which stands in a pseudoR alternation to collective *talk*, the symmetric binary predicate *talk with* stands in a plainR alternation to this collective predicate. Greek and Hebrew are languages that have a more productive "comitative" strategy for deriving verbs in such plainR alternations to collective predicates (see section 6). Formally, such binary "hug with" or *talk with* predicates are derived from *bc* protopredicates in the same way that transitive *marry* is derived above from the *c* protopredicate **marry**. For instance, if **hug** is a *bc* protopredicate with the set {A, B} and the pairs ⟨A, B⟩ and ⟨C, D⟩, then a binary verbal form "hug with" will contain both pairs ⟨A, B⟩ and ⟨B, A⟩: the two ordered pairs for whose members a "collective hug" is encoded by a set in the protopredicate. By contrast, the denotation of the transitive verb *hug* will contain $\langle A, B\rangle$ and $\langle C, D\rangle$: the two ordered pairs whose "directional hugs" are encoded by ordered pairs in the protopredicate. This accounts for the observation by Winter et al. (2016) that a situation as in Figure 1 is a collective hug, despite the lack of one directional hug. In this sense, binary relations like Hebrew/Greek "hug with" and English *talk with* behave similarly to the intransitive/collective *hug* and *talk*, rather than to the transitive/binary *hug* and *talk to*.

To summarize, three different strategies were used for deriving denotations of predicates from denotations of protopredicates:

- A unary-collective strategy (UC): with c and bc protopredicates.
- A non-symmetric binary strategy (BNS): with b and bc protopredicates.
- A symmetric binary strategy (BS): with c and bc protopredicates.

When applied to the proto-predicates in (22), (25) and (28), these strategies lead to the predicate denotations below ("xy" abbreviates "$\langle X, Y\rangle$"):

attack^b: From the protopredicate denotation $\{ab, dc, ee\}$ in (22) we derive:

UC: –
BNS: $[\![attack_{tv}]\!] = \{ab, dc, ee\}$
BS: –

marry^c: From $\{\{a, b\}, \{c, d\}\}$ in (25) we derive:

UC: $[\![marry_{iv}]\!] = \{\{a, b\}, \{c, d\}\}$
BNS: –
BS: $[\![marry_{tv}]\!] = \{ab, ba, cd, dc\}$

hug^c: From $\{ab, ba, \{c, d\}, cd, dc, \{e, f\}, ef\}$ in (28) we derive:

UC: $[\![hug_{iv}]\!] = \{\{c, d\}, \{e, f\}\}$
BNS: $[\![hug_{tv}]\!] = \{ab, ba, cd, dc, ef\}$
BS: $[\![hug\_with]\!] = \{cd, dc, ef, fe\}$

Generalizing this example, we get the following definition for the three general derivational strategies.

(30) Let **P** be a protopredicate of type b, c or bc, with a denotation $[\![\mathbf{P}]\!]$. From **P** we derive a collective predicate denotation $P^{uc}_{\mathbf{P}}$ and two binary predicate denotations $R^{bns}_{\mathbf{P}}$ and $R^{ns}_{\mathbf{P}}$. This is defined as follows:

$$P^{uc}_{\mathbf{P}} = [\![\mathbf{P}]\!]^C = \text{the collective part of } \mathbf{P}\text{, if defined}$$
$$R^{bns}_{\mathbf{P}} = [\![\mathbf{P}]\!]^B = \text{the binary part of } \mathbf{P}\text{, if defined}$$
$$R^{bs}_{\mathbf{P}} = \{\langle x, y\rangle : \{x, y\} \in [\![\mathbf{P}]\!]^C\} = \text{the symmetric predicate based on the collective part of } \mathbf{P}\text{, if defined}$$

An important feature of this system is that it does not presuppose any logical connection between the "B-part" and the "C-part" of protopredicates of type bc. For instance, nothing in the system so far forces protopredicate denotation as in (28) to include the pair $\langle \text{A}, \text{B}\rangle$ when they include the doubleton $\{\text{A}, \text{B}\}$. This means that nothing rules out situations in which *A&B hugged* is modelled as true but *A hugged B* is modelled as false. This is an intentional architectural decision, which is supported by the observations in section 3, showing the lack of logical relations between collective *hug* and binary *hug*. Any restrictions on protopredicates on top of the ones that result from their type are assumed to follow from specific features of the specific concepts they describe. For instance, in relation to the protopredicate **hug**, for two people to be considered "hugging", it might look plausible to assume that each of them is hugging the other one, as virtually all works on the topic have assumed (Dimitriadis 2008, Siloni 2012). However, as Winter et al. (2016) show, it would be too strong to require that each of the two people in a "collective hug" is hugging the other. The maximum we can require with respect to a sentence like *A&B hugged* is that one of the participants hugged the other, whereas the other collaborated in some way or another. By contrast, in relation to a protopredicate like **fall in love**, it is quite likely that when a sentence like *A&B fell in love* is asserted under its collective reading, each of the participants is required to fall in love with the other one. Such differences between the pseudo-reciprocal predicates *hug* and *fall in love* are not encoded in the types of their protopredicates, which are bc in both cases. In the proposed system, any semantic connections between the collective entry and the binary entry of verbs like *hug*, *kiss* and *fall in love* must emanate from properties of the underlying concepts, and not from any grammatical mechanism like the type of protopredicates we assign to these verbs.

The system described above formally specifies types of protopredicates and the restrictions they put on their denotations (29), as well as three methods to use them for deriving denotations for natural language predicates (30). With this formal system, we can establish that the Reciprocity-Symmetry

Generalization in (15) follows as a corollary. To do that, we restate the RSG as the following property of the system we have defined.

(31) **Reciprocity-Symmetry Generalization (RSG, formal):** Let $\mathbf{P}$ be a protopredicate of one of types c or bc, with P and R the corresponding predicates s.t. $P = P^{uc}$ and R is either $R^{bns}_{\mathbf{P}}$ or $R^{bs}_{\mathbf{P}}$. The following conditions are equivalent:

(i) In every model, $[\![R]\!]$ is a symmetric relation.

(ii) In every model, $\{x, y\} \in [\![P]\!]$ iff $\langle x, y\rangle \in [\![R]\!]$ and $\langle y, x\rangle \in [\![R]\!]$.

Proof: For clarity, we abbreviate $R^{bns} = R^{bns}_{\mathbf{P}}$ and $R^{bs} = R^{bs}_{\mathbf{P}}$. There are two cases to consider:

1. $\mathbf{P}$ is of type c. In this case $R = R^{bs}$ by definition, since R^{bns} is undefined. And any R^{bs} satisfies (i) and (ii) by definition.
2. $\mathbf{P}$ is of type bc. If $R = R^{bs}$, then again, (i) and (ii) are both satisfied in every model. Otherwise $R = R^{bns}$. In this case neither (i) nor (ii) holds, because: a model where $[\![\mathbf{P}^{bc}]\!] = \{\langle c, d\rangle\}$ makes $[\![R^{bns}]\!]$ non-symmetric, hence (i) is false; and a model where $[\![\mathbf{P}^{bc}]\!] = \{\langle c, d\rangle, \langle d, c\rangle\}$ derives $[\![R^{bns}]\!] = \{\langle c, d\rangle, \langle d, c\rangle\}$ and $[\![P^{uc}]\!] = \emptyset$, hence (ii) in false.

We conclude that (i) and (ii) are equivalent. Thus, the RSG is supported by the protopredicate system we have defined. Specifically, in this system, artificial predicates like *Xhug* and *Xtalk* in (16) and (17) above cannot be derived.[16]

[16] A sophisticated question here would be to ask why some bc protopredicates should not still be restricted by additional meaning postulates, which might create plainR or symmetry effects that do not follow from the type system. The current approach, and the proof above, rely on the assumption that such meaning postulates are not available. Since languages are assumed to own a type system that encodes the conceptual property of "collectivity" by the label c, they are assumed not to encode plainR or symmetry by predicate-specific meaning postulates. See section 6 for further implications of this assumption in relation to symmetry.

6 Some outstanding issues

This section makes some final remarks on critical issues for further work on reciprocity, symmetry and the mental lexicon.

Sets with more than two members, and Irreducible Collectivity. As Goodman (1951) observes, sentence (32a) below is interpreted differently than (32b) (see also Lasersohn 1995).

(32) a. A, B and C are similar.
b. A is similar to B, B is similar to C, and C is similar to A.

While (32a) strongly favors situations where A, B and C share one property, sentence (32b) does not: (32b) is also true if the members of each of the three pairs share different properties. Further, the sentences in (33a) below require that A, B and C share one opinion, one pair of grandparents, and one (material or non-material) asset. In contrast, (33b) allows different opinions, grandparents and assets to be associated with each of the three pairs.

(33) a. A, B and C agreed/are cousins/are partners.
b. A agreed with/is cousin of/is partner of B, and
B agreed with/is cousin of/is partner of C, and
C agreed with/is cousin of/is partner of A.

We here see that the collective use of predicates like *similar, agree, cousin* and *partner* is more expressive than what their binary forms allow. This is evidence that denotations of collective predicates are basic, and irreducible to reciprocal quantification. As such, they are free to exhibit what Searle's (1990) calls *collective intentionality*: "collective behavior that cannot be analyzed just as the summation of individual intentional behavior". With some predicates, like *agree* and *hug*, collective intentionality is part of the verb's meaning. With other collective predicates, like *cousin*, there is little intentionality that is involved, but still, the collectivity in sentences like (33a) cannot be reduced to reciprocal statements as in (33b).[17] Accordingly, the current paper adopts a general linguistic interpretation of Searle's thesis

[17] Ginzburg (1990:144) and Dalrymple et al. (1998:181) observe that this may also be true for some cases of binary predicates with *overt* reciprocals. E.g. *the gravitational fields of the Earth, the Sun and the Moon cancel each other out* means that each field cancels out the combined fields of the two other bodies, not that every two gravitational fields cancel out

about collective intentionality. Protopredicates induce collectivity as a lexical primitive, which is not explained in terms of any relational concept. Quite the contrary, the binary-symmetric (BS) strategy derives symmetric binary predicates from collective protopredicates. This means that we can analyze symmetric binary predicates like *similar to*, *cousin of* etc. as being derived from the meanings of collective concepts, but not the other way around. In contrast, for pseudoR reciprocals, both the non-symmetric binary meanings and the collective meanings are conceptual primitives: neither of them can be analyzed in terms of the other.

Plain reciprocity and comitative prepositions. The view on plainR alternations in this paper follows Lakoff & Peters's early proposal that meanings of symmetric binary predicates are derived from collective predicates. Lakoff & Peters attribute this to the comitative *with* in constructions like *Sue built the raft with Dan*. Dimitriadis (2008) and Siloni (2012) go further than that, and suggest that Hebrew and Greek have a construction that they call "discontinuous reciprocals". For Dimitriadis and Siloni, a Hebrew sentence like *sue hitxabka im dan* (Sue hugged-fem. with Dan) has the meaning of "Sue and Dan hugged" by virtue of a regular derivational strategy for *im* ("with") constructions. The current approach is both narrower and wider than the approaches by Lakoff & Peters and Dimitriadis/Siloni. Unlike these approaches, I have not assumed that plainR alternations are morphosyntactically regular, but rather that they are derived by an optional lexical rule, which may or may not be operational for each *c*-type and *bc*-type protopredicate. In this sense, the current proposal narrows down the role of grammatical and logical semantic mechanisms, and leaves more room for lexical irregularity with prepositions like *with* and *im*. This is advantageous as an account of the observed facts.[18] On the other hand, the present ap-

(Dalrymple et al.). This requires extending Dalrymple et al.'s analysis of overt reciprocals, which can here be done by using the *unary*-collective meaning of *cancel out*. The precise way of doing that requires further research.

[18]Pace Lakoff & Peters, binary English forms like *collide with* and *be/fall in love with* are non-symmetric, and pseudoR with their reciprocal forms. Pace Siloni, Hebrew binary forms as in *A hitya'ec im B* ('A asked B for advice') are non-symmetric and don't have the same meaning as *A&B hitya'acu* ('A&B conferred-pl'), i.e. this is another case of pseudoR rather than plainR/discontinuous reciprocity. Similarly for *histaxbek im* _ ('treat _ friendly') vs. *histaxbeku* ('treat each other friendly') and *hitxašben im* _ ('engage in bookkeeping with _') vs. *hitxašbenu* ('do bookkeeping with each other'). A lexicon-based approach to the

proach to plainR alternations is wider than previous accounts in that it is not restricted to verbal predicates. Plain reciprocity is used as a canonical lexical strategy for forming symmetric binary predicates from collective protopredicates, also with relational nouns and adjectives.[19]

Predicates, protopredicates, concepts, and polysemy. The present approach assumes three levels of cognitive representations. At the bottom of this "mental hierarchy" there are *concepts*: the mental representations that allow humans to categorize objects and situations in the physical world. Following Dowty's intuitions, it is assumed that once a situation is categorized by a concept, the participants in that situation are assigned protoroles according to the part that they play in it. These protoroles are encoded in what I called *protopredicates*. Only the results of this encoding are visible to derivational mechanisms that form lexical denotations of actual *predicates* in natural language. Of course, this leaves much room for the conceptual system to create meaning effects that are not linguistically encoded. Especially, as we saw, speakers have a tendency to assume that if *A&B hug*, then A must be hugging B and vice versa. This tendency is proposed to appear by virtue of the typical preferences of a collective concept Hug_C. These preferences connect this collective concept to another concept, the binary concept Hug_B. It is only the *bc* protopredicate **hug** that amalgamates the two concepts. However, the typical connections between the concepts Hug_C and Hug_B are not by virtue of any property of the protopredicate **hug** or entries of the verb *hug*. In a way, it may be justified to say that *hug* is a polysemous verb in English, where the two senses are also linguistically distinguished by the

meaning of *im* and *with*, which is consistent with these facts, would be to propose that <u>if</u> there is any symmetric/plainR binary form, the *with* paradigm must express it in cases where it is grammatical. However, predicates formed by *with* may also be non-symmetric and show pseudoR alternations if no other form takes the symmetric/plainR strategy. Thus, *collide with* is only allowed to be pseudoR and non-symmetric by virtue of the fact that the verb *collide* has no plainR alternate. By contrast, we do not expect to find languages with alternations like "talk to/with", where the comitative form takes the meaning of the "to" form in English, and the symmetric/plainR meaning of English "talk with" is taken up by some non-comitative morpheme. Whether Greek has a more regular strategy for "discontinuous reciprocity", as Dimitriadis suggests, is a question for further research.

[19] By contrast, the pseudoR strategy seems to be restricted to verbs, at least in English and Hebrew. Why this should be the case and whether the same holds for other languages, are questions for further research.

verb's transitivity or intransitivity. The systematic relations between the two senses should not surprise us, but so is the fact that those relations are not logically definable. This is similar with other cases of polysemy, where different senses of polysemous words are systematically related (Pustejovsky 1995). However, such connections between lexical senses often resist sharp definitions of the sort that is usually favored by generative grammarians and formal semanticists. The lack of logical regularities with the *hug* variety of pseudoR predicates is a reason to adopt the proposed "polysemy" approach to this class of verbs. Obviously, the full empirical details about this sort of polysemy and its theoretical significance still require further research.

The RSG as a language universal. Throughout this paper, it has been suggested that symmetry of predicates in plainR alternations follows from their derivation from a collective protopredicate. However, nothing was said about symmetric predicates that do not have reciprocal alternates. As was commented above, English has some such predicates, which is illustrated below.

(34) a. A resembles/is near (close to)/is far from B ⇔ B resembles/is near (close to)/is far from A.

b. #A&B resemble/are near (close)/are far. (no collective reading)

The predicates *resemble*, *near*/*close* and *far* have symmetric binary forms (34a). However, unary usages of these predicates cannot be interpreted collectively, if they are interpretable at all. This is demonstrated by the lack of collective readings in (34b) (on *close*, see footnote 21). The RSG in its formulation in (15) only deals with *pairs* of predicates where one predicate (called "*P*") is collective, hence it says nothing about symmetric binary predicates as in (34a). While this is descriptively OK for English, it does raise a question: what is the origin of the symmetry of such predicates? I would like to speculate that denotations of such symmetric predicates are also derived from *c*-type protopredicates. English, possibly for historical reasons, may not have used those protopredicates for deriving collective entries, but it does have the potential to do that. If this line of reasoning is correct, the lack of collective entries for these predicates in English may be seen as some sort of a lexical accident. To substantiate this line, we may like to adopt the following speculation, which strengthens the RSG into a language universal.

(35) **Symmetry as collectivity**: *All symmetric binary predicates, in all natural languages, are derived from collective concepts through c-type protopredicates and the symmetric-binary (BS) strategy.*

A way to support this speculation would be to show the following:

(36) **The symmetry-collectivity conjecture**: *If a language L_1 has a binary symmetric predicate R without any collective alternate, then there exists another language, L_2, where the near translation of R does have a collective alternate.*

Apparently, this conjecture is correct for near parallels of *far* and *resemble* in Greek.[20]

(37) a. i Thessaloniki apexi apo tin Athina
the Thessaloniki-nom.sg be-far.pres.3.sg from the Athens-acc.sg
"Thessaloniki is far from Athens"

b. i Thessaloniki ke i Athina apexun (poli/arketa)
the Thessaloniki.nom.sg and the Athens.acc.sg be-far.pres.3.p (somewhat/very)
"Thessaloniki and Athens are (somewhat/very) far from each other"

(38) a. o Janis mjazi ston Kosta
the Janis.nom.sg resemble-pres.3.sg to.the-acc.sg Kostas-acc.sg
"Janis resembles Kostas"

b. o Janis ke o Kostas miájun
the Janis-nom.sg and the Kostas-nom.sg resemble-pres.3.pl
"Janis and Kostas are similar to each other/look alike"

Such data may be used for supporting the conjecture in (36).[21] Needless to say, any substantial attempt to test this conjecture would require more

[20] In (37b), the adverbials *poli/arketa* 'somewhat/very' may help to boost the reciprocal interpretation, but apparently they are not obligatory. I thank Eleni Tsouloucha for pointing out to me these Greek examples.

[21] The Hebrew adjective for "near" is another piece of evidence: *shtey ha-nekudot krovot* (two the-points near-fem.plu) is ambiguous: "the two points are near each other/a relevant point". Further support may come from English itself. For *resemble* there is also the English collective parallel *similar*. Additionally, one sense of English *near/close* – as in *a near/close friend* – has a collective parallel in cases like *we have been close since we were kids* (apparently, *near* is not very acceptable in such constructions).

specific efforts to compare reciprocal and symmetric predicates in different languages, which would have to go further beyond the extensive typological knowledge on reciprocals that has accumulated over the last 20 years (Frajzyngier & Walker 2000, Nedjalkov 2007, König & Gast 2008, Evans et al. 2011).

7 Conclusion

The complex relations between symmetry and lexical reciprocity have been analyzed in detail, and given rise to a novel foundational observation, the Reciprocity-Symmetry Generalization. The semantic analysis of the RSG motivates Dowty's conception of proto-roles as a lexical engine that formally explains reciprocal alternations, at the interface between mental concepts and lexically interpreted forms.

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